POLICY PAPER

PIGGERY SECTOR IN INDIA

Potential, Policy Implications and Emerging Paradigms

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Santanu Banik, Rajib Deb, Bhupendra Nath Tripathi

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Policy Paper on Piggery Sector in India - Potential, Policy Implications and Emerging Paradigms

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Preface

In an increasingly interconnected and dynamic world, the agri-food sector stands as a vital pillar of economic growth, food security, and cultural heritage. Within this vast landscape, the pig and pork sector occupy a pivotal position, contributing significantly to both global agricultural production and consumer demands.Scientific piggery could not only contribute towards piling-up of quality animal protein at affordable prices in India but also could help in achieving multiplying the income of farmers in short periods.

This policy paper delves into the multifaceted dimensions of the pig and pork industry, exploring its significance from economic, environmental, social, and nutritional perspectives. By examining the challenges and opportunities faced by stakeholders across the value chain, from farmers to processors and consumers, this paper aims to provide a comprehensive understanding of the sector's current state.

With a focus on sustainable development, animal welfare, trade dynamics, and evolving dietary preferences, this policy paper aspires to illuminate pathways for policymakers, industry leaders, and researchers to collaboratively chart a course toward a resilient and responsible future for the pig and pork sector. By blending empirical research with strategic insights, we endeavor to foster informed decision-making and promote dialogue that nurtures a balance between growth, ethical considerations, and the well-being of both the industry and society at large.

The present policy paper has discussed a number of issues related to strengthening the competitiveness of the multi-dimensional issues associated with piggery value chain in India, and has suggested some policy reforms and interventions that are necessary for the sustainability and viability of this sector. I am sure that this paper will be useful to a wider sector of the society in understanding the issues related to piggery sector in India – their potential, policy implications and emerging paradigms.

Vivek Kumar Gupta
Director

1
Scope of the Paper

The policy paper addresses the rapidly evolving commercial piggery sector of India and their growth potential as a means to achieve doubling farmers' income at a much faster pace. We put the development of this sector within the context of the complex social and policy environment in India and illustrate the key issues that confront the future development of this sector. The paper assesses the broad ramifications of the rapid and large-scale development of commercial piggery sector in India with the objective of identifying production potential and constraints in pig rearing. It covers the range of breeding and feeding stocks, new and emerging trans-boundary diseases, postharvest management, etc. that are being considered currently very important by the stakeholders, and discusses their current growth potential, as well as the economic factors that enhance or limit their future growth. Besides, addressing a number of issues related to the competitiveness of the different sectors associated with the piggery value chain, it also highlights some policy reforms and interventions that seem to be necessary to the future efficiency and continued viability of this sector.

2
Background

Pigs are domesticated in various parts of India, especially in the South-Central and North Eastern Regions (NER), each place has its own locally adapted pig breed, and most households raise at least one or two pigs each year. Pigs are more valuable alive than dead, acting as efficient converters of kitchen and agricultural scraps into nutrient-rich fertilizer, before becoming pork. Pigs are sometimes given as a wedding gift, used for political or social favor, or eaten as part of local celebrations, especially in NER. Although the long tradition of pork consumption in India includes variation across different times, places and social relations, the smallholder model of raising pigs as part of diverse crop and livestock agro-ecosystems, coupled with only occasional meat eating, defines much of the country's pig and pork history. The 21st century agricultural and dietary changes, however, represent radical departure from the small holder production system to consolidation of industry, which is clearly visible in the last two decades. It should be noted that the industrialization of pig production is a relatively recent phenomenon globally. In India too, the speed and scale of change has been phenomenal, conditioned by policies, investments and the transforming economic system.

Pig population and distribution scenario

According to the 20th livestock census of India, the country's pig population is 9.06 million in comparison to the world population of about 900 million. Majority of pig population of the world is in China (~48%) followed by United States of America (~6.5%), Brazil (~4%), Germany (~2.8%) and Vietnam (~2.7%). The position of India in pig production within Asia is also below the top five viz. China, Vietnam, Philippines, Japan, and Indonesia. India's contribution to the total pig production in Asia is about 1%, while China alone contributes more than 80%. The pig population in India had a positive trend over all the duration till the year 2000, except during 1960s. However, during the past 15 years, the growth rate in pig population in India was found to be negative. The reasons might be multi-faceted, but the major ones are surely the socio-cultural inhibition and inadequate financial availabilities. Therefore, the challenge is to reverse the declining growth trend through the application of latest science, technology and innovation, and institution of development measures.

Pig is widely distributed in all the eco-regions of the country and is an important occupation of the rural society especially the tribal masses. People of certain

ethnic groups in the country prefer to keep pigs, especially the black coloured ones, for festivals and ceremonial purposes. The highest pig population is observed in eastern and north eastern (NE) states, followed by the northern, southern, central and western India. The highest population is in Assam (2.10 million), succeeded by Jharkhand (1.28 million), Meghalaya (0.71 million) and West Bengal (0.54 million). The northeastern regions houses about 40% of the pig population of the country. Indigenous non-descript pigs (79.03%) mainly cornerstone the pork production in India followed by crossbreds and exotic germplasm (20.97%).

Current structure of pig farming in India

Besides differing farm types (backyard, commercial), there are two basic sets of pig farm structures in India. The first set consists of government-operated breeder farms that supply pigs to local farms. The State governments operate considerable number of breeder farms, which then supply pigs to smaller local producers. These government breeder farms typically operate on a single-site farrow-to-finish farm system and are usually run at a 10-50 sow unit capacity. A wide range of exotic pig breedsfrom the Europe and the United States have been introduced in these governmentfarms in the past decades. The production farms supplied from government pig breeder farms are typically small commercial or backyard farms consisting of 2 to5 sows withon-site finishing capacity. The germplasm supplied includes the crossbreds of Landrace, Large White, Hampshire, and Duroc breeds. The on-farm data from the producers' field indicates that pig growth rates, sow fertility, meat quality and feed conversion ratio of these cross breds were not comparable to original performances of these breeds in their home track. Besides these State government run pig farms, there exist over 20 numbers of pig farms under All India Coordinated Research Projects (AICRP) and Megaseed production units on Pig in different agro-climatic conditions of the country. The performance of these units are monitored and evaluated by ICAR-National Research Centre on Pig. These AICRP units, through their work, have developed 10 crossbred varieties, using locally adaptable pig germplasmwith exotic breeds viz.Landrace, Hamphshire, Yorkshire, etc, for further propagation in the respective agro-climatic zones.

The second type of pig farm structure in India is that of private or semi-private farms. The numbers of such farms are still low in most parts of the country, but emergence of private farms is inevitable for consolidation of pig farming. Larger farms are considered more resilient to transient costs and price issues. Currently, the private farms are mostly concentrated on such locations having proximity to lean-pork markets and/or to the major cereal

crop production areas. Despite the ever existing demand for local pork, there is a growing demand for leaner pork. The new cross-bred lines/varieties developed from crossing of indigenous and exotic breeds have proved more popular locally, because of improved weight, reduced back-fat and improved lean carcass percentage. The widespread backyard farm segment in India tends to produce many fatty local-breed pigs, sold to local markets, especially in more rural areas. However, these native pig breeds have generally not formed part of expansion/consolidations by the commercial private farms, probably due to their slower growth rates and low feed conversion efficiencies.

In general, there are three types of pig farms in India based on the numbers of pigs produced on the farm; small (including backyard farms, <10 head), medium (50-200 head), and large (> 200 head). With urbanization and production efficiency, Indian pig and pork production is slowly shifting from backyard and small farms to specialized household (or local community) farms as well as modern intensive farms, especially in the urban areas close to cities.

Small size pig farm: In India, the small size pig farms including the backyard pig farms are most popular. A small size pig farm has an average herds size of less than 10 pigs; a backyard farm may haveonlya few pigs. Even though, backyard farms accounts for about 65% of the nationwide pig production, it is estimated that over 90% of the pig producers exist in rural household having an average of 3-5 head per household. In general, pigs housed in small farms are usually indigenous breeds or hardy crossbreds and reared under low-inputs. Pork production is low, mostly used for home consumption or supplied predominantly in rural markets (local community) with limited competition. The traditional pig farming practices followed in these units laylittle emphasis on quality and efficiency of pork production. The pigs reared in the traditional farms are usually fed with little grainsand large amounts of locally available green roughage (water plants, grass, vegetable leaves, tubers, carrots, pumpkins, fruits, and various crop stalks). This diet lacks essential nutrients, especially protein, resulting in a low feed efficiency. It is a low-cost production system taking over 300 days for pigs to reach slaughter weight, and hence generating low net income.

In traditional rural farming system, the management and welfare of pigs are largely dependent on their economic status, animal-related experiences, religion, education, etc. The small pig farmers are usually unable to cope up the issues arising from associated social, economic and environmental factors. To overcome these problems and to meet consumers' demand for lean and "healthful" meat, pig production in India need to move towards specialization by adopting more modern management practices toimprove

feed efficiency for enhanced pork production.

Medium size pig farm: The second type is the medium size pig farm that raises herds from 50 to 200. Currently, this production system houses approximately 30% of the total pigs in India. There was a substantial increase in the medium size pig farms in India during the past 10 years (approximately >250%). Taking advantage of increased demand for pork and pork products in local markets, many educated youths as well as rural households have shifted their focus to increasing the herd size for better economic returns. Now, the aim of farming is shifted to capital gain by providing balanced production ration for improved feed efficiency and reduced time to reach slaughter weight.

In order to increase the pork production, the farmers' focus is upon improving the welfare of pigs by controlling and reducing management associated stressors. Such stressors include stock densities, housing environments, disease incidence and climate conditions. In this case, the farmers, and specially trained stock-keepers, play critical roles in maintaining the health and welfare of the pigs based on their experiences, economical status, education and religion.

Modern intensive pig farm: The third farm type is the modern intensive pigfarm (also called 'industrialized' farm) with 200 and more pigs. It is important to note that compared to the previously discussed systems that focus mostly on providing animal products for farm families and the local community, the modern intensive pig farms are specialized economic enterprises with higher herd strength. Also, the production of pork mainly relies on grain-based feed and management skills as well as modern technological advances. In the modern intensive farm, pigs are kept purely as a commercial venture by a firm. The pigs are reared intensively under strictly regulated conditions and are usually provided with all essential inputs, some of which include improved technologies for transportation, preservation of food, prevention of disease, feed efficiency and improved management technology. It is worthy to note that with the emergence of modern pig farming practices, there exists a clear trend in the swine sector in India to simplify the production practices with an ability to grow more pigs in less space. It is very much essential that India's pig development policies shall focus and encourage the development of modern swine farms to meet the rising demand for meat consumption as well as to meet the objective of doubling farmers' income.

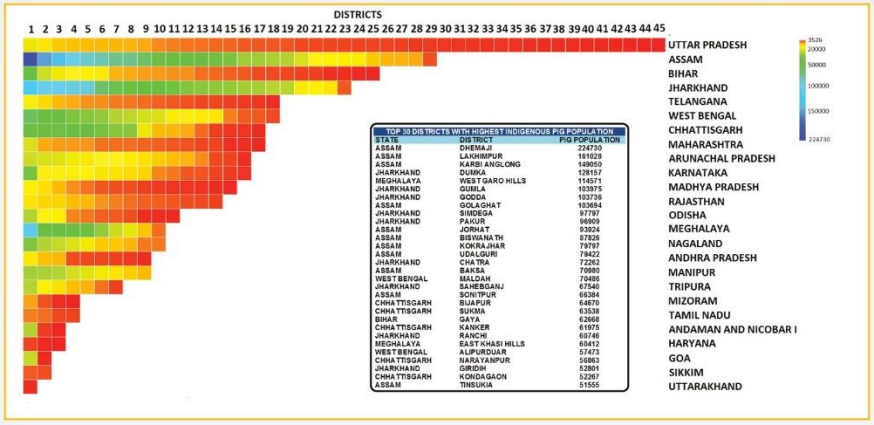
Currently, modern intensive pig farms account for less than 5% of the total pig production in India. It is well understood that with the rising demand for pork and pork products, the modern intensive production system will develop

continuously and will be the dominant contributor in the pork market in the country. These developments will help to translate the Indian piggery into a more organized pigrearing sector in the future. At present, the large-scale pork production enterprises in the country are generally located around big metropolitan cities(high density of population), to serve the growing demand of urban consumers. However, it is important to note that similar to the pig farms in other countries, the modern pig farms in India will also face several major pig welfare and environmental issues, which include housing condition, stock density, herd size, air quality i.e. odor and ammonia production, climate conditions, increased incidence of diseases , food safety, environmental contamination,labour availability and safety. One way to overcome some of these challenges will be to establish the large production units out of the cities, away from the areas with dense populations.

Table 1. Details of pig population in India

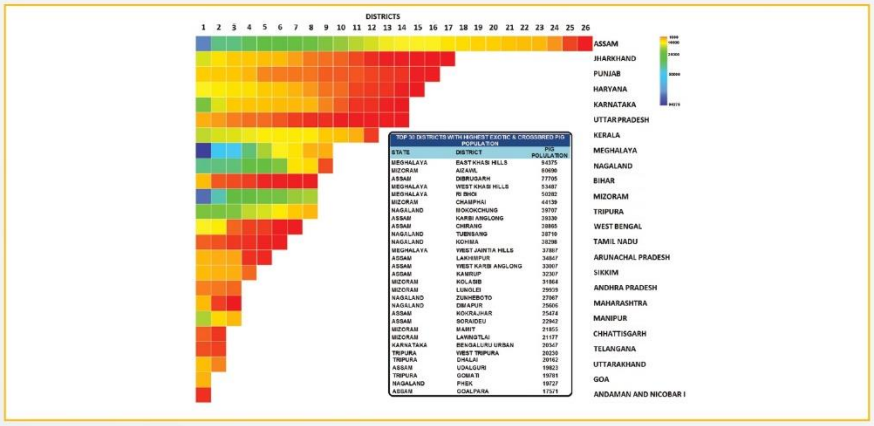
Category	Population in 2012 (in million)	Population in 2019 (in million)	% Change
A. Pig population - Consolidated			
Exotic/ Crossbred	2.46	1.90	-22.76
Indigenous/ Non-descript	7.84	7.16	-8.66
Total pigs	10.29	9.06	-12.03
B. Pig population in major pig producing states			
Assam	1.64	2.10	28.30
Jhanrkhand	0.96	1.28	32.69
Meghalaya	0.54	0.71	29.99
West Bengal	0.65	0.54	-16.63
Chhattisgarh	0.44	0.53	20.01
Uttar Pradesh	1.33	0.41	-69.37
Nagaland	0.50	0.34	-47.14
Bihar	0.30	0.32	6.25
Karnataka	0.30	0.32	6.25
Mizoram	0.25	0.29	19.26

Source: 20th Livestock Census Data, Deptt. of Animal Husbandry, Dairying and Fisheries, Govt. of India



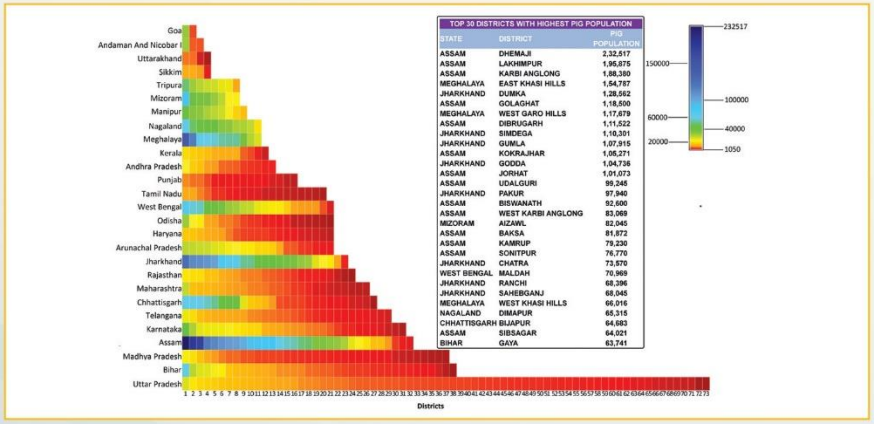
TOP 30 DISTRICTS WITH HIGHEST INDIGENOUS PIG POPULATION

STATE	DISTRICT	PIG POPULATION
ASSAM	DHEMAJI	224730
ASSAM	LAKHIMPUR	191028
ASSAM	KARBI ANGLONG	149050
JHARKHAND	DUMKA	128157
MEGHALAYA	WEST GARO HILLS	114571
JHARKHAND	GUMLA	103975
JHARKHAND	GODDA	103736
ASSAM	GOLAGHAT	103694
JHARKHAND	SIMDEGA	97797
JHARKHAND	PAKUR	96909
ASSAM	JORHAT	93924
ASSAM	BISWANATH	87826
ASSAM	KOKRAJHAR	79797
ASSAM	UDALGURI	79422
JHARKHAND	CHATRA	72262
ASSAM	BAKSA	70980
WEST BENGAL	MALDAH	70486
JHARKHAND	SAHEBGANJ	67540
ASSAM	SONITPUR	66384
CHHATTISGARH	BIJAPUR	64670
CHHATTISGARH	SUKMA	63538
BIHAR	GAYA	62668
CHHATTISGARH	KANKER	61975
JHARKHAND	RANCHI	60746
MEGHALAYA	EAST KHASI HILLS	60412
WEST BENGAL	ALIPURDUAR	57473
CHHATTISGARH	NARAYANPUR	56863
JHARKHAND	GIRIDIH	52801
CHHATTISGARH	KONDAGAON	52267
ASSAM	TINSUKIA	51555



TOP 30 DISTRICTS WITH HIGHEST EXOTIC & CROSSBRED PIG POPULATION

STATE	DISTRICT	PIG POPULATION
MEGHALAYA	EAST KHASI HILLS	94375
MIZORAM	AIZAWL	80696
ASSAM	DIBRUGARH	77705
MEGHALAYA	WEST KHASI HILLS	53487
MEGHALAYA	RI BHOI	50282
MIZORAM	CHAMPHAI	44139
NAGALAND	MOKOKCHUNG	39707
ASSAM	KARBI ANGLONG	39339
ASSAM	CHIRANG	38865
NAGALAND	TUENSANG	38719
NAGALAND	KOHIMA	38298
MEGHALAYA	WEST JAINTIA HILLS	37867
ASSAM	LAKHIMPUR	34867
ASSAM	WEST KARBI ANGLONG	33007
ASSAM	KAMRUP	32307
MIZORAM	KOLASIB	31464
MIZORAM	LUNGLEI	29929
NAGALAND	ZUNHEBOTO	27967
NAGALAND	DIMAPUR	25606
ASSAM	KOKRAJHAR	25474
ASSAM	BORAIDEU	22943
MIZORAM	MAMIT	21855
MIZORAM	LAWNGTLAI	21177
KARNATAKA	BENGALURU URBAN	20567
TRIPURA	WEST TRIPURA	20230
TRIPURA	DHALAI	20162
ASSAM	UDALGURI	19623
TRIPURA	GOMATI	19701
NAGALAND	PHEK	19727
ASSAM	GOALPARA	17571



TOP 30 DISTRICTS WITH HIGHEST PIG POPULATION

STATE	DISTRICT	PIG POPULATION
ASSAM	DHEMAJI	2,32,517
ASSAM	LAKHIMPUR	1,96,875
ASSAM	KARBI ANGLONG	1,88,380
MEGHALAYA	EAST KHASI HILLS	1,54,787
JHARKHAND	DUMKA	1,28,562
ASSAM	GOLAGHAT	1,18,500
MEGHALAYA	WEST GARO HILLS	1,17,679
ASSAM	DIBRUGARH	1,11,522
JHARKHAND	SIMDEGA	1,10,301
JHARKHAND	GUMLA	1,07,915
ASSAM	KOKRAJHAR	1,05,271
JHARKHAND	GODDA	1,04,736
ASSAM	JORHAT	1,01,073
ASSAM	UDALGURI	99,245
JHARKHAND	PAKUR	97,940
ASSAM	BISWANATH	92,600
ASSAM	WEST KARBI ANGLONG	83,069
MIZORAM	AIZAWL	82,045
ASSAM	BAKSA	81,872
ASSAM	KAMRUP	79,230
ASSAM	SONITPUR	76,770
JHARKHAND	CHATRA	73,570
WEST BENGAL	MALDAH	70,969
JHARKHAND	RANCHI	68,396
JHARKHAND	SAHEBGANJ	68,045
MEGHALAYA	WEST KHASI HILLS	66,016
NAGALAND	DIMAPUR	65,315
CHHATTISGARH	BIJAPUR	64,683
ASSAM	SIBSAGAR	64,021
BIHAR	GAYA	63,741

3
Pig Genetic Resources in India

Pig is widely distributed in all the eco-regions of the country,Pig farming is an important occupation of the rural society especially the tribal masses. People of certain ethnic groups prefer to keep more pigs, especially black ones, for festivals and ceremonial purposes. Broadly Indian pig population consists of three types; indigenous, exotic and crossbred.

Indigenous pig germplasm

Out of total pig population, 79.03% are indigenous and non-descript. Most of these population are yet to be characterized with proper scientific intervention. These pigs are of smaller size and almost no efforts have been made for any conservation and selection to improve its economic traits, such as litter size, birth weight, weaning weight, average daily gain, feed conversion efficiency and carcass traits. These animals are well adapted to hot and humid environment and presumably have better disease tolerance. The indigenous pigs of India have been identified as a distinct group as a result of gradual domestication of wild pigs to their surroundings. These pigs differ in their characteristics and colour from region to region within the country depending the topography and climatic conditions. The details of the native/indigenous and exotic / crossbred population of pigs inIndia and population of major pig rearing states are given in Table 1.

Table 1: Registered pig breeds of India

Sl.	Name of the breed	Distribution (state)	Accession No.
1	Ghungroo	West Bengal	INDIA_PIG_2100_GHOONG-ROO_09001
2	Niang Megha	Meghalaya	INDIA_PIG_1300_NIANG-MEGHA_09002
3	AgondaGoan	Goa	INDIA_PIG_3500_ AGONDAGOAN _09003
4	Tanyi-Vo	Nagaland	INDIA_PIG_1400_ TENYIVO _09004
5	Nicobari	A&N Island	INDIA_PIG_3300_ NICOBARI _09005
6	Doom	Assam	INDIA_PIG_0200_ DOOM _09006

7	Zovawk	Mizoram	INDIA_PIG_2700_ ZOVAWK _09007
8	Gurrah	Uttar Pradesh	INDIA_PIG_2000_GHURRAH_09008
9	Mali	Tripura	INDIA_PIG_1900_MALI_09009
10	Purnea	Bihar, Jharkhand	INDIA_PIG_0325_ PURNEA_09010
11	Banda	Jharkhand	INDIA_PIG_2500_BANDA_09011
12	Manipuri Black	Manipur	INDIA_PIG_1200_MANIPURI-BLACK_09012
13	WakChambil	Meghalaya	INDIA_PIG_1300_WAKCHAM-BIL_09013

Some other prominent variants of pigs like Andaman Wild, Andaman Local, Ankamali, Burudi, Dome, Golla, Lepchamoun, and Pondi/Jhinga are yet to be characterized for registration.

Exotic pig germplasm

Due to poor performance of indigenous pig germplasm and for further upscaling the performance of piggery sector in India, exotic pigs were imported by various Government and non-Government organizations from 1960 onwards as per recommendation of National Commission on Agriculture (NCA) and others. These breed were extensively used for subsequent crossbreeding programme. Berkshire, Charmukha, Duroc, Hampshire, Landrace, Large Black, Large White Yorkshire, Middle White Yorkshire, Tamworth and Wessex Saddleback are the major known exotic breeds imported in India for piggery developmental programme. These breeds have well studied in different All India Coordinated Research Project on Pig (AICRP), State Government and privet sector farms.

Crossbred pig germplasm

Piggery developmental programmes undertaken by the central and state departments namely; Department of Animal Husbandry and Dairying, Government of India, Veterinary and Animal Husbandry Departments and Animal Resource Development Departments of different states and research organizations viz. Indian Council of Agricultural Research (ICAR), Central Agricultural Universities(CAU), State Agricultural/Veterinary University(SAUs)

have resulted in noticeable progress over the time. During the initial period of development, focus was on genetic improvement of indigenous pig through selective breeding. Subsequently exotic breeds were introduced in India and efforts were made for stabilize their performance in Indian agro-climatic condition. Consequent to slow progress of indigenous pigs and based on demand, crossbreeding of native pigs with exotic boars gained momentum in different parts of the country. Several crossbred pig varieties have beenreported by different organizations.

The crossbred pigsinclude high-producing varieties viz. Rani, Asha, HD K-75, Lumsniang, Jharsuk, Mannuthy White, TANUVAS KPM Gold, SVVU T-17 and Landlly suitable for different agro-climatic condition of the country.

Table 2. List of major crossbred pigs in India

Name	Cross between		Developed by
Rani	Ghungroo	Hampshire	ICAR-NRC on Pig, Assam
HD-K75	Doom	Hampshire	AICRP on Pig, CVSc, Assam
Mannuthy white	Ankamali	Large White Yorkshire	AICRP on Pig, CVSc, Kerala
TANUVAS KPM Gold	Local pig of Tamil Nadu	Large White Yorkshire	AICRP on Pig, TANUVAS, Tamil Nadu
Asha	Rani	Duroc	ICAR-NRC on Pig, Assam
Jharsuk	Purnea	Tamworth	AICRP on Pig, BAU, Jharkhand
Lumsniang	Niang Megha	Hampshire	AICRP on Pig, ICAR-RC for NEH, Meghalaya
SVVU-T17	Local pig of Andhra Pradesh	Large White Yorkshire	AICRP on Pig, SVVU, Andhra Pradesh
Landlly	Gurrah	Landrace	AICRP on Pig, ICAR-IVRI, Uttar Pradesh

Ghungroo

Niang Megha

Agonda Gaon

Tenyi Vo

Nicobari

Doom

Zovawk

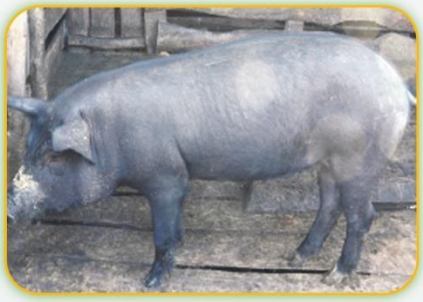
Fig. 1. Indigenous pig genetic resources of India

Gurrah

Mali

Gurrah

Purnea



Manipuri Black

Wak Chambil

Fig. 2. Indigenous pig genetic resources of India

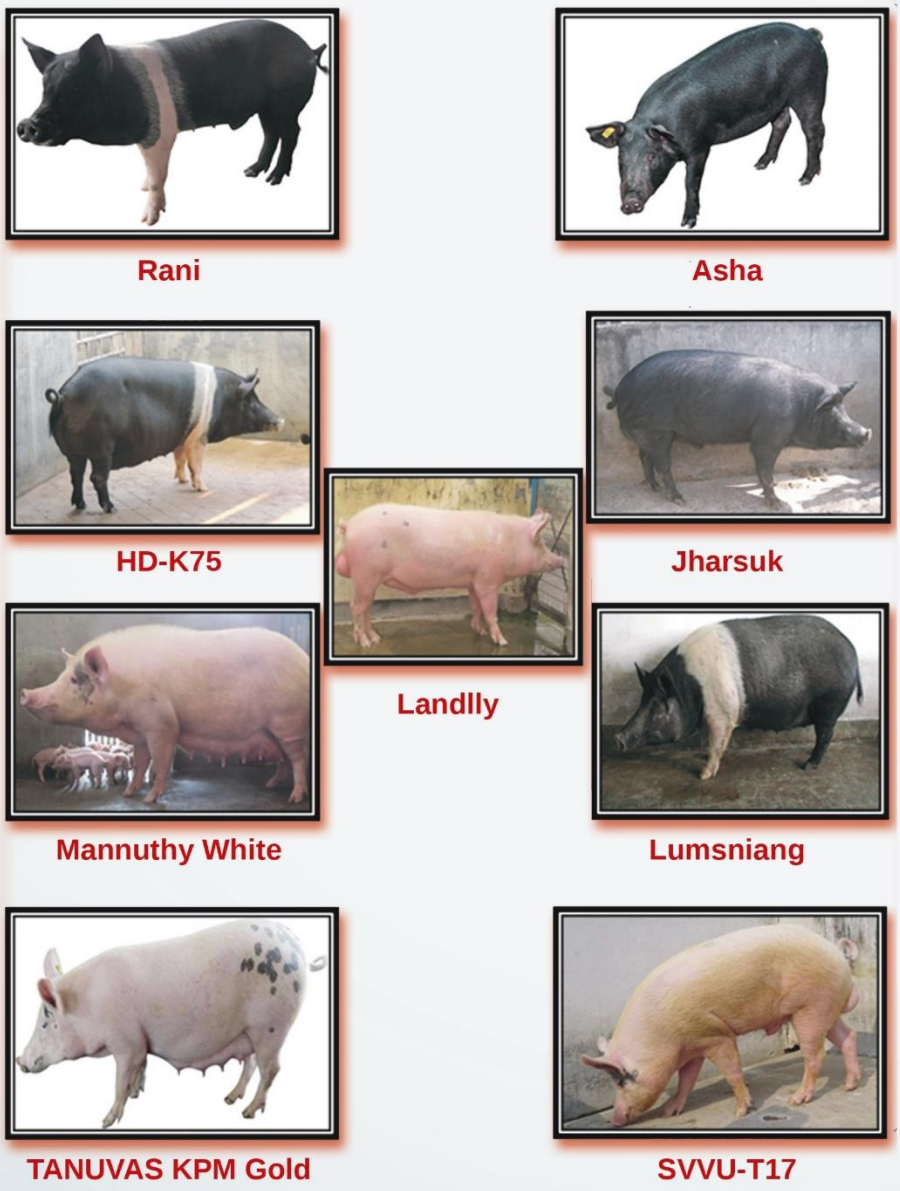


Fig. 3. Crossbred pig germplasm of India

4
Piggery Sector Development Programmes in India

The chronological developments in the piggery sector made only after independence are given below.

1. Plan period-wise development

In the First Five Year Plan (1951-1956), little attention was given to the piggery development in the country. In the second Five Year Plan (1956-1961), for the first time, a Coordinated Development Programme was launched during1959-60 for development of piggery. Two Regional Pig Breeding Stations, two bacon factories and 15 Pig breeding units/farms and 33 piggery development blocks were established under this programme. In the Third Five Year Plan (1961-1966), a greater number of regional pig breeding stations, pig breeding units/farms, piggery development blocks and bacon factories were established. Selective breeding for distribution to pig breeding farms/units in rural areas for further multiplication was the main objective of Regional Pig Breeding Stations.

Major leap forward in pig population was observed during the Fourth Five Year Plan (1969-1974)whereinthe Indian Council on Agricultural Research (ICAR) started an All India Coordinated Research Project (AICRP) on Pig (1970) with the objective of studying the performance of purebred native germplasm of India under existing management conditions.

In the Fifth Five Year Plan (1974-1979), urgent need for genetic improvement of indigenous pig was realized in view of their large number and high socio-economic importance to the rural population. Efforts were made to develop types of pig suitable for both intensive and diversified farming system including backyard system of rearing with optimal feed conversion efficiency. The technical programme of AICRP on pig was completely remodelled to undertake research; first on indigenous pig and then subsequently on the crossbreeding between indigenous pig andappropriate exotic breed to evaluate their performance under various agro-climatic condition prevailing in the country. A multi-disciplinary approach was introduced in the technical programme. Exotic Breeds such as Large White Yorkshire, Middle White Yorkshire, Landrace, Tamworth, Saddleback and Hampshire were maintained at Government Pig Breeding Farm f forgenetic improvement of the stock and distribution of improved piglets to farmers for rearing.

In the Sixth and Seventh Five Year Plan (1980-1985 and 1985-1990), superior quality of exotic and crossbred pigs wasproduced at theGovernment Pig Breeding farms in the country. Improved quality of piglets was distributed to the farmers either for establishment of finisher unit or small breeding units. Ministry of Agriculture, Department of Animal Husbandry & Dairying, Govt. of India started the centrally sponsored scheme namely "Assistance to States for Integrated Piggery Development" in Annual Plan (1991-92), to strengthen existing pig breeding farms and to establish new pig breeding farms at Krishi Vigyan Kendra, Veterinary College and state departments.

In the Eighth and Ninth Five Year Plan (1992-1997 and 1997-2002), emphasis was given to strengthen the previous scheme "Assistance to States for Integrated Piggery Development" for establishment of more units throughout the country.In Tenth Five Year Plan (2002-2007),considering the growing importance of piggery sector in the country, National Research Centre on Pig was established at Guwahati, Assam after reviewing the work of the All India Coordinated Research Project (AICRP) on Pig under Indian Council of Agricultural Research. The institute being one of its kind was mandated to undertake basic, strategic and applied research in the areas of pig production and health including product/by-product processing, value addition through quality control measures and transfer of the evolved technologies to the client groups. Further, the Institute was also mandated to act as a repository of information on pig production and health for regional, national and global policy planning and implementation.

In the Eleventh Five Year Plan (2007-2012), the Department of Animal Husbandry, Dairying and Fisheries (DADF) launched a central sector scheme namely; "Pig Development" with National Bank for Agriculture and Rural Development (NABARD) as nodal organization. The scheme envisaged encouraging commercial rearing of pigs by adopting scientific methods and creation of infrastructure forproduction and supply of improved germplasm. The scheme also included organization of training for stakeholders to popularize scientific practices and create supply chain for meat industry with encouragement in value addition of pork for better income. In addition, the department also runs a centrally sponsored scheme on "Conservation of Threatened Breeds of Livestock" which also includes pig. Further, during this period the "Mega Seed Project on Pig" was launched by ICAR in 2008 with the objective of production and supply of quality swine germplasm to the farmers.

The Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture, Government of India implemented a "National Mission for Protein Supplements" (NMPS) in 16 states (Andhra Pradesh, Arunachal Pradesh,

Assam, Bihar, Jharkhand, Kerala, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura, Uttar Pradesh and West Bengal) during financial year 2012-13, to encourage meat production from piggery. The programme envisaged formation of 16 Pig Nucleus Breeding Units each with upto 18 Satellite Field Breeding Units.

In the Twelfth Five Year Plan onwards (2012 onwards), the existing policies were revamped and newer technologies were introduced in the sector. Under National Livestock Mission (NLM) scheme special emphasis was given to the sector with respect to import of exotic germplasm, development of infrastructure and attracting entrepreneurs by easy loans and credit facilities in the sector.

The drivers of piggery development programmes in the country have been restricted to governmental and institutional players, such as DFAHD, State Animal Husbandry Department /Animal Resource Development Departments and Livestock Development Boards of different states and ICAR through National Research Centre on Pig, AICRP on Pig and Mega Seed Project on Pig. However, private organizations are currently meagrely involved in pig husbandryand pork production on commercial scale.

2. All India Coordinated Research Project (AICRP) on Pig

AICRP on Pig started its journey during Fourth Five Year Plan (1970-1971) with the main objective of evaluating the performance of purebred under existing management conditions at the four Centres. Over the time several Centreswere included in the programme based on region-specific availability and importance of piggery throughout the country. Presently, there are 20 Centres of AICRP on Pig spread over in different agro climatic regions of the country. All existing AICRP centres on pig listed below are coordinated by NRC on Pig. The name of the AICRP on Pig centers are as follows:

- ICAR-National Research Centre on Pig, Rani, Guwahati
- Assam Agricultural University, Khanapara, Guwahati
- Kerala Veterinary and Animal Science University, Mannuthy
- Sri Venkateswara Veterinary University, Tirupati
- Tamil Nadu Veterinary and Animal Science University, Kattupakkam
- Indian Veterinary Research Institute, Izatnagar
- ICAR-Central Coastal Agricultural Research Institute, Old Goa.
- Central Agricultural University, Aizawl, Mizoram

- SASARD, Nagaland University, Medziphema.
- Krishi Vigyan Kendra, ICAR-NRC on Pig, Dudhnoi, Goalpara, Assam
- Central Agricultural University, Imphal, Manipur
- Indian Veterinary Research Institute, Eastern Regional Station, Kolkata, West Bengal
- ICAR Research Complex for NEH Region, Barapani, Shillong, Meghalaya
- ICAR-Central Island Agricultural Research Institute, Port Blair, Andaman and Nicobar Island
- Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, Punjab
- Birsa Agricultural University, Ranchi, Jharkand
- ICAR Research Complex for NEH Region, Nagaland Centre, Medziphema, Nagaland
- Animal Resource Development Department, Govt. of Tripura, Agartala, Tripura
- Dept. of Animal Husbandry and Veterinary Services, Govt. of Sikkim, Sikkim
- Nanaji Deshmukh Veterinary Science University, Jabalpur, Madhya Pradesh

The AICRP on Pig programme is mandated to augment productivity and profitability in pig production with economic and environmental sustainability. The project is continuously working on development of region specific package of practices on improved pig husbandry and promotion of latest scientific knowhow through training and demonstration. Major achievements of the AICRP on Pig project are as follows:

- Development of crossbreds of varying exotic inheritance with consistent superior performance with respect to traits notably litter size and weight, growth rate and better feed conversion efficiency has been the major objective of the project. The AICRP has led to development of ofand release of seven more crossbred pig variety namely; HD K75 from Assam Agricultural University, Guwahati, Assam; Lumsniang from ICAR –RC for NEH, Barapani, Meghalaya; Jharsuk from Birsa Agricultural University, Ranchi, Jharkhand; Mannuthy White from Kerala Veterinary and Animal Sciences University, Kerala; TANUVAS KPM Gold from Tamil Nadu Veterinary and Animal Sciences University, Tamil Nadu; SVVU T-17 from

Sri Venkateswara Veterinary University, Tirupati, Andhra Pradesh and Landlly from ICAR-Indian Veterinary Research Institute, Bareilly, Uttar Pradesh. The developed varieties are distributed to North Eastern states and all other parts of the country.

- Successful raising and multiplication of exotic breeds of pig viz. Large White Yorkshire, Landrace and Hampshire under organized farm conditions were achieved.
- Genetic improvement of indigenous pigs through selective breeding especially for litter size and growth rate traits were reported.
- Piggery was successfully incorporated in the integrated farming system with considerable economic gain.

The AICRP on Pig has made meaningful and extensive studies by generating useful information and necessary knowledge on pig production and productivity under Indian conditions. Significant research has been conducted specially in the field of breeding and genetics, nutrition, reproduction, disease and health management under farm and field conditions in indigenous and exotic breeds of pigs and their crosses. However, due to limited scope and specific programme of the project, progress on many important aspects of pig production and productivity especially pertaining to economic and commercial aspects, efficiency of production, sustainability and environmental footprint, meat products technology and standardization of meat and meat products from the quality production point of view are still slow. Comprehensive information and knowledge on wholesome development of all these aspects needs attention.

3. Mega Seed Project on Pig

The Mega Seed Project was launched in Eleventh Five Year Plan and started functioning in 2009 for production and supply of quality pig germplasm to the farmers with the following objectives.

- Production of 900 piglets per year by each unit to target production of quality pig covering 300 farm families per annum.
- Capacity building in institutes to produce above number of quality piglets
- Initiating gender friendly pro-poor growth through improved pig husbandry

Mega Seed Project on Pig has contributed significantly in terms of supply of developed variety of piglets to the farmers. Large numbers of farm families were benefited through the project. The project has been merged with AICRP on Pig in the year 2023.

Fig. 1. Location of AICRP on Pig Centres

5
SWOT Analysis

Strength of piggery sector

At present, the country has 9.06 million pigs, which is considered a meagrepopulation to meet the animal protein deficiency experienced in the country. Ability of the pig to thrive and produce under adverse husbandry conditions makes this animal most appropriate particularly for the weaker and economically down trodden tribal and landless population of the country. Increased demand for pork and pork products like sausage, bacon, etc, is the strength for economic upliftment of the pig growers. Pig by-products, namely bristle and inedible offal's are strength to support allied industries. Both commercialization and organic pork production are considered strengths to give a meat revolution to the country and thereby provide employment to a large section of the rural poor.

India has still significant number of population living below the poverty line and pig rearing can result in substantial economic development in these groups because of the fewer requirements of the resources for starting piggery. Most of this population is again in the tribal belts of the country, where the people are non-vegetarian in their dietary habit and even people of some of the north-eastern states are voracious meat eaters preferring mostly pork. Pork consumption being popular among these populations, pig husbandry has been considered an important area for poverty alleviation programmes of the Government.

Further, through the initiative of ICAR and other state government farms, the development of high producing crossbred pig germplasm will mitigate the protein deficiency in rural poor by producing larger quantity of pork. Development of good management practice including economic ration using locally available feed ingredients reduces the cost of production and attracts more farmers and entrepreneurs in piggery venture. Recent development and implementation of pig breeding policies adopted by state Government Animal Husbandry Departments will further boost the piggery sector in the country. Promotion of high yielding crossbred germplasm will not only help poverty reduction and employment generation but also help to double the farmers' income in shorter time interval.

Weakness of piggery sector

The concise major weaknesses observed in recent past are as follows:

- Poor availability of quality breeding animals/ exotic germplasm

- Lack of coordinated breeding programmes
- Absence of efficient post-harvest infrastructure
- High cost of the commercially available feed ingredients
- Emergence of transboundary and emerging diseases due to porous borders with neighbouring countries and poor biosecurity
- Poor awareness level of stakeholders and low quality feeding
- Lack of structured marketing channels
- Lack of a distinctive voice of pig farmer groups/companies: This has a number of knock-on effects. For example, the typical figures for farm costs/requirements are analyzed by the government administrators only when there is clear voice on the need for suitable facilities with respect of pig production and marketing at state/ regional level.

Opportunities of piggery sector

Pig being a live source of insurance particularly for the weaker section of the community, there is a tremendous opportunities to use pig as a medium of poverty alleviation in the country.Since regions like North East in the country, where more than 50% of country's pork is consumed, has to procure live pigs from other parts of the country to meet their pork requirement, a very good opportunity exists for opening up employment generation for rural youth in this sector. Self-employment to another set of pork product processor and workers is yet another opportunities through pig husbandry not to mention about Self Help group (SHG) personnel to be engaged in service delivery like A.I, Vaccination etc.Since pig is a prolific breeder, achieving the targeted growth of 10% in meat sector is another opportunity through piggery. In the North Eastern regions of the country alone, immense opportunity exists for employment generation for rural youth in the piggery sector.

Threats

More than 65% deficiency in concentrate feed sources is a threat to the pig industry which compete humans for grains. Non-availability of by-product utilization facility particularly in areas where maximum pigs is concentrated and slaughtered is another threat from public health point of view for which general public might offer negative views for the growth of pig industry. Limited availability of swine fever vaccine is a serious threat to the piggery husbandry. Emergence of new diseases such asAfrican swine fever (ASF), porcine reproductive and respiratory syndrome (PRRS), porcine circo virus 2, porcine rotavirus and porcine parvovirus infections, etc,are important and eminent threat for pig production in India.

6
Glimpses of National Pig Breeding Policy

The National Guidelines for formulation of State Pig Breeding Policy of Department of Animal Husbandry, Dairying & Fisheries, Government of India focuses on outline of pig-breeding needs of the country, leaving flexibility to States to work upon as per their requirement within the frame-work.

1. Objectives

1. Genetic improvement of local pigs through selective breeding
2. Conserve/maintain nucleus hard of well-developed indigenous pig germplasm.
3. Genetic improvement of local/non-descript animals by crossbreeding and gradually replacing the non-descript animals with crossbred germplasm of desired level of exotic inheritance.
4. Maintenance of well-developed planned crossbred animals at farmers' field.
5. Expansion and strengthening of breeding infrastructure and support mechanism to propagate elite germplasm through Artificial Insemination (AI).
6. Holistic development of piggery sector w.r.t. breeding, feeding, management, housing, value addition and marketing. The target is to improve the integration and position of local farmers and entrepreneurs into a pig-production and marketing value chain.

2. Breeding Policy

2.1. Recognition and Conservation of Indigenous Germplasm

1. Breed registration: All the states will take necessary steps for breed registration of indigenous germplasm in collaboration with ICAR-NRC on Pig and ICAR-NBAGR, Karnal.
2. Nucleus breeding farm for such type of indigenous registered germplasm need to establish in its breeding tract separately. Breeding pyramid should be followed for indigenous prized germplasm also.
3. Prized animals may be collected from farmers' field/state/central Govt. farm to the nucleus hard.
4. Pedigreed animals should be propagated only to interested farmers

who want to keep local germplasm.

5. No crossbreeding should be allowed to farmers' field for these prized animals.
6. Separate rates and incentive from the state department may be provided to such farmers.
7. Most of the indigenous germplasm are smaller in size with less litter performance. However, in specific cases, indigenous animals with higher litter size and body weight, if available, may be used for upgradation of non-descript animals with proper plan.

2.2. Cross Breeding

Table 1. Crossbred to be propagated in different region

1	Northern India	• Large White Yorkshire • Large White Yorkshire cross • Landrace cross
2	North-Eastern India	• Hampshire cross • Large white Yorkshire specifically for Mizoram and Tripura • Triple cross with Duroc as terminal sire • Large Black cross
3	Eastern India	• Hampshire cross • Tamworth cross (specifically Jharkhand)
4	Central India	• Landrace cross • Large white Yorkshire cross
5	Southern India	• Large white Yorkshire cross • Triple cross with Duroc as terminal sire
6	Western India	• Large white Yorkshire cross

2.3 Breeding with Exotic Germplasm

1. Import of exotic germplasm, specifically, Hampshire, Large White Yorkshire, Duroc, Landrace and Large Black from reputed source after all bio-security checking. Preference may be given to the first three breeds for import.

2. Import may be done for live animal instead of frozen semen, as the success rate of frozen semen is very low.
3. Developed breed-specific nucleus herd of imported germplasm for subsequent use in crossbreeding programme.

3. Breeding plan

3.1 Nucleus Farm

1. Nucleus farm may be of pure exotic breed, well-developed crossbred or pure indigenous breed.
2. Crossbred animals of desired level of exotic inheritance should be maintained. Crossbreeding may be restricted to 50% level of exotic inheritance. However, the level of exotic inheritance may be increased in state-specific breeding programme. In case of nucleus hard of pure animals, mixing/crossing of germplasm must be restricted.
3. Minimum 30 breedable sows unit should be maintained with a sex ratio of 1:3 and thus 10 sires (2 sires from each 5 unrelated sire lines) need to be maintained by each of the unit.
4. Selection of male animals should be based on weaning weight (best 25%) and 8 month body weight (best 5%), based on two stage sequential selection. Selection of female animals should be based on dam's litter size at birth (>7) and weaning weight (best 25%) and number of functional teats (at least 6 pairs of functional teats). However, these can be changed as per performance of local crossbred animals.
5. Centralized data recording system may be initiated. Generation wise genetic evaluation may be carried out to estimate the response to selection. The overall genetic gain due to selection, selection differential and heritability may also be calculated.
6. Inbreeding should be avoided. Replacement of boars need to be done at regular interval of 2 years of productive herd life. Sire exchange programme among the farms will also be helpful to reduce the inbreeding effect. Culled male animals should be castrated before selling to avoid indiscriminate breeding.
7. Three number of farrowing per sow need to be recorded. Three farrowing par sow should be completed in 2 years.
8. Weightage of selection need to be given on litter size and weight at birth and weaning.

9. Besides routine productive, reproductive, adaptive and carcass traits lifetime production traits may also be recorded.

3.2 Multiplier and Farmers' Farm

1. Multiplier farm should maintain grand parent (GP) and parent (P) stock of desired variety. The replacement (GP and P) stock of multiplier farm should be made available from nucleus farm. Multiplier farm should produce desired animals for propagation to farmers' field.
2. Breeding plan for farmers' field should be separate with that of nucleus and multiplier farm. They are only to make inter-se-mating among the developed crossbred animals. No indiscriminate crossbreeding is allowed at farmers' field.

3.3 Mating system

All the breeding propagation activity should preferably follow Artificial Insemination (AI) practice. To achieve the target the State level Multiplier farm must have a training center for the local farmers including modest facility/laboratory for semen collection, evaluation and preservation. However, natural mating in some cases may also be adopted based on infrastructure of different states. Selection of boars in breeding programme should be based on following points:

1. The breeding boars require a recorded pedigree, a quality certificate for the breed issued by the authority for boars used for AI/natural mating.
2. The boars used for AI must be quarterly performance tested for semen quality.
3. The minimum area for keeping a breeding boar is 5 m2 for the local breed and 6 m2 for the exotic breed.
4. The maximum frequency of use of boars is 2 times a week for AI boars younger than two years, 3 times a week for AI boars older than 2 years, and 3 times a week for natural mating boars.
5. The earliest age of use for AI or natural mating is 8 months for local boars and 10 months for exotic boars.
6. AI boars should not be used for more than 3.5 years, and natural mating boars for not more than 3 years.
7. The reports on the quality of these boars shall be annually sent to

DADF for evaluation.

8. Boars needs to be vaccinated against swine fever, pasteurellosis, foot and mouth disease and other diseases as regulated.
9. A certification system should be implemented step by step for better quality breeding boars and sows for organized farms which can be recognized as certified breeding animals

3.4 Culling

Bad/ unproductive animals should be eliminated from each generation. Animals along with its family with specific genetic disorders should be eliminated from the breeding programme.

3.5 Traceability and disease control

A systematic process of identification, registration and recording of animals should be followed to keep track of the individual animals. Specific system should develop for pig disease surveillance and monitoring.

3.5 Capacity building

1. Training of farm managers/large scale entrepreneurs on breeding management
2. Regular/refresher training for technical personnel, para-vets and livestock service provider
3. Training on semen collection and AI to farmers/service provider

3.6 Infrastructure building

1. Provision may be kept for import/purchase of advanced machinery for feeding and watering.
2. Development/provision of infrastructure at farmers' field for climate resilient housing for pigs.
3. Establishment of a bacon factory in the State would reduce the transportation cost by rail and boost piggery in the State.
4. Value addition of pork and pork-products should be promoted for better profitability of the farmers.
5. Cooperative based market chain should be developed.
6. All the states should develop specific quarantine facilities for import of animals.

3.7 Subsidies and other financial support

1. Easy bank credit facility
2. One time subsidy for smallholders purchasing breeding boars
3. Annual subsidies for using AI services
4. One time subsidy for AI service providers
5. One time subsidy for waste management system
6. Subsidies for the import of GP and PS stocks
7. Price subsidies for indigenous pork producers
8. Subsidies for infrastructure development
9. Tax holiday for specific period for large scale commercial pig farms

4. Development of state specific policy and Implementation

The states having significant effect of piggery in livelihood of the population should work upon as per their requirement within the frame-work of this policy considering following facts:

i) Involvement of cultural and social system of the state.

ii) Sectoral analysis of pig rearers of the states need to be done for formulation of specific policy with zero input, low input and intensive pig farming system.

iii) Formulation of state-specific breeding plan should target the defined single or multiple objectives/breeding goal as mentioned in para 1.

iv) Tentative time span for achieving the breeding objective need to be fixed based on socio-cultural status of the states.

v) State may target to encourage the entrepreneurs and private/ commercial pig farmers.

vi) Policies for development of state specific organic pig farms may be taken up.

vii) State Pig Breeding Policy will be mandatory for importing States before submission of any proposal for import of exotic breeds of pigs

viii) The Policy should target to improve the integration and position of local farmers and entrepreneurs into a pig-production and marketing value chain.

7
Potential of Piggery Towards Doubling the Farmer's Income and Achieving SDGs

It is very well understood that piggery has tremendous potential to contribute towards attaining the vision of doubling of farmer's income by the Government for a developed and prosperous country with healthy and gainfully employed people. Piggery could also very well fit into the rural based agricultural and livestock production systems, and can provide a better option to the farmers to mitigate the risk of production failures thereby increase the profitability in a more sustainable way. Sustainable Development Goals (SDGs) were adopted by the United Nations General Assembly on 25 September 2015 and six years since the adoption of the SDGs by the Governments, it is now well understood that piggery sector could immensely contribute not only towards achieving these SDGs . However, there exists a felt need to augment/ improve the specific aspects of piggery towards achieving the full potential of piggery sector in the country. Some of the relevant points are outlined in the following table.

Table 1. Areas which need further thrust to augment the output from piggery sector in the country and to attain the specific SDGs.

Sl. No.	Relevant SDG	Areas that need attention to achieve the SDG
1	SDG 1- No poverty & SDG 2 - Zero Hunger	1. Promotion of piggery based entrepreneurships at village level and the support thereof. 2. Ensuring that the crossbred/ improved germplasm goes to the correct hands, where provisions for better feeding and management options are available. 3. Creating a "Corpus fund for insurance of piggery sector" [effective mechanism for fast settlement of claims]. 4. Improving veterinary service delivery system – Affordable and quality veterinary service at the farmer's door step.

2	SDG 3 – Good Health and Well Being	1. Strengthening the disease monitoring, diagnostic and reporting systems of Veterinary Departments, which in turn facilitate the health certification process required for exports. 2. Bringing pig vaccinations under 'compulsory vaccination' schemes as in the lines of dairy sector, which will also facilitate in establishing designated Disease Free Zones (DFZ) for animal sourcing [In-turn facilitates exports]. 3. Enhancing the monitoring on pig transport through the borders with respect to disease transmittance and outbreaks. 4. Improving bio-security measures in the farms – proactive steps are essential to prevent the entry of ASF, PRRS etc. 5. Increasing the capacity of vaccine production centresto meet the country's requirement. Option for new units can also explore.
3	SDG 4 – Quality Education	1. Let us understand the commercial pig production – need to provide exposure visits for the stakeholders to those countries where it is present. 2. Effective skill development mechanism need to be enforced in the area of scientific pig production, pen side disease diagnosis, hygienic pig slaughter and value addition of pork.
4	SDG 5 – Gender Equality	1. Effective mechanism to be implemented to ensure selection of women beneficiaries' w.r.t. pig germplasm distribution or skill development programme.

5	SDG 6 - Clean Water and Sanitation & SDG 7 – Affordable and Clean Energy	1. Promotion schemes for mechanization in piggery sector, say it in production or processing. 2. Development of SOPs and water and carbon foot prints in complete piggery value chain [ICAR-NRCP could offer technical support]. 3. Implementation of schemes to ensure efficient waste disposal from the farms. Most of the cases, the wash remains in the premises and result in flaring of mosquitoes and flies. It also results in bad smell and incidence of *Japanese Encephalitis*, too.
6	SDG 8 – Decent work and Economic Growth	1. Strict laws need to be enforced to prevent the scavenging system of pig rearing. It will help to improve the image of piggery in the society as well as help to reduce the incidence of *Neuro-cysticercosis* in consumers. 2. Implementation of new schemes to promote value chain completion at the site of production. Such measures will support the economic growth in the production sites.
7		1. Development of micro-entrepreneurship in the clusters - This model is for completion of value chain within the cluster itself.
8	SDG 10 – Reduced In-equalities	1. Implement mechanism to ensure cohesive participation of all stakeholders associated with piggery sector.

9	SDG 11 – Sustainable cities and communities	1. Implement effective mechanism to demarcate the pig production and processing areas in the municipal/city areas. 2. Enforcement of FSS Act to prevent unauthorized/ clandestine pig slaughter and retailing to ensure supply of quality pork to the consumers. 3. Implement risk assessment and monitoring system with respect to the risk factors associated with production and marketing of pork viz. residues, antibiotics, growth hormones etc.
10	SDG 12 – Sustainable consumption and production	1. Promoting "Integrated pig production" [integrating with fishery, paddy etc.] 2. Focus on Traceability: Efforts need to make to ensure 'premise identification' and 'group/lot identification' for ensuring traceability. 3. Establishing "Liquid Boar Semen processing labs" at multiple points to promote Artificial Insemination and planned breed improvement. 4. Focus on producing protein rich grasses (e.g. Berseem, leucerne) as an alternate pig feed. Pig can very well digest grass as it is omnivorous in nature. Explore the options of effectively using jackfruit, tapioca and sweet potato [utilization of unconventional feed resources]. 5. Ensure convergence of departmental schemes/ activities to avoid duplication and effective implementation.

11	SDG 13 – Climate Action	1. Implementation of schemes to promote "Climate resilient pig housing". 2. Focus on effective "Disaster management of pigs", especially during flood period.
12	SDG 14 – Life Below Water	1. Promotional schemes for piggery-fishery- paddy integration.
13	SDG 15 – Life on Land	1. Implementation of schemes toutilize the barren land/ river bank as fodder production units, which will in turn provide quality feed to pig as well as become a means to prevent soil erosion.
14	SDG 16 – Peace, justice and strong institutions	1. Ensure cohesive action among the institutions associated with piggery sector, as outlined under sl.no.8. 2. Also, promote capacity building of professionals, institutions and stakeholders associated with piggery sector.
15	SDG 17 – Partnerships for the Goals	1. Shift the developmental focus to 'cluster oriented' approaches, whereby the state will be able to develop a comprehensive database for particular cluster (Private pig breeding farms in the lines of poultry). 2. Establish "Strategic co-operation with northern states" for making raw material for pig feed available in the state at affordable price.

8
Feeds and Feeding Options in Pig Farming

Feed is one of the major challenges of intensive pig production in India. In some areas where feed and transport costs are reasonable, it is profitable to feed pigs on commercial fully balanced concentrates. Pig producers will have to continue using a combined programme of scavenging with little supplementation of wheat and rice bran particularly during finishing period. In addition, some good quality fodders can also be provided especially on farms, which produce legumes as part of the pasture programme. The advantage of complementary forage feeding is that it can counteract certain deficiency symptoms that arise due to improper balance of certain minerals and vitamins. Most of the time small-scale pig producers cannot purchase commercial rations. The challenge is to formulate alternative diets which combine some commercial ingredients with other ingredients, which are available locally.

Under standard management condition, feed alone accounts for nearly 70% of the pork production cost. Pigs are single stomach animals and therefore, they cannot digest more fibrous feed and the fibre content of the pig feed, in any case should not increase 6-8% . Since pigs have simple stomach like human being, its nutrient requirement in terms of protein, carbohydrate, vitamins, mineral etc., are to be provided through a balanced ration. It is a proven fact that a good number of pigs farrowed die before they reached market due to bad feeding and nutritional deficiency. Hence, it is important to feed the pigs with well balance ration especially in protein, energy and amino acid.

An efficient pig feed formulation requires knowledge about nutrient requirement of different categories of pig and nutritive value of individual ingredient. The nutrient requirement of pigs varies with age, body weight, pregnancy, lactation etc. Though the % of protein required for different category of pig is known, it requires a thorough skill and knowledge to formulate a balanced ration. Among energy feeds maize, rice, barley, oats, maize, wheat bran, rice bran and rice polishes are commonly used for feeding the pigs and the common protein supplements in the pig feed include ground nut cake, mustard oil cake, cotton cake, soya cake, fish meal etc.

Pig feeding system under resource driven production system mainly dependent on the local vegetations, agro-wastes, household and kitchen wastes. Since the inception of pig rearing, farmers fed their pigs with locally

available plants suitable for feeding pigs, left out rice and kitchen wastes. In this feeding system, local pigs proved more prolific than exotic breeds. Of late, when the necessity of increasing pork production was felt, importing exotic breed pigs having high body weight gain and upgrading local pigs became inevitable. Though the germplasm improvement has been undertaken, no significant steps have been taken up in improving the managemental practices especially feeding strategies.

Pig Feed Sources

Depending on the quantitative nutrient supply, feed sources may be termed as energy sources, protein sources etc.

Energy sources

Maize (Zea maize): It is the principal energy source in pigs' diet and contains 3350 Kcal/kg ME. Yellow maize provides carotene and xanthophylls pigments. Maize is an excellent source of linoleic acid but deficient in lysine and tryptophan.

Sorghum (Sorghum vulgare): Sorghum contains slightly lower energy but more protein than maize (ME 3200 Kcal/kg; protein 10-11%). It is deficient in lysine, methionine and arginine. Light coloured sorghum varieties can be used as energy sources, however, darker varieties, that are bird resistant, can contain tannins in the seed coat and should be used less.

Wheat (Trificumoestium): Wheat is good source of energy (ME 3100 Kcal/kg; 11-14% CP).

Broken rice (Oryza sativa): Rice contain 7-8% CP and 3300 ME Kcal/kg.

Barley (Hordeum vulgare): Barley contains 10% CP and 2900 Kcal/kg ME. The protein of barley is deficient in lysine and methionine and it contains D-glucose.

Millets: Bajra (Pennisetum typhoides), Korra (Setariaitalica), Ragi (Eleusine coracana) is a satisfactory source of energy.

Rice bran: Rice bran contains 13% protein, 13% fat and 13% fibre. It is a good source of energy (2900 Kcal/kg ME) and B-complex group of vitamins. It is high in phytate (1.28%) and because of it oil content and the presence of lipolytic enzymes is prone to cause rancidity. It is deficient in lysine.

Wheat bran: What bran is a poor source of energy (1300 Kcal ME/kg) 13-14% CP but deficient in lysine and methionine and high in fibre (11%) and

phytate (0.95%).

Salseed, deoiled: contains 10% protein and 2400 Kcal ME/kg. It is deficient in methionine and threonine and contains 3.5 to 13% tannins.

Molasses: Molasses contain 80-90% NFE.

Mango (Mangifere indica) kernel meal: Mango kernel contains about 2000 Kcal ME/kg and tannins (0.5%). Hydrocyanic acid is eliminated during deoiling and drying process.

Fats and oils: Animal fats contains 7700 Kcal ME/kg and vegetable oils 8000 Kcal ME/kg are very good source of energy. Vegetable oils also provide essential fatty acids. Fats and oils tends to get rancid, when stored for a long time at high temperature.

Tapioca (Monihot esculenta crantz): Tapioca root meal is rich in energy (3300ME Kcal/kg). It contains cyanogenic glucosides (HCN 15-400 mg/kg). Drying of roots eliminates 8.5% HCN.

Sweet potato (Ipomea batatas) tuber meal: It is a good source of energy (3500 kcal ME/kg) and protein. It contains antitrypsin. On drying, the antitrypsins are denatured.

Leucaena (Leucaena leucocephala) leaf meal: It contains 1500 Kcal ME / kg. It is a good source of protein (19%) and contains mimosine (3-5%), and tannins (0.95%).

Tea waste (Camelia sinensis): A major portion of these by-products is going as waste at present, and only a small part of it is utilized by caffeine industries for extraction of caffeine. The factory tea waste contains CP, DCP and TDN value of 19.5, 9.7 and 43.3 per cent respectively. It contains about 4.9% tannic acid. It also contains higher level of all other essential amino acid more than cotton seed cake and methionine content exceeds that of whole egg protein. The material can be used upto the 15 per cent level in the concentrate mixture of pigs.

Nahar seed meal (Mesua ferrea): Approximately, total annual availability of Nahar seed in N.E. region is about 15-20,000 metric tonns (MT). The seeds contain DM 90; CP 12.80; EE 25.31; CF 7.08; NFE 50.01; Ash-4.8; Ca 2.20 and P 1.02 per cent. The DCP and TDN values of Nahar seed meal were found to be 12.84 and 78.06 per cent respectively on DM basis. The expeller pressed Nahar seed meal can be used upto 15% level in growing pigs.

Ajar seed (Lagerstroemia flosreginae): Ajar tree is a large deciduous tree and abundantly grow in the forest of India mostly in N.E. states. It provides durable timber for constructional purposes and bears a large amount of seeds. The population density of Ajar tree in 24.061 km2 forest area of Assam is 3.279 million cubic meters which can produce about 13,116 metric tonnes of seed per year. The chemical composition of ajar seed was CP-10.03, EE-0.84, CF-17.50, NFE-63.3, Total ash-8.43 and tannic acid-3.06 per cent. The nutritive value of ajar seed in goat was DCP-7.42 and TDN-65.87 per cent.

Colocasia (Colocasia esculenta): The ratio of leaf petiole and corm of colocasia is 1:3.03:2.04. The boiled colocasia contain 13% DM, 9.86% CP, 1.70% EE, 8.53% CF, 74.83% NFE, 5.08% TA and 4150 Kcal GE/kg. On boiling the oxalate content has been reduced from 3.48 to 0.79 and tannic acid from 1.92 to 0.77 per cent.

Protein sources

Soyabean (Glycine max) meal : Soyabean meal contains 38-40% protein and 18-20% fat. It contains protease inhibitors which bind and render unavailable the enzyme trypsin and chymotrypsin. It is the source of allergenic proteins such as conglycinin and β–conglycinin that reduces the efficiency and caused scouring in young piglets. It is an excellent source of lysine, tryptophan and threonine but is deficient in methionine. ME content is 1200-2500 kcal/kg.

Mustard or Rapeseed meal: It has lower protein and energy than soyabean meal. The conditioning process destroys the enzyme myrosinase, which converts glucosinolates to goitrogenic compounds : oxalolidone-2-thione and isothiocynate.

Ground nut meal: G.N. meal contain about 35-40% protein and has a poor amino acid profile and is deficient in methionine, lysine and tryptophan. G.N. meal contains trypsin inhibitors and other protease inhibitors. The undesirable constituent often associated with G.N. meal is aflatoxin-produced by the fungus Astargillus flavus that infest ground nuts. This mycotoxin causes hemorrhages in the liver, kidneys and breast muscle and reduced immune competence. Aflatoxin B1 levels as low as 250 ppb are known to exert these effects. The US food and Drug Administration, has set a limit of 100 ppb for animal feeds.

Sunflower (Helianthus annus) meal: Sunflower meal has about 25% protein but high levels of chlorogenic acid a tannin like compound inhibits activity of digestive enzymes (trypsin, chymotrypsin, amylase and lipase). Additions of methionine and choline are required to counteract the effect of chlorogenic acid.

Cotton (Gossypium spp.) seed meal: Cotton seed meal contains protein but may contain free gossypol (0.02 to 0.05%). The protein is deficient in lysine, methionine, thereonine and tryptophan. It also contains the cyclopropenoid fatty acids, malvalic and steraulic acid. Gossypol can bind with iron 1:4 and hence for the purpose of detoxification with ferrous sulphate 1.2% is optimum level.

Sesame (Sesamum indicum) meal: The protein content is 40%. The sesame is an excellent source of methionine, cystine and tryptophan but low in lysine and threonine. Soyabean and sesame meal ratio of 2:1 is the best. It contains high level of oxalic acid (35mg/100g) and phytic acid (5%). Oxalic acid and phytate interfere with mineral.

Linseed (Linumusitatissimum) meal: Linseed meal contains 35% protein but low in lysine and tryptophan. It contains the antinutritional factors, Linatin (an antipyridoxine) and linamarin (a cyanogenic glucoside: HCN 10-300 mg/kg meal).

Niger (Guizoticaabyssinica) cake: Niger cake contain about 35% protein but deficient in lysine, methionine and tryptophan.

Keranja (Ponganiaglobra vent) meal: It contains 30% protein and 28% oil. The oil contains karanjine (1.47 mg /ml oil).

Rubber (Hevea brasiliensis) seed meal: It contains 26% protein and 20-40 mg/kg HCN.

Ambadi (Hibiscus cannabinus) meal: Ambadi seed meal contains 28% protein and 0.35% tannins. The protein is low in lysine and methionine.

Mahua (Madhuca indica) meal: Mahua seed meal contains about 20% protein. Mowrein, a saponins (19%) and tannins (1.5%) are present in mahua seed meal.

Guar (Cyamopsis tetragonolaba) meal: The guar meal contains about 40% protein and is deficient in methionine and lysine. The antinutrients present are trypsin inhibitors, HCN, haemagglutins and residual gums.

Fish meal: Fish meal contains 40-60% protein.

Deoiled silkworm pupae meal: Deoiled silkworm pupae meal is good source of protein (about 65%) and phosphorus. The protein is rich in lysine, methionine, arginine, tryptophan and isoleocine, but low in threonine.

Table 1. Examples of available feed resources of the North Eastern Region

Types of Feed	Available Resources	Limitation	Maximum Level of Inclusion on DM basis (%)
Cereals and by-products	Maize, rice, rice milling by-products etc.	Phytate and fibre in rice milling by-products	40 - 80
Herbs	Alternanthera, Girardina, Laportea, Mikania, Spilanthes etc	Fibre and tannin etc.	10 - 20
Tubers	Sweet potato *(Ipomoea botatus)*, Arrowroot *(Canna edulis)*, Tapioca *(Manihot esculenta)*, Kachhu *(Colocasia esculenta)* etc.	sweet potato, HCN in tapioca, oxalate in kachhu etc.	25 - 60
Vegetables	Squash *(Schiumedule)*, Pumpkin *(Cucurbita moschata)*, Radish *(Raphanus sativus)*, Cabbage *(Brassica oleracea)* etc.	Fibre	10 - 20
Fruit Waste	Pineapple, Jackfruit, Banana pseudo stem etc.	Fibre	10 - 20
Non-conventional Feed	Job's tears *(Coixlachryma Jobi)*, Buckwheat *(Fagopyrum esculentum)*, Jack Bean *(Canavalia ensiformis)* etc.	Canavanine in jack bean	20 - 60

Resource based feed formulae for different categories of pigs

Ration formulae from feed ingredients available in different parts of the region have been given for feeding of pigs at different stages of growth and production.

Creep ration: The rations of high protein and energy content offered to piglets from second week of life upto weaning (6-8 weeks) are starter or creep ration. Adequate amount of good quality protein is very important for balancing the ration. Suckling piglets under intensive management are prone to anaemia due to deficient of iron in sow's milk. Thus, iron preparations are injected in the 4th and 14th day of life. The piglets may be fed 4 ml of 1.8% FeSO4 solution prepared on glucose based from day 1 to 7 after birth.

Grower ration: The ration offered to piglets from the weaning to 35 kg body weight. It is possible to replace large proportion of cereal grains and their by-products and several agro-industrial wastes.

Finisher ration: The rations fed to fattening pigs from 35 kg live weight to slaughter at 70-90 kg body weight are finisher rations. The finisher ration can be prepared according to the availability feed stuffs.

Feeding of pregnant and lactating sows: During this stage about 20-25 kg gain in body weight of pregnant gilts and sows has been found to be optimum, and pregnant sows should be fed about 2 kg mixed feed daily. The lactating sows are fed a similar ration at the rate of 3-4 kg daily. In addition to this, piglet allowance is offered at the rate of 200 g per piglet daily during 6-8 weeks of lactation period. The ration is reduced to 2 kg daily during last week of weaning period for drying the sows.

Feeding of breeding sows: Breeding boars can maintain good vigour on the feeding of the grower ration at the rate of 3.0 kg before 18 months of age, and 2.5 kg to mature boars. Feeding of 4-5 kg succulent green fodder keep the breeding stock active and vigorous.

Table 2. Requirements for pig feed (IS 7472:1986)

Sl. No.	Characteristic	Requirement		
		Pig starter / Creep feed	Pig growth meal	Pig finishing / Breeding meal
1	Moisture content, percent by mass, Max.	11.0	11.0	11.0

2	Crude protein (N2 x 6.25), percent by mass, Min.	20.0	18.0	16.0
3	Crude fat or ether extract, percent by mass, Min.	2.0	2.0	2.0
4	Crude fibre, percent by mass, Max.	5.0	6.0	8.0
5	Total ash, percent by mass, Max.	8.0	8.0	8.0
6	Acid insoluble ash, percent by mass, Max.	4.0	4.0	4.0
7	Metabolizable energy (Kcal/kg), Min.	3360	3170	3170
8	Calcium (as Ca), percent by mass, Min.	0.6	0.6	0.6
9	Available phosphorus, % by mass, Min.	0.6	0.4	0.5
10	Iron (as Fe), mg/kg, Min	100	90	80
11	Copper, mg/kg, Min	8	6	6
12	Manganese, mg/kg, Min	30	30	20
13	Zinc, mg/kg, Min	50	50	50
14	Common salt (as NaCl), percent by mass, Max.	0.5	0.5	0.5
15	Niacin, mg/kg	17	14	10
16	Pantothenic acid, mg/kg	11	10	10
17	Riboflavin, mg/kg	3	2.4	2.2
18	Vitamin B_{12} activity, µg/kg	15	11	11
19	Vitamin A, IU/kg	1700	1300	1300
20	Vitamin D, IU/kg	190	180	130

Note : Sl. No. 1 to 14 values specified requirements are on moisture free basis.

Table 3. Nutrient requirements of breeding swine (adapted from NRC, 1988)

Intake levels	Bred gilts, sows and adult boars	Lactating gilts and sows
DE, Kcal/kg diet	3,340	3,340
ME, Kcal/kg diet	3,210	3,210
CP %	12	13

Table 4. Example of composition of creep ration for pigs

Ingredients	Parts		
	I	II	III
Maize powder	45	35	25
Rice powder	-	20	20
Wheat bran	2	2	2
Skim milk powder	10	10	10
Soyabean meal	6	6	6
Sesame oil cake	15	15	15
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
Vitabland (AB2D3)	25 g	25 g	25 g

Table 5. Example of composition of Grower ration for pigs

Ingredients	Parts				
	I	II	III	IV	V
Maize crush	60	40	10	50	-
Broken rice	-	20	-	8	54.5
Wheat bran	10	10	34	3	19
Deoiled rice bran	-	-	30	-	-
Deoiled G.N. cake	20	10	12.5	14	9
Sesame cake	-	10	5	-	5
Soyabean meal	7.5	7.5	6	5.5	10

Factory tea waste	-	-	-	15	-
Mineral mixture	2	2	2	2	2
Salt	0.5	0.5	0.5	0.5	0.5
Vitablend (AB2D3)	25 g	25 g	25 g	25 g	25 g

Table 6. Example of composition of finisher ration for pigs

Ingredients	Parts			
	I	II	III	IV
Maize crush	60	40	12	-
Rice polish	-	20	-	-
Wheat bran	10	10	23.5	25.5
Deoiled rice bran	-	-	50	-
Deoiled rice polish	-	-	-	60
G.N. cake	10	7.5	-	-
Sesame cake	7.5	10	6	4
Soyabean cake	10	10	6	8
Mineral mixture	2	2	2	2
Salt	0.5	0.5	0.5	0.5
Vitablend (AB2D3)	25 g	25 g	25 g	25 g

Table 7. Example of composition of ration for pregnant and lactating sows

Ingredients	Parts
Wheat bran	40
Deoiled rice bran	30
Deoiled G.N. cake	10.5
Soyabean cake	12
Sesame cake	5
Mineral mixture	2.5
Salt	0.5
Vitablend (AB2D3)	20 g

9
Status of Swine Diseases and it's Economic Impact in India

Since the last census, the pig population has declined by 12.03 %. Among the key reasons for the pig population's decline are the development of several infectious diseases with significant mortality rates in compared to other livestock species, as well as the neglect and absence of a good national programme for controlling pig diseases in India. Although the Government of India has already begun a control programme for few of the disease like Classical Swine Fever in pigs, we are not self-sufficient in terms of diagnostic facilities and vaccine doses.As a result, these diseases have caused substantial economic losses among pig farmers, particularly in the Northeast India. These losses could be direct, such as a higher mortality rate or abortion, or indirect, such as a restriction on the sale of live pigs.

African swine fever (ASF), Porcine reproductive and respiratory syndrome (PRRS), Porcine parvovirus (PPV), Porcine circovirus (PCV), Classical swine fever (CSF), Rotavirus infection, Coronavirus infection, Atrophic rhinitis, E Coli infection, and Salmonellosis are the most economically important infectious diseases of pigs.Aside from these diseases, zoonotic diseases such as Japanese Encephalitis, Nipah, and Swine Influenza affect both domestic and wild pigs.PRRS and ASF were not present in our country prior to 2013. Porcine reproductive and respiratory syndrome (PRRS) was first reported in India in the state of Mizoram in 2013, and the disease has since become nearly endemic in the country. In the month of May 2020, we had an outbreak of African swine fever in Assam and Arunachal Pradesh. The occurrence of these two outbreaks in our country demonstrates the lack of biosecurity at our international borders. The prevalence of CSF, PRRS, PCV and PPV in the NE states of India was found to be 12-52%, 0.84 %, 20-42% and 10%, respectively. On May 21, 2020, the OIE released the first report of ASF in India, revealing that a total of 3701 pigs died in 11 outbreaks in Assam and Arunachal Pradesh with the morbidity and mortality rates of 38.45% and 33.89%, respectively.

The International Livestock Research Institute (ILRI), with support from the Ratan Tata Foundation, conducted a participatory epidemiological study for CSF in Assam, Nagaland, and Mizoram in 2011. It was estimated that pig farmers in India lose over 2 billion Indian rupees (INR) each year due to mortality, treatment, and replacement costs due to CSF.African Swine Fever (ASF) was described for the first time 100 years ago. It is a highly infectious

and fatal pig disease that originated in Sub-Saharan Africa and has since spread to many parts of Europe and Asia. The World Organization for Animal Health (Office International des Épizooties, OIE) reported the deaths of 8.20 million pigs between 2016 and 2020, with Asia accounting for 82% of all global cases. ASF has been reported in five different areas of theworld in 35 countries sinceJanuary 2020, affecting over 1,100,000 pigs and over 30,000 wild, with over 1,700,000 animal losses.

ASF has resulted in both economic losses and disruption of the food chain in several countries, with no vaccines or cures available and often with nearly 100% mortality. Although the exact number of pigs killed in India as a result of ASF is unknown, official and media reports indicate that approximately 54,150 pigs have died as of July 2021. A recent study by the researchers from ICAR-National Research Centre on Pig could estimate the extent of losses caused by this devastating disease in the region. Using a conservative estimate that each infected pig would have transmitted ASF to two more pigs, which would then be culled, the direct losses due to animal loss are INR 2.76 billion (US$ 37.32 million). Other direct losses include the cost of disposing of contaminated in-contact materials such as feed and bedding (INR 8.12 million, US$ 0.11 million), foregone export revenue (INR 180.6 million, US$ 2.47 million), expenses incurred for carcass culling and disposal (INR 1000, US$ 13.51 per animal), and risk reduction measures such as the use of disinfectants on farm premises (INR 11.40, US$ 0.15 per animal). The cost of antigen and real-time PCR-based tests to detect ASF ranges from approximately INR206 (US$ 2.78) to INR700 (US$ 9.46) per sample, respectively.

10
Factors for Disease Outbreaks

Despite having a tremendous economic potential and using better management techniques, pig producers frequently suffer enormous financial losses due to various viral diseases that cause reproductive failure and high pigmortality.The economic viability and overall profitability of the pig farms are both impacted by the mortality of an adult pig or its litter. Neonatal piglet mortality has become a significant barrier to pig farming being a lucrative venture. Due to various diseases, piglet mortality in India was reported to reach 25% during the preweaning stage. Among the various infectious causes, severe viral disease outbreaks consistently occur and are a serious cause for concern since for their socioeconomically destructive effects, which result in significant economic loss for the piggery sector. The expansion in national and international trading of animals and animal products, brought on by the globalisation of economies and the removal of trade barriers, presents a variety of difficulties in addressing the viral disease epidemics in the piggery sector. Several outbreaks of porcine viral infections have been reported in the past two decades in different countries. India most recently experienced the outbreak of African swine fever in 2020. The lack of most common vaccines, with the exception of a few, is another factor contributing to the frequent breakout of viral infections that cause pig mortality in developing nations like India.

While some of these viral infections are well under control, others spread sporadically throughout affected nations and become endemic. The highly contagious viral diseases, such as African swine fever, classical swine fever, foot-and-mouth disease, and reproductive failure caused by porcine parvovirus, porcine circovirus, porcine PRRS, porcine circovirus, etc. result in significant economic losses in piggery production, which eventually results in a shortage of pork supplies and higher pork prices worldwide. Veterinarian professionals frequently participate in disease investigation and serve a crucial role in preventing and effectively controlling the spread of viral infections during outbreaks.

The following discussion highlights the key elements involved in disease outbreaks in piggery farms.

Biosecurity practises at various levels

In order to reduce the risk of introduction and spread of disease agents,

biosecurity requires the adoption of a set of attitudes and behaviours by people. These attitudes and behaviours must be used in all activities involving domestic, captive/exotic, and wild animals as well as their products. Two tier systems are used to implement biosecurity: at the national level and on farms. The main components of disease containment through biosecurity at the national level include the development of methods to prevent the spread of disease outbreaks, control or elimination of endemic diseases, and transboundary disease transmission.The location of the pig farm, its size and design, the introduction of new pigs, replacement stock, pig buyers, visitor entrance, fencing, working personnel, the quarantining method, vaccination, and farm management are important variables to increase biosecurity at the level of the swine farm.

Small to medium farms with subpar biosecurity practices continues to be a major element in outbreaks. Small farmers frequently feed their pigs with improperly handled as well as processed food waste or leftovers from different sources such as homes, markets, industries, restaurants, and other public places. This might be contaminated and contain pathogenic pathogens, affecting the farm.Moreover, large farms and backyards are typically found next to one another in many locations, which may be a major role in accelerating the spread of infectious diseases in such circumstances. However, for successful biosecurity at the farm level, segregation, cleaning, and disinfection will be the crucial steps.

Trade and globalisation

Infectious pathogens can spread quickly and widely through the trade of pigs and pork within and between nearby nations. The different players in the supply chains for pork include pig farmers, brokers, traders, slaughterhouses, retailers, and consumers. Through the movement of polluted vehicles and diseased animals, this may make it easier for diseases to spread quickly and over great distances between nations.

Vaccines availability

Vaccinations are crucial strategies for controlling viral infections in pigs and other animals, as well. ASF is not one of the primary viral diseases of pigs for which vaccinations are already available, unlike FMD and CSF. The pressure of pathogens, shedding, and disease in the area is decreased by vaccination. However, the suggested vaccines must have passed efficacy tests that adhere to the current requirements for preventative measures against viral infections (OIE).

Disease's epidemiology

It's important to take into account the possibility of new viruses or viral strains spreading to a region as a result of the rising importation of breeding pigs. If these imported pigs are not closely inspected, viruses and other infections with alien origins could be introduced, which could further cause disease outbreaks in the nations.These viruses may establish themselves and possibly overtake other circulating viruses to cause complex issues. Furthermore, given that there are existing local viruses circulating in the area, it might serve as a focal point for viral recombination, particularly for RNA viruses. Recombination between novel and local strains when they co-circulated in the same farm is not surprising.In reality, certain viruses in Asian nations have already demonstrated these tendencies, such as NADC30-like PRRSVs in China. In addition, several factors like contagiousness, tenacity, and case fatality rate, as well as their effects on persistence and virus transmission, are crucial for predicting future disease outbreaks.

Behaviour of pork consumers

Still today, a lot of customers favour purchasing their pork from wet animal marketplaces. Poor biosecurity control in small-scale slaughterhouses and wet markets is to blame for the contamination of pork and its products in the region with numerous swine infections. Additionally, eating wild boar as a traditional delicacy causes infections to transfer to domestic pigs and humans either directly or indirectly through contaminated environments.

Wildlife reservoir

Wild boars have the potential to be a significant source of disease spread in many areas, particularly those that use substantial agricultural. A growing hazard to outbreaks is the transfer of diseases between pigs and other animals. In all nations that raise pigs, the dangers posed by diseases in wild pigs have been acknowledged. As a possible source of interspecies transmission, wild pigs (Sus scrofa), which comprise feral domestic pigs (Sus scrofa domestica), Eurasian wild boars (Sus scrofa Linnaeus), and hybrids between the two, are the most prevalent free-ranging, exotic ungulates.Wild pigs have been identified as a major reservoir for epidemics of diseases like foot-and-mouth disease, the African swine fever virus, and classical swine fever in several parts of the world. Through outbreaks, these diseases, which are frequently referred to as transboundary animal diseases, can significantly increase morbidity and mortality in pig herds.

Being unaware

When an infectious disease outbreak occurs, it is crucial to gather as much information as we can regarding the public's worries, knowledge, attitudes, and behaviour. The improvement of communication efforts by veterinary disease investigation officers may depend on such information. Due to the general public's lack of information about the disease, increased concern may not necessarily convert into a higher adherence to preventative advice. The spread of diseases is caused by a lack of knowledge about the illnesses in farmers and livestock dealers, as it is well known that the movement of animals through livestock traders is frequently the main epidemiological element in the transmission of diseases. Since public education and training through media resources are essential, joint efforts orchestrated by the animal health department are required.

Table 1.Important swine diseases's outbreaks in Asian and other countries

Sl. No.	Swine diseases	Causative pathogen	OIE listed (Yes/No)	Outbreaks in Asian and other countries
1	African Swine Fever (ASF)	Double-stranded DNA virus in the Asfarviridae family	Yes (List A)	2018: China 2019: Mangolia, Vietnam, Cambodia, Hong Kong, North Korea, Laos, Myanmar, Phillippines, South Korea, Timor-Leste, Indonesia 2020: India 2021: Dominican Republic and Haiti 2022: North Macedonia, Thailand
2	Porcine reproductive and respiratory syndrome (PRRS)	PRRS virus under the family of Arteriviridae, genus Arterivirus	Yes	2006: China 2007: Vietnam 2008: Philippines 2010: Laos, Thailand, Cambodia 2011: Myanmar 2013: India 2015: Ireland

3	Classical Swine Fever	Pestivirus	Yes (List A)	1944: India 1992: Japan
4	Foot-and -mouth disease	Aphthovirus in the family Picornaviridae	Yes (Category of multiple species disease)	1997: Taiwan
5	Porcine Circo Virus 2 (PCV 2)	Porcine circovirus type	No	2004: Canada 2005: Kansas, North Carolina, Iowa 2014: India
6	Porcine epidemic diarrhoea	Porcine epidemic diarrhoea virus (PEDV)	No	2007: Thailand 2009: Vietnam 2010: China 2013: South Korea
7	Japanese B encephalitis	Flavivirus	No	1952: India 1998: Australia 2018: China
8	Nipah virus encephalitis	Nipah virus	Yes	198-1999: Malysia
9	Porcine cysticercosis	*Taenia solium* (Parasite)	Yes	Eastern and Southern Africa, India

11
Surveillance System for Disease Outbreaks and Preparedness in Piggery Sector

Catastrophic animal losses causedby infectious diseases are now more likely as a result of globalisation, intensive swine production, increasing trade and travel, and changing climatic conditions. Any outbreak that begins on small farms as a result of the use of contaminated swill feeding, inadequate biosecurity, and ignorance may serve as a crucial springboard for infectious viral outbreaks to spread to undeveloped regions. These farms may have contracted the virus through a variety of channels, such as swill feeding or using contaminated facilities and vehicles.The potential of disease introduction is often low for larger farms with excellent biosecurity management. However, when outbreaks in nearby farms, especially backyard farms, cause a rise in the viral load contaminating the environment in the vicinity, the danger will also increase.Therefore, it is strongly advised that the afflicted regions implement farm standardisation policies to eradicate the farms with poor biosecurity, as well as compartmentalization or zoning. Therefore, efficient surveillance is seen as a requirement for the certification of a region's or country's disease-free status.

The epidemiological "know-how" about infectious diseases in context of potential risk factors, including their geographical distribution, pathogens and their serotypes, vector distribution, host range, reservoirs, ongoing surveillance activities, climatic change scenario, disease and/or vector control programmes, vaccination, is necessary to support the risk of any exotic disease(s) or status of endemic disease in a region for implementation of surveillance system. The outcomes required to support decision-making should determine the surveillance objectives, which should be policy-driven.

Several factors should be taken into account while using surveys and diagnostic tools in the surveillance system. Based on the current epidemiological conditions, the sampling techniques, sample size, design, prevalence, and suitable confidence interval for surveys should be justified. The sensitivity and specificity of the diagnostic tests for the targeted species should be properly validated on the front of diagnostics.Additionally, it is crucial to distinguish "vaccinated vs infected" animals using diagnostic tests for the diseases for which a vaccine is available in order to evaluate surveillance data objectively.

Table 1.Strategies for disease surveillance and estimate of disease prevalence

Targeted approach	Description
Measure of disease/ epidemic	Targeted disease/pathogen prevalence in the research population, together with any related reservoir or vector capacity
Coverage	Structured active surveillance to gather the most reliable data possible regarding the disease condition/pathogen
Methods for gathering data	Primarily by conducting active surveillance. Although passive surveillance can be employed as an additional source of information, it is frequently challenging to account for any bias.
Continuity of sampling	It can be a one-time survey to assess prevalence or follow-up surveys to estimate prevalence changes, such as to track the impact of control or intervention measures.
Methods of testing	Serological testing is chosen over pathogen detection because it is more practical and frequently less expensive.
Design Prevalence	A conservative estimate entails selecting a design prevalence that trends near 50% in accordance with the anticipated prevalence in order to maximise sample size and hence boost precision.
Frequency of analysis	Following each survey. The risk-based surveillance technique may also be chosen in other risk-related situations (such as the import of sick animals or epidemics linked to live vaccines).
For vaccination Programme	To guarantee that all viral serotypes are included in the vaccination programme, it is necessary to describe the circulating virus serotypes in specific regions using serological and virological tests.

12
Control of Pig Diseases at Farm Level

Attending the disease outbreaks in a farm depends on the clearly defined purpose, the accessibility of facilities, the availability of resources, and the costs associated with conducting investigations like particular diagnostic tests. Investigations into disease outbreaks' primary goals are to (a) understand the disease's origin and pinpoint its contributing causes, and (b) determine its mechanism of transmission.

Reporting disease outbreaks and gathering preliminary basic data: Any suspected swine disease outbreak can be reported to a variety of people or organisations, including local/public authorities, pig farmers, private veterinarians, pork traders, and veterinary staff in the village. Animal health authorities should promote reporting of disease outbreaks even when doing so can result in significant expenditures to the public and private sectors and deter future reporting; if this happens, the outbreak may go unreported and develop into an unmanageable disease crisis.After receiving a report of a disease outbreak, it is important to carefully document the fundamental details on the disease's nature, location, extent, and timing.

Getting ready to participate in the field outbreak investigation: Prior to a field visit, it is crucial to gather specific details that may be useful throughout the investigation process, such as the age group and breed of the participating pigs, the date of the epidemic, the clinical indicators, and the location of the outbreak. After that, a team of experts for diseases investigation is to be assembled, and the expert team is to decide on the list of items/equipment needed for the inquiry. However, some things, such as paper and pens, post-mortem/collection of biological and allied sample collection accessories, cleaning equipment, recording accessories, pig restraint equipment, and other essential materials, which always be incorporated. However, this action can be successfully carried out utilising a regular tool.

Confirmation of the outbreak: The probable cause of the outbreak must first be determined in order to confirm the outbreak. After then, the outbreak's scope is evaluated, and data is gathered for further research and the implementation of suitable control measures. Information gathering on the species, breed, and age of the animal involved in the epidemic, the area (geographic location, homes, farms, or communities), and the time (the moment the disease first appeared) are all crucial. In addition to this, there are also animal in the community who are at risk for disease, as well as

registered for morbidity, mortality, and case fatality rates. The disease is characterised by taking into consideration the subsequent procedures after acquiring all of the information that is conceivable.

(a) Classical symptoms of animal before death

(b) Documenting the clinical examination and history of each individual case, including both sick and unaffected pigs. Collection of all biological and clinical samples from both healthy and infected animals

(c) Expert veterinary pathologists examine carcasses on-site following a post-mortem

(e) Gathering morbid samples for post-mortem investigation. Examining and gathering related elements, including water, vectors, feeds, etc., to see whether they may have contributed to the spread of diseases.

Analysis and reporting: To decide whether to accept or reject a hypothesis, a statistical relationship between the cause and potential diseases must be established after analysis of all the aforementioned data, laboratory investigation, and post-mortem examination of carcasses. In the event that hypothesis is rejected, it is necessary to re-evaluate the data gathered. Report preparation involves two steps (1) specifics of the observations and analytical report; and (2) appropriate suggestions to stop future outbreaks, new cases, and mortality.

(1) Specifics of the observations and analytical report: It comprises any experimental results, post-mortem examination findings, data analysis, pictures, and laboratory test results.

(2) appropriate suggestions to stop future outbreaks, new cases, and mortality: In order to stop the spread of disease as rapidly as possible, the proper recommendation following disease outbreak investigations is crucial. The following areas should be the focus of the main recommendation

a) Immediate farm disinfection procedures are necessary because the symptoms of various viruses may vary.

b) Strengthening the farm's biosecurity procedures.

c) Breaking or restricting a virus's ability to spread.

d) Communication of the control measures to the various stakeholder groups responsible for their implementation, including the local

authorities, police, municipal officials, pork dealers, pork market owners, other farmers, and the general public, is step number.

List of tasks for a successful epidemic investigation: An exotic animal disease epidemic would have a significant effect on animal species, agriculture, tourism, wildlife, and other industries if such an outbreak was not contained, it would cause substantial losses in a timely and efficient manner. In a nutshell, the crucial things to be noted prior to, during, and following investigation during the outbreak are as below.

Prior and early phase of the outbreak

- How sensitive is the swine population to the disease?
- Where will the pathogen enter? Where should surveillance efforts be focused?
- Which kind of surveillance ought to be employed?
- What is the pathogen situation right now, and how difficult is the present outbreak?
- Where and how many measures be put in place to swiftly eliminate the pathogen?
- How can the infection be prevented from spreading to healthy animals?
- Where will the dead animals from infected animals be disposed of, and how?
- Which data and tools are required for forecasting and control to be effectively carried out?

The following observations to be considered once a significant outbreak is ongoing

- How can a disease transmit from one animal to another, and how does it do so?
- According to, how many cases will be documented each day?
- How successful are the current prevention and control strategies?
- Which actions ought to be taken, and how ought they to be changed as the pandemic gets worse?

Observations to be taken into account after a significant epidemic

Can the pandemic be deemed over, or do unreported cases (reservoir/carrier

status) still exist in the animal population?

Requirements for an investigation of an outbreak

An outbreak investigation is a methodical process used to locate the origin of infection cases with the goal of controlling and preventing a potential recurrence. The investigation into the epidemic is crucial to determining whether or not the proper preventive and control measures have been implemented. In addition to identifying changes in the disease agent, supportive environment, or occurrences that may be outside the scope of a disease control programme, outbreak investigations aid in the evaluation of the interventions' achievements and failures.As a result, it is crucial to continue using the right outbreak investigation documenting techniques. The investigation of zoonotic outbreaks should be carried out in conjunction with public health authorities.

- Laboratory diagnostic capabilities: Only well-equipped laboratories with a variety of chemicals/reagents, skilled staff, and standardised tools can make a speedy and accurate diagnosis.
- Collaboration with institutions and labs abroad: Around the world, a network of FAO and OIE reference laboratories and cooperating institutions are accessible to offer guidance and support to nations during disease outbreaks. In India, Regional Disease Diagnostic Laboratories (RDDL) and Central Disease Diagnostic Laboratories 395 (CDDL) frequently work together to investigate animal disease outbreaks.
- Making rapid diagnostic tests (ELISA-based, nucleic acid-based, lateral flow assay-based, or other) in order to get results quickly (FAO animal production and health manual).

Descriptive epidemiological steps in the analysis of an outbreak

Who?

- How many pigs were impacted by the outbreak?
- Which pig breed including age group, sex as well as human populations (pregnant women, children, elder etc.) is more sensitive?

When?

Temporal correlation of disease frequency and associated events.These incidents could be linked to epidemics of the infectious disease.

- Importing wildlife from endemic regions
- Effectiveness of used diagnostic and quarantine techniques (if any)
- Change in agricultural management and dietary practises
- Seasonal variations and related vector activity, particularly ticks

Where?

In terms of the geographic spread to observe associated risk factor, the outbreak can be described. The following spatial distribution parameters can be laid out using the geographic information system (GIS).

- Seasonal patterns and climate zones
- Geographical features
- Vegetation index

Why?

- What agent is behind the outbreak?
- What caused the infection?
- Wildlife reservoir?
- Transmission mechanism
- Risk elements that can make susceptible animals more vulnerable to infection.

Farm related risk factors for disease outbreaks

A farm level outbreak may be influenced by associated risk factors in the animal population, including farm size, stocking density, contact rate, production type, importation of infected animals, quarantine procedures, nutritional status, contaminated feed, contaminated water, immunosuppressive disorders, and other farm management practises. In addition to zoonoses in the human population, other risk factors that may contribute to outbreaks include interaction with animals, the use of personal protective equipment (PPE), at-risk demographics, unsanitary behaviours, and immunosuppressive illnesses.

Steps of disease outbreak investigation

- Determine whether an outbreak is present:Are there more cases than predicted that have been observed? A single case may be regarded an

outbreak in a farm free of any infectious diseases, however in endemic areas, an outbreak is defined as the presence of cases or more.

- Clinical and analytical testing should be used to confirm the diagnosis: The clinical samples of the farm animals, linked human contacts, and environmental samples, such as farm soil and sewage, can be collected for laboratory analysis during the suspected outbreak (for example, a high rate of miscarriages in pig.To find the pathogens, a variety of laboratory tests can be used, like as standard methods, serological identification, and molecular approaches.
- Determine a case's standard components (such as clinical information, time, location, and impacted parties) and varied degrees of certainty (with associated risk factors).
- Linked with other cases that are related to outbreak
- Carry out a descriptive epidemiology of the epidemic curve and geographic spread of the disease.
- Create a hypothesis based on descriptive epidemiology (e.g., animal herds/farms, places, and times with the clinical and laboratory findings), and then test the new hypothesis based on analytic epidemiology (e.g., cohort or case-control study).
- The theory should be re-evaluated by "squaring" it with the clinical, laboratory, and epidemiologic facts. The development of a new theory for further testing may also take place.
- Carry out additional research (if required) to better define the scope of the pandemic, evaluate brand-new laboratory procedures, identify new case-finding strategies, or carry out an environmental inquiry.
- Control measures are put into action.
- Share results with the public to raise awareness.

Planning for emergencies and contingencies

According to OIE recommendations, all nations should create emergency preparedness and contingency plans for quick response to disasters. The emergency response plans should be integrated into the legal framework and should have undergone recent testing. In order to assure the execution of quick control activities, a proper chain of command and coordination with pertinent support services must be in place. A contingency plan is a collection of activities that include both short-term and long-term responses to an animal health emergency, such as disease outbreaks. The contingency plan should

be easy to comprehend and put into action. It should comprise assembling a group of pertinent authorities and stakeholders, correctly identifying crucial authorities and stakeholders, and establishing a strategy for recovery. The contingency plan needs to be thoroughly documented, tested, and updated on a regular basis. A contingency plan to include a clear chain of command, mechanisms for quick detection and confirmation, processes for looking into outbreaks, quick containment measures (such as movement control, disinfection, vaccination, and culling), and a communication strategy. The establishment of the control zones and containment zones may occur after the confirmation of an outbreak.The magnitude of these zones is influenced by a variety of variables, particularly the epidemiological traits of the agent and illness. Movement restrictions, increased surveillance, emergency vaccination, targeted culling (in cases of highly infectious animal diseases), and other pertinent, specialised actions applied to affected establishments are frequently included in the control measures implemented in these regions.

13
Biosecurity Measures in Piggery Management

Biosecurity is defined as the deployment of steps that limit the risk of contamination. There is a risk of disease agents being introduced and spreading. It necessitates the adoption of a set of attitudes and behaviours in all actions with domestic, captive/exotic, and wild animals and their products in order to limit risk. Biosecurity measures should be employed to prevent infections from entering a herd or farm (external biosecurity) and to prevent disease spread to uninfected animals inside a herd or farm as well as to other farms when the pathogen is already present (internal biosecurity).

Route of disease transmission in piggery

Direct pig-to-pig contact is one of the most common ways of infectious agent transmission: the mobility of infected pigs in close physical contact with non-infected pigs is critical in disease transmission. The spread of disease by contaminated sperm is extensively recognised. People's roles in disease transmission have been extensively researched over the last decade: individuals can transfer viruses on their footwear, clothing, hands, and so on. People can carry viruses on their nasal mucosae without becoming sick. They can also be infected with diseases and shed them as healthy or sick carriers. People also control the movement of domestic animals and goods between herds, markets, and regions. Economic incentives can cause animals to be moved over long distances, increasing the likelihood of disease spread.Vehicles and equipment can aid in the spread of illnesses. Airborne transmission is more difficult to document, but it has been experimentally examined. Because some germs might live in meat waste, special care must be taken when using food waste to feed pigs. Feed, water, and bedding can all get polluted and contribute to illness transmission. Because faeces from diseased pigs can contain huge amounts of dangerous viruses, bacteria, or parasites, spreading manure on agricultural land may introduce pathogens into the human food chain and ecology if proper precautions are not taken during storage and spreading. Birds, rodents, stray dogs and cats, wildlife, and feral pigs, as well as arthropods, can all be potential carriers, either mechanically or by being infected.

Primary components of biosecurity

1) **Segregation:** The construction and upkeep of barriers to reduce the ability for infectious animals and hazardous goods to enter an uninfected site. This procedure, when followed correctly, will prevent

the majority of contamination and infection.

2) **Cleaning:** Materials that must enter/leave a site (e.g., vehicles, equipment) must be carefully cleaned to remove visible dirt. This will also eliminate the majority of germs that contaminate the materials. In addition, the majority of the bacteria that contaminate the materials will be eliminated.

3) **Disinfection:** Disinfection, when done correctly, will render any pathogens existing on materials that have already undergone a thorough cleaning inactive.

The actions employed to strengthen biosecurity within each of these three categories are dependent on the pig production system in question as well as the local geographic and socioeconomic variables. Controlling the entry of pigs from outside farms, markets, or villages; implementing quarantine for newly purchased animals; limiting the number of replacement stock sources; fencing a farm area and controlling access for people, as well as birds, bats, rodents, cats, and dogs; maintaining adequate distances between farms; providing footwear and clothing to be worn only on the farm; and using an all-in-all-out management system are all examples of segregation measures.

Biosecurity measures in different piggery production system

Scavenging pig production system: The limited capacity of producers to commit resources and time, as well as the nature of scavenging pig production, limit the deployment of biosecurity measures in scavenging pig production systems. However, basic procedures that are mostly connected to segregation can be recommended: new pigs introduced into a community must be disease-free, and special care must be taken when they are purchased from a market. The usage of quarantine is critical. Concerns have also been raised about sows and boars being relocated from one place to another for mating.The health of the boars must be known, particularly in terms of diseases of concern. Poor pig farmers frequently sell their animals for slaughter as soon as sickness is diagnosed. Marketing sick animals poses a major disease risk since incubating or excreting diseased pigs spread diseases, especially when sold at live-animal marketplaces. This technique must be avoided. Untreated pig swill must be avoided and is frequently restricted by national rules. When atypical pig fatalities occur, veterinary services should be notified so that prompt action can be taken to limit disease outbreaks; proper carcass disposal by burying, composting, or burning is also critical. Cleaning of night shelters and equipment is required.

Small scale piggery production system: The three elements of biosecurity

(as discussed) will be prioritised in small-scale confined pig rearing. One significant distinction between small-scale confined and scavenging pig farming is that confinement allows for more effective segregation techniques. The scavenging pig measures proposed are also applicable to small-scale confined pig operations. Newly purchased pigs should be quarantined in a quarantine pen for at least 30 days.Additional measures can be implemented in this system. The pig farm's location can be changed. Age-segregated rearing should be encouraged, and buildings should be structured so that pigs of different health statuses do not mix. An all-encompassing management system is feasible. It is possible to promote proper fencing and steps to control contact with birds, rats, cats, and dogs. It is critical to design farm standards that visitors must rigorously follow; with confined pigs, access for cars and personnel, including drivers and feed providers, can be controlled.Authorized visitors, particularly those working with pigs - including other farmers - should be provided with appropriate attire and clean footwear by the farm being visited, and they should wash their hands upon entering. All instruments or equipment that may come into contact with pigs should be assigned to the farm and cleaned regularly. The need of regular and thorough cleaning of the pig unit is frequently underestimated: dung should be removed from the pens every day, unless slatted floors or an equivalent are used.Contact with sick and deceased animals' excrement, urine, and straw bedding should be avoided. Following cleaning, the usage of disinfectant should be encouraged. When a group of pigs of the same age departs a facility, the room should be completely cleaned and disinfected. Before returning to or visiting other farms, vehicles, particularly those used to transport pigs, should be completely cleaned and disinfected. A secure pig loading facility will limit vehicle traffic on the farm.

Large Scale piggery production unit: The same principles apply in large-scale limited production systems as they do in previously stated systems, but the impact of illness has the potential to be correspondingly greater. Herds should be physically separated from neighbouring farms and heavily travelled roadways. The same restrictions apply for aerosol transmission as for the previous method. Filtration of air can be practiced in large investment farms for reducing the risk of airborne infection. Standards for the purchasing of incoming genetic material should be developed. When using artificial insemination (AI), the AI unit's health should be comparable to that of the recipient herd, and its biosecurity controls should be appropriate. Visitors and fomites must be kept under control because both can transmit infections to the farm. Staff must be trained and updated by veterinarians and professionals that specialise in disease control.To control important infections in commercial

farms, a variety of disease control strategies and approaches are now available. The most difficult aspect is frequently ensuring proper application of appropriate husbandry techniques. Pathogen eradication in stages adds to regional biosecurity by lowering disease risk in the region. If carried out to its logical conclusion, this approach can result in disease eradication from the region or country.Biosecurity for large-scale outdoor production systems must prioritise feedstuff control, water and pasture contamination, wildlife, and human visits. Other elements, such as transportation, pests, and breeding stock sources, must also be considered, as the hazards are the same as in other production systems. The essential links in the pig production and marketing chains include intermediaries, service providers, and transporters. Their potential roles in disease transmission, but also as biosecurity champions, are significant; as a result, they must be actively involved in the execution of biosecurity programmes.

Biosecurity measures in piggery practices: Slaughterhouses are another critical component of the marketing chain where all three parts of biosecurity must be implemented, with a particular emphasis on bio-containment. To maintain a high health status at AI centres, it is critical that the boars purchased are disease-free. Implementing a quality assurance plan in these practices should be a top priority. Live-animal marketplaces are apparent sources of contact and a possible source of disease spread: bio-containment is essential at these locations, and contact between animals of diverse origins must be regulated. Animals that have not been sold should not be reintroduced into the home herd without a quarantine period to reduce the danger of disease spread. Wastewater and slurries must be adequately controlled. However, such markets can also be used to disseminate and collect information.

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Piggery Waste Utilization

Due to commercial concerns, intensive pig farming has been gradually increasing to meet global pork production demand, and as a result, the piggery waste management problem may pose a number of threats to human health as well as the surrounding environment (FAO, 2003). A 60 kg pig can produce 0.8-1.5 kg/ day and 3-4 L/ day of urine and manure, respectively. Pig waste quantity and characteristics are determined by pig weight, feed type, pig health, and pig farm management.Piggery farm waste/ excreta are a major source of different zoonotic infections, environmental pollution with heavy toxic metals as well as transmission of antimicrobial resistant (AMR) bacteria to the surroundings. Aside from these annoyances, piggery manures can also contribute to ground water contamination, either by seepage or waste spray into the surrounding area. The piggery waste spray has been observed to create many quirks such as nasty smell, respiratory difficulties, mucosal irritations, increasing blood pressures, and increased stress among the residents in the surrounding areas. Industrial pig farmers have attempted to devise methods of controlling these wastes, however small-scale pig farmers have no choice except to place their farms in rural regions distant from metropolitan areas in order to limit the waste's perceived impacts on the environment. There are scopes for utilizing piggery waste for generating bioresources as mentioned below

Biogas production: In our modern world, any renewable energy source is seen as quite vital. With a changing climate causing harsh droughts, devastating hurricanes, and ozone depletion, investing in a clean, renewable energy source is unquestionably the way of the future. Biogas is quickly becoming a valuable energy source that contributes to the global generation of electric capacity. An adult pig produces approximately 5 kg of manure every day. This trash contains 90% water and 7% volatile solids and can generate 0.136 cubic metres (4.8 cubic feet) of biogas each day. According to various studies, a variety of factors may directly or indirectly interfere with the creation of biogas or methene from piggery waste materials.The significance of anaerobic piggery waste treatment and the environmental benefits of biogas production can be described as follows.

- *Odour emission reduction:* this is significant when constructing a piggery farm near a municipality or locality.
- Improving liquidity: boosting homogeneity, making mixing and pumping easier, and allowing for easy dissipation in the soil.

- No nutrient loss: Because of anaerobic fermentation, plant nutrients are not lost due to evaporation or rainwater leaching.
- Reduced germinability: Weed germinability decreases with higher temperature fermentation (50 °C).
- Concerns about hygiene: fermentation can be utilised as an antiseptic treatment against viral, bacterial, and parasite diseases.

Biofuel production: Because of the global demand for fuel efficiency, environmental quality, and energy security, liquid bio-fuels such as bioethanol and biodiesel have received a lot of attention. Brazil and the United States are the world's most dominant industrial actors, accounting for 87 % of global biofuel output and relying largely on government assistance. Bioethanol production is one of the most important industries in the current environment, and it will continue to expand in importance in the next years, owing to the high demand for ethanol in both domestic and global markets. Bioethanol can replace at least a percentage of petroleum-based fuels, which is especially crucial for developing countries like India and in the future when present petroleum-based fuels decrease. Ethanol is a cleaner-burning fuel that offers equivalent efficiency at a lower cost than gasoline. A roadmap for ethanol blending was recently issued in India, and it states that a successful 20% ethanol blending (E20) programme may save the country's economy up to $4 billion per year. In India, sugarcane molasses is the principal source of bioethanol; yet, it is insufficient to satisfy the 20% blending target.Diversifying feedstocks, particularly the utilization of lignocellulosic biomass and other low-cost sources such as livestock farm waste-based technologies for domestic ethanol production in the blending sectors, is necessary in this respect. Many agricultural waste-based residues such as wheat straw (Lantz et al., 2018); banana stem; sugarcane bagasse; sweet sorghum; jackfruit and weeds such as Saccharum spontaneum, Typha latifolia, Eicchornia crassipes, Prosopis juliflora, Lantana camara etc. are utilized to produce bioethanol.Furthermore, manufacturing bioethanol from animal waste provides a low-cost alternative to petroleum-based chemicals that should be pushed. It has the potential to lead to the multi-layered, full utilisation of biological waste from animal farms in the future, boosting the value of biological resources in India today. Various research has demonstrated cattle excreta to be a feasible source of bioethanol. Furthermore, manufacturing bioethanol from animal waste provides a low-cost alternative to petroleum-based chemicals that should be pushed. It has the potential to lead to the multi-layered, full utilisation of biological waste from animal farms in the future, boosting the value of biological resources in India today. Pigs are monogastric animals with

diverse feeding preferences, as they may take a wide range of traditional meals strong in carbohydrate, protein, fat, and fibre. However, carbohydrate digestibility, absorption, and assimilation in pigs is reduced when compared to the meal provided. As a result, the vast majority of the carbohydrates in pig feed were lost in the faeces. When using anaerobic yeast, this carbohydrate generated in pig excreta can simply be utilised as a pre-treatment to obtain the largest concentration of fermentable sugars.Recently, researchers noted that piggery excreta are the most cost-effective way for producing small-scale bioethanol from pig excreta with minimal chemical requirements. The diet is expected to have a considerable impact on the production of bioethanol from monogastric animals such as pig excreta. As proven by the fact that pig excreta obtained from well-managed commercial farms where the animals are fed a well-balanced diet, as well as kitchen/restaurant waste, is adequate for bioethanol synthesis. As a result, employing massively collected piggery excreta on a large scale in resource-constrained areas to make bioethanol is a realistic solution for long-term piggery waste management.

Antibiotic degradation: Antimicrobial agents and growth promoters derived from veterinary antibiotics are currently widely utilised in the livestock, poultry, and aquaculture industries to enhance animal growth. Several antibiotics that are difficult to degrade continue to be active in the environment and enter the food chain via enrichment, endangering human health. The soil antibiotic content is risk threshold for antibiotic concentration. Tetracycline antibiotics are the most common forms of soil antibiotics, and their concentration in soil is significant. As a result, tetracycline antibiotic residues should be minimised or eliminated using technical techniques.As a result, tetracycline antibiotic residues should be minimised or eliminated using technical techniques. To remove antibiotic contaminants, many enhanced oxidation methods and some new processes are being researched and developed. Furthermore, using peroxymonosulfate (PMS), persulfate (PS), and H2O2 as oxidants, the enhanced oxidation process may efficiently remove antibiotics. Magnetic biochar made from dewatered piggery sludge was used to activate peroxymonosulfate, which degraded the antibiotic tetracycline.The results showed that magnetic biochar had higher catalytic activity than unmagnetized sludge biochar, and magnetic biochar had superior separation and sustainability in recovery and reuse. Magnetic biochar made from dewatered piggery sludge was used to activate peroxymonosulfate, which degraded the antibiotic tetracycline. The results showed that magnetic biochar made from piggery waste had higher catalytic activity than unmagnetized sludge biochar, and magnetic biochar had superior separation and sustainability in recovery and reuse.

15
Indian Meat Industry vis-à-vis Pork Trade

Meat is an integral part of a healthy diet and meat consumption continues to increase steadily, while the world's producers of livestock for red meat production are finding it difficult to cope with the increase in demand. Pig meat and then beef are the most important red meats consumed. World trade in meat has increased steadily over the years and will continue to do so in the future even though the recent commodities boom that contributed to lower livestock and meat prices and declining consumer demand for meat has ended. Food safety concerns and the need for hygienically processed meat products have resulted in the development of modern meat processing facilities in many parts of the world, although there are still areas where slaughter facilities are very rudimentary or have not been modernized. Further investment is required in the meat processing industry, although margins in this sector are low compared with the margins in many other economic sectors, making it difficult to generate sufficient funds for investment purposes.

Pork production scenario in the world

China dominates global pig meat production, accounting for 44% of total production, and has also been by the far the main contributor to global growth in production during the last ten years. The United States accounts for 9% of total production and is an important consumer country and exporter. Pig meat is the most important meat produced in the EU. The EU accounts for 23% of global production, with Germany and Spain being the largest EU producers. Pig meat production has increased in Canada during the last ten years and is helped by a growing export demand. Meat prices show large differences from country to country. There are differences not only in product specifications (with prices generally higher for chilled meat versus frozen meat) but also in meat quality. Unlike some commodities, meat is far from being a product with uniform characteristics. Production and processing costs as well as the level of demand influence meat prices.

Pig meat is the most widely consumed meat, being the preferred meat in many parts of the world, including the EU, which has the highest level of per capita consumption. More than half of the pig meat is consumed in further processed form in a wide range of products, while fresh pork is normally consumed in much smaller quantities. Pig meat is the preferred red meat in both developed and developing economies but in developed countries the

per capita consumption is about 150% higher than per capita consumption in developing countries in spite of a high level of consumption in China (more than 25 kg per capita). In the developed economies, per capita consumption of pig meat is expected to be stable or increase slightly at the expense of per capita beef and veal consumption that could even edge down over the long term. In the developing economies, per capita beef and veal consumption is expected to edge up, while the per capita consumption of pig meat is expected to rise by almost 1% per year and to reach 10 kg by 2028.

Trade in pig meat is the most important trade and this is mainly due to the high level of trade within the EU. In regional trade, such as within the EU, where distances are relatively short, most pork is traded in chilled form. Chilled pork has a shorter shelf life than chilled beef. In inter-regional trade, most port is traded in frozen form, both bone-in and boneless. In the importing countries, most frozen pork is used in further processing for products such as smoked or cooked sausage. There is also a large world trade in further processed products. Pig meat sausages are the most important product, followed by preparations of pig meat, especially canned preparations. Trade in bacon and ham is also important. The export trade in chilled and frozen pork is dominated by the EU and North America. Brazil is the only other major exporter. EU countries are also major importers, while both Japan and the Russian Federation have a substantial import requirement.

The main import of the EU countries is pork for further processing plus limited quantities of pork for the fresh market. Almost all of the pork imported by EU countries is imported from other EU countries. Japan imports chilled pork from North America for the fresh meat market and frozen pork for further processing in Japan. The Russian Federation imports lower-quality frozen pork for further processing. EU exporters dominate trade in the different types of further processed pig meat products, with Denmark in the lead, supplying other EU countries but also exporting to non-EU markets. The only other major exporter is China. Outside of the EU, the main importers of further processed pig meat products are Japan and China.

Livestock production in India

Livestock production in most livestock economies includes bovines (especially cattle and buffalo), ovines (sheep), caprines(goats) and pigs. Livestock production is extremely widespread throughout the world whether resource availability is high or low (i.e. agricultural potential of areas), with different types of livestock suited to different environments. Across the world, in 2020, livestock has yielded about 180 million tons of meat, with pig meat being the

most important and accounting for 56% of total output. The production of pigs, which are produced solely for meat, is much greater than production of the other livestock species. Bovine meat accounts for 36% of total output. Ovine meat is less widely produced and only accounted for 7% of total output. The present production of meat in India is estimated at 6.27 million tons, which is 2.21% of the world's meat production. The contribution of meat from buffalo is about 23.33%, while cattle contribute about 17.34%, sheep 4.61%, goat 9.36%, pig 5.31%, poultry 36.68% and other species 3.37%. Rising incomes and aspirations of consumers are contributing to the growing demand for meat and this trend can be expected to continue.

Indian pork consumption segments

1. The vast majority takes place in the informal sector in the form of locally raised fresh pork. This meat is not widely distributed in the organized retail sector. Given cultural perceptions and consumer perceptions about pork meat, consumption of fresh local meat is limited to north eastern India where pork consumption is more prevalent.

2. The second segment of the pork market deals with high-value processed pork products. These products include cured meats such as sausages, ham, bacon and canned meat products, as well as small quantities of frozen meat.

Currently, the per capita pork consumption is very low in India, with the exception of the north-east while it is a major item elsewhere. In the European Union, 42.6 kg pork is consumed per person every year, while in the US, 29.7 kgs are consumed. Pork is a staple for Chinese, and so over 35 kg are consumed per person per year. India's consumption levels of pork are significantly low when compared to other meats, for example, 1.9 kg per person per annum for poultry meat. The total world consumption of meat is estimated to be of the order of 240 million tons per annum and India's share of consumption is only 2.2%. However, in the next ten years, it is predicted that the total consumption of pork in the country will double from its present numbers. As per capita income of individuals rises, they tend to spend on improving their lifestyle and food consumption habits.

Regional pork demand in India

1. North-East India: The eight states in North East India (Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura) are ethnically and culturally akin to South East Asia and has much higher pork consumption that the rest of the country. Of these states, Nagaland has the highest per capita consumption. Traders in both Assam and Nagaland

reported that the demand for pork was increasing along with prices.

2. South India: Pork consumption is again high in the southern states viz. Goa, Karnataka, Andhra Pradesh, Tamilnadu and Kerala.

Key production parameters

Key parameters for livestock production include the cost and availability of feed, the availability of water, and the availability of animal health services, which in turn has an impact on the animal disease situation. In India, bovines are produced both extensively and intensively. Extensive bovine production is the most important. It relies on forage and is best suited to areas where large grazing lands are available. Intensive bovine production, normally involving feedlots, is prominent only in organized export oriented units. Sheep and goats are mainly produced extensively.

Pigs are more suited to intensive production as they have a much higher feed conversion than ruminants and this in turn results in reduced feed costs. In an efficient pig production system, a pig for slaughter can put on 1 kg in live weight using less than 3 kg of feed while cattle per head can put on 1 kg in live weight using at least 5 kg of feed. So unless a high-value market is being supplied and/or feed prices are low, ruminants are best suited to forage. World pig production has now become mainly intensive with backyard production (such as in India and China) falling steadily in importance. Intensive pig production is best located in grain producing areas or in proximity to ports if there is reliance on imported feed. Disease and animal health issues play an important part in determining the location of livestock production and livestock productivity. They can also have an impact on trade as some countries may not allow meat imports from countries where certain diseases are prevalent.

Quality of livestock for meat production

There can be large differences in the yield and quality of livestock for red meat production. Livestock yield and quality will depend upon a number of factors, including a) the weight of the slaughter animal and hence the yield of meat; b) the degree of finish (influenced by the feeding regime) and hence proportion of lean meat; and c) the age of the animal as a younger animal will normally produce a higher quality of meat. Such variations can be related to the breed of animal, the availability of feed and forage, and management practices. If animals are transported to the abattoir and then held there before slaughter, it is important that they are not stressed as stress has an impact on meat quality. Stress can occur as a result of transportation over long distances,

food and water deprivation, and rough handling or fighting. It can result in the meat being tough or in the case of pigs, it can result in the meat being pale, soft and exudative (referred to as PSE), with a loss in muscle structure. In addition, when an animal is stressed less lactic acid is produced, resulting in a high pH value and encouraging rapid bacterial growth.

Environmental issues

The meat processing sector (slaughtering and downstream processing) is a heavy user of water, especially during the slaughtering process, and energy, especially during refrigeration and further processing. The slaughtering process also generates considerable quantities of waste material that have little or no economic value. The waste is often disposed of with little or no treatment (landfill). This is particularly the case in outdated slaughtering facilities that have little or no modern equipment, a feature of the meat processing industry in many parts of the world. Such practices are increasingly unacceptable. Much of the waste could have an economic value such as use in power generation, soil improvement and even a food source if properly processed.

Description of the pork processing chain

The main stages in the pork processing chain are the following:

Primary processing that involves:

- taking live animals into lairages (the resting of animals prior to slaughter) and conducting a preslaughter inspection (including sometimes recording of the live weight);
- slaughtering/dressing, which in larger plants takes place at the point where the animal is stunned and exsanguinated (bled). The carcass is then moved along a mechanized line (suspended from an overhead rail) to specific workstations at which the various processes involved in converting live animals into carcasses are undertaken. In plants that handle multispecies, there is a separate slaughter line for each species;
- chilling of carcasses in refrigerators to specified deep-muscle temperatures (the specified temperature is 7oC for carcass meat and 3oC for offal);
- cutting of deboned primal (chilled carcasses or half or quarter carcasses) and then vacuum packing, boxing and palletizing the products; and storing in refrigerators. Refrigerated storage is used for the short-term storage of the meat before sale as fresh product or before transfer for secondary processing. It is also used for the ageing/maturation of meat

to improve the eating quality. For longer life, products need to be frozen.

Secondary processing that involves:

- cutting up primals into smaller, fresh cuts of meat such as consumer portions of steaks and chops. This process ends with the packing/labelling of the product for sale through either the retail sector or food services;
- preparing and dicing and mincing meat to produce, for example, comminuted meat (packed and chilled or frozen for longer life) for sale as fresh product or for use in further processing;
- preparing fresh meat and recipe products such as burgers, sausages and reformed products, and ready-to-cook convenience meats breaded and coated, with flavourings or seasonings; and
- cooking, curing, drying/smoking or canning fresh meat to produce manufactured products that include prepared foods and ready meals for which meat is an ingredient.

In smaller, low-throughput "artisanal" plants, the whole slaughtering process is usually carried out in one small "slaughter hall" and accompanied by basic chilling (although some of the fresh meat is sent for butchering soon after slaughter), with meat products (typically dried/cured sausages) being produced in an adjoining room.

Differences in the dressing process for pigs

- The process for buffalo/sheep/goat and pigs differs after bleeding, when pig carcasses are then subjected to thorough additional treatment to clean and remove the bristles from the skin. In larger plants this process involves immersing the carcass in a tank of very hot water or in a steam chamber to scald the skin and soften the bristles, which are then removed with rotating scrapers. The carcass is then singed (passing it by flame jets) to remove any surplus bristles and finally polished (by softer rotating paddles). If the skin is to be removed, it will be done at this point before evisceration (usually by machine).
- In some small, low throughput plants, carcasses are sometimes only washed and the bristles are shaved off.
- In addition, the head and feet of pigs are usually left on the carcasses.

Key variable cost factors in red meat production

There are three major areas of variable costs that are of crucial importance

to the commercial viability of an abattoir/meat processing facility:

- Labour: This is a very important element of the operational cost of an abattoir/meat processing facility. It is not only the cost of the labour involved in slaughtering and cutting but also the higher cost of the more highly skilled labour involved in veterinary inspection and quality control (including carcass assessment and grading).
- Waste disposal: The waste material (as defined above) with commercial potential can be processed to derive a return rather than to constitute a disposal cost.
- Energy and water: The costs of energy and water can vary significantly from country to country but the long-term environmental objective must be to reduce these costs. Water usage per animal slaughtered can also vary considerably and in modern plants can be one-half of the normal average usage.

16
Pork Industry vis-à-vis Meat Industry in NER

The NER is the amalgamation of eight states viz. Arunachal Pradesh, Assam, Meghalaya, Mizoram, Manipur, Nagaland, Sikkim and Tripura that shares more than 2000 km of border with China, Nepal, Bhutan, Myanmar and Bangladesh. The region is connected to the rest of the country by a narrow 20 km corridor of land which in coined as "Chicken Neck" by the local people. While going through a glimpse of the region, it is seen that the Region's climatic condition, traditions, habits and culture, food habits and other culinary practices are similar to South East Asian Countries. The dominant proportion of inhabitants of NER is from Mongoloid origin viz. Myanmar, China, Thailand, etc.

The region covers an area of 7.9% of the country's total geographical area and provides shelter for only 3.8% of the total population. Approximately, 225 out of 450 tribes of India reside in the region and they have more than 1200 distinct races and sub-tribes within the tribes that are in record. The entire North East is full of lush green valleys, mountains, springs, green vegetation, flora & fauna. Because of these rich natural resources, the region is identified as one of the world's biodiversity hot spot area. Around 52% of the total land area of this region is covered by forest. The region shares about 5.8% of the countries domesticated animals apart from rare varieties of wild animal species.

The economy of the people largely depends upon the income generated both from crop and animal production. The people of NER have strong preference for foods of animal origin. The ethnic and tribal groups are confined to their traditional food habit and customs where consumption of meat is an integral part. They produce verities of meat and poultry products since time immemorial. Diversity in tradition and culture among different communities in NER has resulted in large varieties of traditional meat products. However, there is a large gap between the demand and supply of meat and meat products consequent to which NER imports huge quantities of fresh and processed animal foods from outside the region. To meet the ever-increasing demand for meat, varieties of non-conventional meats obtained from Mithun, Yak, Deer, Rabbit, Dog, Jackal, Monkey Elephant, Rhinoceros, Snake, Mongoose, Frog and Tortoise etc. are also consumed frequently, although, wild animals are not permitted to be killed under Wild Life Protection Act. There is a great threat to our wildlife because of their indiscriminate killing as food animals.

With more than 90% of the NER population being non-vegetarian against the national average of 70%, there is demand for meat and other animal products. To meet the ever rising demand, meat from both conventional and non-conventional animals is equally consumed in many parts of the region. Apart from this, meat is being used in religious and social functions. A sizeable portion of meat is processed using their indigenous method and ingredients. Some of the meat products are preserved years together at normal room temperature. Some hidden indigenous technologies are applied which need to be explored for commercial exploitation. So far a glimpse of the NER and its people and meat eating habit etc. are given in the foregoing paragraphs. However, the discussion was restricted to the tribal people residing in the hilly areas which comprises of 75% of the total population. The rest 25% are non-tribal and they migrated to this region and settled permanently either in the Brahmaputra Valley or the Barak Valley of Assam and few capital cities and towns of NE states.

Scope of meat industry in NER

The NER offers a tremendous scope for development of meat industry. Inspite of many advantages for establishing meat industry in NER, not a single state is in a position to recognize their meat trades as a major industrial venture. The “Five M” principles viz. Man, Money, Machines, Materials and Market which are prerequisite and complementary to each other to establish an industry are moderately applicable to meat industry in NER. The vast scope and potential lying in NER for establishment of meat industries may be realized from the under mentioned discussion.

a) **Highest consumer concentration:** The traditional meat eating habits of the people of NER which accounts for more than 90% against the national average of 70% offers tremendous scope for setting up of meat industries and their expansion in future. No food industry will thrive without active participation of the consumers. The region is blessed with large number of meat eaters because of their strong preference for foods of animal origin and their relationship with the Mongoloid culture of South East Asian Countries. It is found that Mongoloid people need more Iron in their blood so as to support normal respiratory process at higher altitude and meat is a good source of Iron. The number of consumers is also increasing at a steady rate.

b) **Meat animal production potential:** The region shares around 5.8% of the total food animals for 3.8% of total human population in the country. At present, food animal population density including poultry for every thousand human population in NER is 768 compared to national

density of 487. In spite of so much of food animal resources in NER, large number of live animals, particularly pig, goat, cattle and poultry are regularly imported to the region to meet the demand for food animals. Similarly, a huge number of animals are also smuggled out through our international borders to neighbouring countries, mostly through informal trade. Enhancement of production of conventional meat animals will also help in conservation of wild life as the insufficient supply of meat from conventional animals leads to indiscriminate killing of wild animals. Therefore, great scope is lying to produce meat animals in the region to meet the growing demand.

c) **Strategic location, look east policy and export potential:** Although the region is neglected by the main land, it has the advantage that it is strategically located with an access to most of the domestic markets of eastern India along with proximity to five South East Asian Countries. Its location opens up vast opportunities for future international trade and commerce. Economic integration with its transitional neighbours is expected to usher new opportunity for the region. India's Look East Policy marked a strategic shift for a closer and deeper economic integration with eastern neighbourhood. No initiation has been taken to export of animal products to Asian countries through the NER. Once the international border is opened for trade and commerce, the export will be easier and cheaper. The way the meat industry is flourishing in Maharashtra and Mumbai, because of its proximity to Arab and Middle East Countries, the same way the meat industries will flourish in NER if international border is opened for trade. The geopolitical advantage has not been translated into region's economic development.

d) **Meat processing and value addition both for indigenous and exotic products:** Varieties of indigenous meat products are being manufactured by different ethnic and tribal groups in NER. They do so because of difficult terrain, transportation bottlenecks, economic backwardness and non-availability of modern processed meat products in remote areas. As a result, most of the people are bound to adopt their own method of preparation which is comparatively cheaper. However, the meat consumers are not without problems. They often face problems like food poisoning probably due to wrong preservation technique and unhygienic handling method. Therefore, enormous potentialities for meat processing are there in NER. Some of the traditional meat products may be upgraded and popularized as value added convenience products of good palatability.

e) **Modern slaughter house, by-product utilization and setting up of carcass utilization plant:** Except one in Nazira, Sivasagar, Assam, which has a capacity of 400 pigs/shift, no other states have modern centralized pig slaughter houses in NER. Slaughter houses generate a wide variety of by-products suitable for further processing. There are many advantages of utilization of by-products, the important being extra income generation, human food, animal feed, pharmaceutical, cosmetic products preparation, environmental pollution control and organic fertilizer preparation etc. It can even provide employment opportunity to thousands of educated youths. Thus, it is a road from waste to wealth. Unfortunately, the region does not have any scientific modern by-product processing or carcass utilization centre till date. Most of the by-products are now going waste or sent to outside for processing. This area needs to be brought into active consideration of State, Central Government and private entrepreneurs.

f) **Human resources development:** Shortage of manpower in the animal husbandry sector especially in production and processing of meat is a major concern in the region. To meet the growing demand for high value livestock products in most hygienic way, thousands of veterinarians, meat specialists and skilled technicians will be required in coming years. Except a few veterinary colleges, no other educational institutions are available to develop human resources in this specialized area. Thus, there is need for resource allocation to establish few more food technology institutes in the NER so as to provide quality human resource.

g) **Special economic zone:** The region has been declared as special economic zone by the central Government. The central Govt. has implemented various schemes to attract investors such as 90% transportation subsidy, 50% transportation subsidy for finished goods, income tax exemption for new industries etc. Any entrepreneur can avail this opportunity in NER.

Challenges for meat industries in NER

Most of the scopes that we have discussed in the foregoing pages can be considered as challenges for development of meat industry in the NER. Meat trade is still in infant stage, unorganized and need to be revamped urgently. Few of the challenges faced by the meat trade in NER are mentioned below:

a) **Poor productivity of livestock and non-availability of superior**

germ plasm. The productivity of indigenous food animals of NE region is very poor compared to other parts of the country. The basic reason for poor productivity is the absence of good meat breeds of livestock. Crossbreeding programmes is in vogue in all the states of NER, however, these are not enough to meet the demand. A sound breeding policy suiting the need of the region with superior germplasm is the need of the present time.

b) **Managemental problems.** The traditional tendency of rearing livestock at *"Zero Inputs and Low Outputs*" needs to be changed to *"High Inputs and High Outputs"* basis of management in the NER. Except in a limited areas where intensive management system is practised for cross bred animals, in most of other places, animals are let loose throughout the day for open grazing with minimum attention. This managemental practice is very detrimental.

c) **Feed and fodder crisis.** A big challenge of livestock sector and poultry in the NER is short supply of feed & fodder. The region highly depends upon the mainland for supply of feed ingredients. Commercial fodder production is not successful because of high investment and free grazing system of management where guarding of fodder plots is not possible by small farmers.

d) **Inaccessibility, remoteness and transportation bottleneck:** The region is handicapped with poor road connectivity and difficult geo-physical terrain. Except the highways, connecting roads to most of the villages are in deplorable condition. The tribal communities are living widely scattered and isolated condition. Transportation to those places is very troublesome. Therefore, it is difficult to take common and cohesive socio-economic programmes for the region. The region has an advantage of extensive international border however, it has failed to convert its strength optimally into growth opportunity due to underdeveloped road connectivity.

e) **Vulnerability to natural calamities:** The high vulnerability to natural calamities viz. seasonal flood and erosion, landslide, snow falling etc. result in low and uncertain productivity. Even there is hesitation in the minds of entrepreneurs to take up business ventures due to these reasons.

f) **Inadequate cold chain facilities:** Meat being a perishable item needs strong cold chain facilities along its whole marketing channel. Poor infrastructure and lack of adequate cold chain facilities are one of the stumbling blocks in the path of growth of meat industry.

Table 1. Details of state wise meat production in India (in million kg)

Sl. No	State	Beef	Cara beef	Mutton	Chevon	Pork	Poultry	Oth-ers	Total
1	Andhra Pradesh	3.31	41.9	97.75	43.28	0.60	267.89	-	457.1
2	Arunachal Pradesh	-	-	-	-	3.30	-	-	20.00
3	Assam	4.53	0.40	0.19	5.07	13.00	6.46	-	26.64
4	Bihar	22.0	38.00	1.00	62.00	61.00	-	-	176.0
5	Chattis-garh	-	-	0.70	2.60	0. 80	-	-	3.88
6	Goa	-	-	-	-	0.03	-	-	-
7	Gujarat	0.27	2.44	0.73	1.39	0.1	13.29	-	18.20
8	Haryana	-	-	24.09	34.73	3.50	-	-	73.27
9	Himachal Pradesh	-	-	0.80	1.87	0.1	-	-	2.94
10	J&K	-	-	-	-	-	-	-	27.00
11	Jharkhand	-	-	3.71	23.98	16.00	-	-	42.80
12	Karnataka	15.3	8.44	30.04	20.55	12.00	10.52	-	99.80
13	Kerala	31.4	13.48	-	6.71	3.40	-	-	55.92
14	Madhya Pradesh	-	9.39	0.62	8.64	0.90	-	-	19.45
15	Maharash-tra	61.8	88.64	26.36	53.88	5.58	-	-	236.28
16	Manipur	6.59	3.37	0.09	0.27	7.40	5.42	-	23.00
17	Meghalaya	20.9	0.46	-	1.02	10.00	3.65	-	36.54
18	Mizoram	1.43	0.04	-	0.08	5.30	1.37	0.01	9.24
19	Nagaland	25.8	3.15	-	3.65	31.0	-	-	63.25
20	Odisha	0.01	-	9.08	38.12	11.00	-	-	52.04
21	Punjab		-	1.55	2.56	0.50	-	-	4.46
22	Rajasthan	-	-	-	-	4.10	-	-	-
23	Sikkim	-	-	-	-	-	-	-	
24	Tamil Nadu	8.61	6.33	17.17	17.18	0.70	68.71	-	118.6
25	Tripura	-	-	-	1.26	7.60	5.63	0.03	12.22
26	Uttar Pradesh	-	147.9	5.04	33.10	14.0	-	-	198.3

27	Uttrakhand	-	1.47	1.27	2.69	1.20	-	-	6.19
28	West Bengal	125	10.45	16.62	152.23	23.00	150.99	-	487.2
29	A&N Islands	-	0.06	0.02	-	0.20	0.10	-	0.29
30	Chandigarh	-	-	0.29	0.34	0.40	-	-	1.10
31	D & N Haveli	-	-	-	-	-	-	-	-
32	Daman & Diu	-	-	-	-	-	-	-	-
33	Delhi	-	26.46	3.17	1.58	-	-	-	31.20
34	Lakshdweep	-	-	-	-	-	-	-	-
35	Puducherry	1.11	0.13	0.27	2.57	0.10	2.58	-	6.71

Table 2. Details of meat production in North Eastern India

2a. District wise meat production in Assam ('000 tons)

Sl. No.	District	Indigenous cattle	Cross-bred cattle	Buffalo	Goat	Sheep	Pig	Fowl	Duck	Total meat
1.	Goalpara	0.16	0.01	0.02	0.22	0.02	0.20	0.14	0.06	0.64
2.	Dhubri	0.32	0.01	0.02	0.31	0.02	0.26	0.22	0.06	0.87
3.	Kokrajhar	0.12	0.01	0.02	0.21	0.01	0.57	0.17	0.07	1.03
4.	Bongaigaon	0.13	0.01	0.02	0.22	0.02	0.26	0.19	0.06	0.75
5.	Barpeta	0.19	0.01	0.03	0.29	0.03	0.22	0.24	0.08	0.86
6.	Nalbari	0.18	0.01	0.01	0.21	0.02	0.26	0.19	0.05	0.73
7.	Kamrup	0.35	0.04	0.02	0.37	0.00	0.74	0.35	0.04	1.50
8.	Baksa	NA	NA	NA	NA	NA	NA	NA	NA	NA
9.	Udalguri	NA	NA	NA	NA	NA	NA	NA	NA	NA
10	Darang	0.20	0.01	0.03	0.25	0.01	0.35	0.19	0.08	0.88
11	Sonitpur	0.27	0.02	0.02	0.30	0.01	0.60	0.27	0.11	1.29
12	Lakhimpur	0.21	0.02	0.02	0.17	0.00	0.64	0.30	0.09	1.20
13	Dhemaji	0.18	0.01	0.02	0.19	0.00	0.83	0.18	0.07	1.27
14	Morigaon	0.12	0.01	0.02	0.16	0.01	0.14	0.15	0.03	0.49

15	Nagaon	0.30	0.03	0.02	0.30	0.00	0.25	0.23	0.05	0.83
16	Golaghat	0.15	0.02	0.01	0.19	0.01	0.57	0.21	0.08	1.06
17	Jorhat	0.13	0.01	0.01	0.21	0.00	0.39	0.22	0..06	0.82
18	Sibsagar	0.14	0.01	0.01	0.14	0.00	0.38	0.19	0.06	0.77
19	Dibru-garh	0.24	0.02	0.01	0.24	0.00	0.85	0.15	0.09	1.33
20	Tinsukia	0.20	0.01	0.01	0.21	0.00	0.57	0.18	0.01	0.97
21	Karbi Anglong	0.21	0.02	0.02	0.24	0.00	0.82	0.44	0.05	1.55
22	N.C. Hills	0.05	0.01	0.01	0.11	0.00	0.42	0.19	0.03	0.75
23	Karimganj	0.13	0.01	0.02	0.19	0.01	0.16	0.19	0.07	0.62
24	Hailakan-di	0.05	0.01	0.02	0.18	0.02	0.22	0.18	0.02	0.62
25	Cachar	0.21	0.01	0.03	0.18	0.01	0.33	0.25	0.07	0.84
	Total	4.24	0.33	0.42	5.09	0.20	10.33	5.02	1.33	26.96

2b. District-wise meat production in Meghalaya ('000 Tons)

Sl. No.	District	Cattle	Buffalo	Sheep/ Goat	Pig	Poultry	Total
1.	East Khasi Hills	11.42	0.04	0.50	5.53	2.40	19.89
2.	Ri-Bhoi	1.63	0.02	0.06	0.65	0.20	2.56
3.	West Khasi Hills	2.78	NA	0.02	1.03	0.28	4.11
4.	Jaintia Hills	1.70	0.18	0.15	1.27	0.30	3.60
5.	East Garo Hills	1.05	0.02	0.08	0.56	0.14	1.85
6.	West Garo Hills	1.93	0.20	0.17	1.12	0.30	3.72
7.	South Garo Hills	0.48	NA	0.04	0.29	0.04	0.85
	Total	20.99	0.46	1.02	10.45	3.66	36.58

2c. District-wise meat production in Mizoram ('000 Tons)

Sl. No.	District	Cattle	Buffalo	Mithun	Goat	Pig	Poultry	Total
1.	Mamit	0.03	0.002	0	0.01	0.16	0.03	0.23
2.	Kolasib	0.07	0.00	0	0.01	0.31	0.03	0.42

3.	Aizawl	0.86	0.01	0.001	0.032	3.70	1.07	5.67
4.	Champhai	0.11	0.01	0.004	0.004	0.41	0.05	0.59
5.	Serchhip	0.06	0.01	0.001	0.002	0.31	0.04	0.42
6.	Lunglei	0.18	0.002	0	0.010	0.73	0.06	0.98
7.	Lawngtlai	0.06	0.002	0	0.004	0.34	0.04	0.45
8.	Saiha	0.06	0.01	0.002	0.01	0.36	0.04	0.49
	Total	1.43	0.05	0.01	0.08	6.32	1.36	9.25

2d. District-wise meat production in Nagaland ('000 Tons)

Sl. No.	District	Cattle	Buffalo	Sheep/ Goat	Pig	Total
1.	Kohima	3.76	0.21	Goat	5.34	9.78
2.	Dimapur	9.98	1.56	2.06	6.57	20.17
3.	Mokokchung	1.92	0.10	0.14	2.76	4.92
4.	Tuensang	1.70	0.01	0.15	2.23	4.09
5.	Wokha	2.02	0.09	0.43	3.63	6.17
6.	Phek	0.80	0.23	0.08	2.79	3.90
7.	Zunheboto	2.22	0.07	0.11	2.67	5.07
8.	Mon	1.50	0.30	0.09	2.07	3.96
9.	Peren	0.81	0.58	0.02	1.12	2.53
10.	Kiphire	0.64	NA	0.08	1.00	1.72
11.	Longleng	0.43	NA	0.02	0.49	0.94
	Total	25.78	3.14	3.65	30.67	63.25

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Opportunities for Start-Ups in Pork Processing

Most small businesses start with an idea which, combined with an entrepreneurial spirit, can be turned into reality. Undertaking a feasibility study and preparing a business plan are essentially first steps for business success and are of vital importance to new enterprises and those considering expansion or diversification. Simply having a 'good idea' is not enough. A feasibility study asks questions and provides the information needed to write a business plan. The amount of detail required in the business plan will be related to the size and complexity of the planned business venture and the need for financial support from formal institutions such as banks. However, even a microenterprise, funded by family resources, will benefit greatly from writing a plan and highlighting areas that need investigation.

Steps to start a pork processing business

The following is a list of the basic steps to start a business in meat processing. While each business is unique and subject to specific product requirements, the list below outlines the overall process. The steps are grouped by topic. Keep in mind that each topic affects the others: your product type and packaging will affect your labels; the ingredients to make your product will affect your cost and production plans.

The Product:

1. Develop a prototype. Test it out on family and friends. Collect and incorporate feedback on flavor, texture, and appearance.
2. Determine the market form you would like the product to have: refrigerated, shelf-stable, frozen, smoked, cured, etc.
3. Determine the batch size you will need for commercial operation. A good start-up size for solid meat products will be 200-250 g/packet.
4. Consult an expert or Process Authority to scale up your recipe. Take the following into consideration:
    - The formulation may change due to regulatory and food safety requirements.
    - Testing (pH, water activity, etc.) may be required for compliance with regulations.
    - It may take several attempts to achieve a scaled-up product

comparable to the original; ingredient amounts will not change proportionately.

5. Get approval for your recipe from a Process Authority i.e. Food Safety and Standards Authority of India (FSSAI). This resulting document, a Scheduled Process, will help to avoid product safety and quality issues.
6. Determine the cost of ingredients based on your approved, scaled-up recipe.

Business Planning:

1. Write a Business Plan. It will help you focus your business goals and determine if you need funding.
2. Consider liability insurance. It is affordable and can protect personal assets in the event of a problem with your product.
3. Determine a form for your business: sole proprietorship, corporation, partnership, limited liability etc.
4. Register your business with the Central and State authorities, as applicable. Fill out and submit the required forms to licensing/ registering authorities.
5. Get assistance from business resources: state agricultural departments, state extension organizations, NABARD, local economic development agencies etc.

Labels:

1. Decide on a product name.
2. Determine applicable regulatory requirements. Ask your state regulatory officials for help or contact FSSAI. Consult the FSSAI Food Labeling Guide.
3. Determine what storage information must be on your package: refrigerate, refrigerate after opening, etc.
4. Choose a size and shape, which is compatible with your packaging.
5. Invest as much in your label as possible. They are the first thing customers will see.
6. Make test labels, or labels for small, initial, batches, on a computer printer to cut costs.
7. Decide if you wish to make health or nutrient claims. If you do, you must

have nutritional analysis done and invest the time and money for FSSAI compliant nutrition labeling.

8. Decide whether or not to invest in a bar code. The yearly fee is based on the number of products and gross sales, but most large stores and chains will not consider your product without one. If you do not plan to sell to large distributors, you don't need one.

Market decisions:

1. Write a Marketing Plan. It is a framework for research on competition, ceiling prices, target markets, etc. and structures your marketing goals and methods.
2. Decide where you will sell your product. Generally, start off small – at farmers markets, fairs, roadside stands, etc. These are also good places to test market your product.
3. Determine a selling price for your product, taking the competition and your financial needs into account.
4. Develop a distribution method: your car, the mail, a fellow specialty food entrepreneur or distributor.

Production:

1. Decide where you will produce your product: commercial kitchen, pilot plant, or co-packer.
2. Obtain all necessary permits and approvals, both Central and State, required for food manufacturing.
3. Find storage space for ingredients, packaging, and the final product.
4. Schedule time with experts at the production facility to learn about equipment.
5. Determine when, based on ordering supplies, you can produce and package product.
6. Schedule time at a processing facility to produce your product.

Pros and cons of starting a pork processing business

The pork processing business can be rewarding and exciting. It can also be a real struggle. Listed below are some pros and cons of starting and running your own meat processing business. The list is intended to provide a realistic picture of meat product processing. Keep in mind that several of the

items listed are qualitative, that is, their importance depends largely on how strongly one feel about them.

Advantages:

- Being one's own boss
- Creating your own work environment: hours, flexibility, etc.
- Doing something in which you believe
- Reaping the benefits of hard work and long hours directly
- Variety, challenges, and opportunities for creativity, full use of knowledge
- More open earning and growth potential
- Satisfaction of a successful venture, a product well received
- Empowerment

Disadvantages:

- Risk of failure
- Time Commitment – 60-70 hr per week is normal
- Financial strain as assets become tied to business start up and success
- Strain on family due to financial and lifestyle change
- Emotional burnout
- Unavoidable business roles/requirements you'd rather not fill
- Rejection of the product by consumers

Should one decide to pursue a meat processing business venture, there are a number of things he/she can do to minimize risk and maximize your chance of success:

- Develop a Business Plan
- Regularly review your business plan to remind yourself of goals and maintain focus
- Develop a marketing plan
- Learn and follow food regulations and requirements
- Maintain accurate, current records

- Analyze the financial status on a regular basis and make necessary adjustments
- Learn to recognize and solve problems promptly
- Draw a line between the personal life and the business life and stick to it.

Marketing considerations for small-scale meat processors

Small-scale meat processors face unique challenges and opportunities when marketing their products. If the venture is to be successful, the processor must decide what market the product will thrive in, what the competition is, and how to market the product given the processor's available resources. A marketing plan facilitates business success by requiring the processor to address each of these marketing issues through marketing goals and strategies. The research necessary for marketing plan development also prevents entry into an unprofitable business venture.

The marketing goals should meet the following "SMART" criteria:

1. **S**pecific – for example, earn 10,00,000 in net sales
2. **M**easurable - target date for completion
3. **A**ttainable – not so high that you cannot reach them
4. **R**ewarding – they reflect the reasons you started the business in the first place
5. **T**imeline – they should include short term and long-term goals

Once goals have been defined, the entrepreneurs must research the existing market place and competition (market & competitive analysis). In addition, the entrepreneurs must test market the product and evaluate the results. This test will indicate how and if the marketing goals can be reached, given the entrepreneur's available resources. Analysis of test marketing also provides a basis for a marketing strategy for the product. As part of the market strategy, the meat processor must pursue venues for product introduction to the market place. One of the most cost-effective methods is through direct marketing at local farm stands, farmers markets, and festivals. The product's reception at these outlets is a good indication of how the product will be received in the larger market place. An added benefit comes from meeting customers face-to-face, providing an opportunity to determine customer preferences and get a sense of the reasons people buy a product. This information can give entrepreneurs new marketing ideas or revise existing ones. Even the most

established producers try out new ideas and products at local markets. This is a good time to study the competition, identify trends in local and regional specialty food items, market size, and pricing. Further information on product availability and pricing can be found on the web (on-line) by searching for the product type in your favorite search engine.

The marketing strategy for a product must be re-evaluated and revised whenever changes in the business, the market, or the product occur. For example, as the business expands, the entrepreneur may decide to hire a co-packer to handle the manufacturing. The entrepreneur may also decide to hand over product distribution to a distributor. This distributor sells to retailers and other distributors, developing new markets for the product. The above changes in the business will affect product price, the product's position in the market, and the amount of profit the entrepreneur receives from each unit sold. Since the product's market attributes have changed, a new market strategy is necessary. As the business grows, you will need to research national markets for wider distribution. Attending trade shows for specialty foods will broaden your view of the specialty food business and market in such areas as the gift trade, health food stores, ethnic foods, and the export market. As you expand your marketing views, your marketing plan must expand to include them.

18
Industry Legislations Pertaining to Pork and Pork Products

Meeting the demands of the seemingly ever increasing legal requirements affecting the meat industry can seem an overwhelming task. The safe production of meat is a fundamental legal obligation of the meat business operator and Competent Authorities have a duty to undertake official controls and enforce the regulations. Food Safety and Standards Act, 2006 emphasises every food business operator's responsibility to produce food safely by applying good hygienic practices and food safety management procedures based on hazard analysis and critical control point (HACCP) principles. Operators are expected to apply good hygiene practices and food safety management procedures to control food safety hazards. These procedures should cover adequate training and/or instruction of staff, working instructions for staff, including what to do in the case of foreseeable disruptions to normal working, such as breakdowns or contamination incidents, periodic verification checks to see if working instructions are being followed continuously and properly, corrective actions to restore control if food safety management procedures fail; including dealing with any contaminated product; establishing the underlying cause of a failure; preventing similar incidents in the future, and confirming (verifying) that company procedures meet legal requirements. This article is structured to provide a holistic view to the reader about FSSAI Act, 2006 and basic quality systems applicable to the food industry with special reference to meat industry.

Quality: What do we mean by it?

The American Society for Quality Control (ASOC. 1987) defines quality as 'the totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs'. The term quality has come to embody stringent standards in industrial operations, products and services. To consumers, quality implies that products will perform as stated by the vendor and that services will be reliable. To the meat industry, quality can be interpreted as satisfying the consumer expectations in terms of specific product quality attributes such as food safety, aesthetics, convenience and nutrition.

It is very important that modern meat industry companies define the quality standards for the specific customers they serve. Customers are more demanding than ever and, in general, will seek products and services

offered by companies that have a reputation for adhering to stringent quality standards. To remain profitable, meat processors must increasingly strive for quality improvement and more uniform products. If these industries are to realize customer confidence and long term benefits in the future, quality must always be a top priority.

I. Food Safety Standards Authority of India

The Central Government has established a body known as the Food Safety and Standards Authority of India to ensure availability of safe and wholesome food for human consumption and matters connected therewith and incidental thereto. The head office of the Food Authority is located at New Delhi and is responsible for implementing Food Safety Standards Act, 2006. The Act provides for consolidation of laws relating to food and to establish the Food Safety and Standards Authority of India for laying down science based standards for articles of food and to regulate their manufacture, storage, distribution, sale and import, to ensure availability of safe and wholesome food for human consumption.

Salient features of FSS ACT, 2006: The Act provides for consolidation of laws relating to food and to establish the Food Safety and Standards Authority of India for laying down science based standards for articles of food and to regulate their manufacture, storage, distribution, sale and import, to ensure availability of safe and wholesome food for human consumption. Some of the salient features of the Act are:

1. Movement from multi-level and multi-department control to a single line of command
2. FSSAI as a single reference point for all matters relating to Food Safety and Standards, Regulations and Enforcement
3. Integrated response to strategic issues like Novel foods, Health Foods, Nutraceuticals, GM foods, international trade etc.
4. Decentralisation of licensing for manufacture of food products
5. Achieve high degree of consumer confidence in quality & safety of food
6. Effective, transparent and accountable regulatory framework within which the industry can work efficiently
7. Investors friendly regulatory mechanism with emphasis on self regulations and capacity building
8. Emphasis on gradual shift from regulatory regime to self compliance

9. Consistency between domestic and international food policy measures without reducing safeguards to public health and consumer protection
10. Adequate information dissemination on food to enable consumer to make informed choices.
11. Graded penalty depending upon the gravity of offences
12. Adequate representation of government, industry organizations, consumers, farmers, technical experts, retailers etc.
13. Enforcement of the legislation by the State Governments/ UTs through the state Commissioner for Food Safety, his officers and Panchayati Raj/Municipal bodies

The Act, inter alia, incorporates the salient provisions of the Prevention of Food Adulteration Act, 1954 and is based on international legislations and instrumentalities. In a nutshell, the Act takes care of international practices and envisages a overreaching policy framework and provision of single window to guide and regulate persons engaged in manufacture, marketing, processing, handling, transportation, import and sale of food. The Act is contemporary, comprehensive and intends to ensure better consumer safety through Food Safety Management Systems and setting standards based on science and transparency as also to meet the dynamic requirements of Indian Food Trade and Industry and International trade. The Food Safety and Standards Act, 2006 is an attempt to have single reference point for all matters relating to Food Safety and Standards, regulations and enforcement. Suggested for effective, transparent and accountable regulatory framework with investors friendly regulatory mechanism with emphasis on self regulations and capacity building. More responsibility has been left on the part of Food Businesses to ensure safe and quality food for the consumers. The Act has empowered the consumers by more emphasis on adequate information dissemination on food to enable consumer to make informed choices and achieve high degree of consumer confidence in quality & safety of food. Local Panchayat and Municipalities are also considered to be involved in the implementation of Act to have the spread of concept of food safety up to grass root level. Food regulations are mandatory and must be complied with by the processor and enforced by the food safety regulatory authorities in all cases, because violations constitute offences.

Under the Article 31 of FSS Act, 2006 (Food Safety and Standards (Licensing/ Registration of Food Businesses) Regulations, 2009, lays down Licensing and Registration conditions which are compulsory for any food business. Any

person desirous to commence or carry on any food business shall make an application to grant of a License to the Designated Officer along with fees. The provision of obtaining a licence for carrying on any food business shall not apply to a petty retailer, hawker, itinerant vendor or a temporary stall holder or small scale or cottage or such other industries relating to food business or tiny Food Business Operator. But they shall have to register themselves with the registering authority. Licensing procedures have been unified under the FSS Act 2006, to be implemented by the Food Safety and Standards Authority, Food Safety Commissioner in the States and the officers working under the Commissioner. Common application forms and procedures have been laid down to bring out uniformity of the food standards in the country as mandated by the Food Safety and Standards Act. As mandated by the Act, a distinction has been introduced between "registration" and "licensing". Cut off limits for registration and licensing have been proposed. Food sub-sectors which are currently under the control of the Government of India have been retained and unified. In addition, sectors which have high potential for food contamination and hazard have been brought under central licensing. This includes food service establishments under the various organs of the Government of India and interstate operations of large food businesses. Set of safety, sand hygiene conditions have been laid down for registration/ licensing according to the potential for food related hazards.

II. Total quality management

Total quality management (TQM) can be defined as an effort for continuously improving the quality of all processes, products and services through universal participation of all employees that leads to greater customer satisfaction and loyalty, and improved business results. The results of TQM is that companies supply products and services that are economical, useful, competitive and of uniform quality. The TQM approach requires a company to develop a strategy, involving all levels and function of the company that focuses on satisfying the customer. Everyone involved in TQM will have a new 'mind set' towards quality. Consequently, there will a drastic and permanent change in the 'culture' of the company, giving company personnel an entirely new focus on quality improvement.

Because the TQM approach, in many respects, is foreign to current and past management procedures, management must undergo a transformation of philosophy in order to execute TQM. For example, a company operating with a TQM system will not award contracts to suppliers based solely on the lowest bid, but will alternatively develop a long term, mutually supportive relationship to assure that suppliers provide the stipulated quality. The company will

utilized teamwork to build quality into its products or services, relying heavily on input from suppliers and customers in order to continuously improve all processes and services. Also, managers will not be evaluated solely by profits nor employees solely by production quotas; instead, quality will be emphasized over production throughout statistics. Statistical process control procedures will be employed to determine product quality variation so that continuous quality improvement can be effectively measured. Employees at all levels need to be trained and empowered to correct problems on their own initiative, and barriers that typically rob workers of pride in their workmanship must be removed.

Phases of TQM implementation

There are five phases necessary for the successful implementation of TQM. These include 1. Preparation, 2. Planning, 3. Assessment, 4. Implementation and 5. Diversification. The initial phase, preparation, is unique relative to other phases in that it has a definite beginning and end. The other phases evolve over time and are continuous. In the preparation phase, key executives of the company, with the aid of a professional facilitator, prepare a vision statement, set goals and write a policy that supports the strategic plan of the company. The preparation phase concludes with a commitment of resources necessary to plan for TQM implementation. Planning lays the foundation for change within the organization. In this phase, the implementation plan is developed and resources are committed for specific objectives.

The assessment phase involves exchange of information necessary to support the preparation, planning, implementation and diversification phases. It consists of surveys, evaluations, questionnaires, and interviews throughout all levels of the company. Implementation entails training managers and workers with the intent of evaluating and improving processes and implementing change. Finally, diversification may be performed after successful completion of the previous stages. If TQM has a favourable impact on the organization, an effort is made to include other company departments, subsidiaries and suppliers. Within the diversification phase, a company should select the best suppliers, with the ultimate goal of developing a long-term, mutually supporting relationship with a limited number of suppliers.

Creation of a TQM programme demands time, training, research and fine tuning. Successful TQM programmes require commitment and patience. Few advantages of this approach include: more uniform products and/or services, a continuous flow of products, inventory reduction, increased efficiency with price negotiations and more time working with the supplier on quality

specifications. As a consequence, good supplier/ company relationships will be developed because the company treats the supplier as a partner rather than a vendor.

III. HACCP system

The Hazard Analysis Critical Control Point (HACCP) system was established to control and monitor every step of a food process to evolve as a preventive rather than an inspection oriented quality control system. As a result, HACCP was espoused as a zero defects approach to safe food processing. HACCP is most widely defined as a systematic preventive, seven principle approach to food safety. The steps include: 1. Conducting a hazard analysis and risk assessment, 2. Determining critical control points (CCPs), 3. Establishing critical limits for the CCPs, 4. Monitoring critical limits, 5. Correcting deviations from critical limits, 6. Establishing an effective record keeping system and 7. Verifying that the HACCP programme is working correctly.

For the HACCP system to be successfully incorporated into a food process, all of the principles must be carefully implemented for the specific process. This is best accomplished within a TQM framework. The objective of a HACCP programme is to preclude problems associated with hazards (physical, chemical and microbiological) in food products. The essential preventive evaluations and corrective actions are controlled by the worker. In other words, quality control of potentially hazardous points is built into the process as production occurs versus evaluation or testing of final products. This is how the TQM concept is applied in the implementation of a successful HACCP system.

The combination of TQM and HACCP provides a total systems approach to food processing, encompassing the elements of food safety, food quality and productivity. This combined approach will stress commitment, education, preventive and corrective action, statistical control, record keeping, verification and team work. Incorporation of effective statistical, record keeping and verification procedures are critical in making the HACCP system work effectively. HACCP records should include, but not limited to HACCP team members and responsibilities, hazards associated with each CCP and corresponding preventive measures, critical limits, monitoring systems and corrective actions. To assure that the HACCP system is operating as outlined, verification procedures should include such activities as: 1. Scientific evaluation of critical limits to assure that these limits are adequate, 2. Random sample collection and analysis, 3. Frequent reviews of the HACCP plan to demonstrate its effectiveness, 4. Review of process

deviations or product dispositions and 5. Revalidation of the HACCP plan.

TQM teams, responsible for developing and implementing HACCP should comprise representatives from a variety of disciplines and workers from all levels. This type of diversity assures effective evaluation of all areas that may have an impact on safe food processing. Those responsible for developing and implementing a HACCP system within a TQM programme should not complacent and believe that a simple HACCP approach is sufficient to prevent or solve all food safety problems. Rather, a HACCP system, within a TQM programme, must entail a philosophy, culture and discipline that educates everyone in the company to anticipate and solve even the most complex problems associated with food safety.

HACCP incorporation in a TQM meat processing company

Although HACCP focuses on food safety, incorporating HACCP principles within the TQM plan allows monitoring of both food safety and food quality. In addition to the critical control points (CCPs) defined by t HACCP system, essential quality control points (QCPs) can be specified and implemented by employing the same seven principle system used for HACCP. Thus, the same procedures that are employed to define CCPs in a HACCP system can be effectively used to define QCPs in a TQM programme. Identification and monitoring of both CCPs and QCPs are necessary in an effective TQM program. It is critical to note that HACCP should deal almost exclusively with food safety issues. Therefore, CCPs should remain the priority of the HACCP system, with the QCPs being a separate but important part of QCM programme.

The five phases of TQM implementation may serve as a guide for establishing a company HACCP system. HACCP must be the cornerstone of a food processor's safety system and an integrated part of the company's quality assurance programme. In the preparation of a HACCP system, the company must be willing to set goals, commit resources, and offer management support. A HACCP team should be assembled and contain individuals with backgrounds appropriate to the food product or process. In the planning phase, the team will describe the food process, identify the intended use of the food product and develop a flow diagram that characterizes the food process. The flow diagram must be verified for the food process when assessing the HACCP plan. In addition, a hazard analysis will be conducted to identify where significant hazards may occur in the food process, and what preventive measures will be needed to control these hazards.

When the HACCP team is confident that they have thoroughly characterized the food process, the HACCP system is ready for implementation. Modifications of the HACCP plan may occur during implementation to further enhance the safety of the food process. Diversification of the HACCP system will require that the company seek cooperation from ingredient suppliers to further ensure food safety. Letters of guarantee from each supplier should indicate that the ingredients provided to the company meet the specifications of hazard levels outlined by the HACCP plan. Some elements of TQM should be considered important in the implementation of an effective HACCP programme. These include: 1. Management and employee training and education, 2. Operator control, 3. Teamwork, 4. Effective communication between management and workers and 5. Constancy of purpose by the management.

IV. ISO 9000

The ISO 9000 series of standards are relevant to all types of industries and food processing is no exemption. Adoption of ISO 9000 series of standards in meat processing companies will facilitate trade, increase confidence in outside quality systems and establish procedures for product certification. Until recently, only few Indian food processing companies have attempted ISO 9000 registration. However, several factors are now increasing interest in these standards, namely: 1. The nearly unanimous acceptance of ISO 9000 series as quality system standards, 2. The perception that ISO 9000 will be required in order to conduct business in foreign markets in future and 3. The potential for regulatory agencies to require ISO 9000 registration as a prerequisite to product certification.

ISO 9000 series is comprised of five individual standards. Three standards provide models for a quality management system. The remaining two standards are guidelines for selection and employment of the appropriate quality system. The five standards are:

ISO 9000: Quality management and quality assurance standards- guidelines for selection and use.

ISO 9001: Quality systems – model for quality assurance in design/ development, production, installation and servicing.

ISO 9002: Quality systems – model for quality assurance in final inspection and test.

ISO 9003: Quality systems – model for quality assurance in final inspection and test.

ISO 9004: Quality management and quality system elements-guidelines.

The ISO 9001 standard is designed for companies that want to assure conformance to requirements as dictated by the customer for design, development, production, installation and service. ISO 9002 is the standard most often employed by manufactures. Conformance to this standard indicates that the company is continuing to meet the established designs or specifications for a product. ISO 9003 applies only to companies that demonstrate the ability to competently perform inspection and testing of their own products. Certain elements of ISO 9004 apply to establishing quality systems in service organizations.

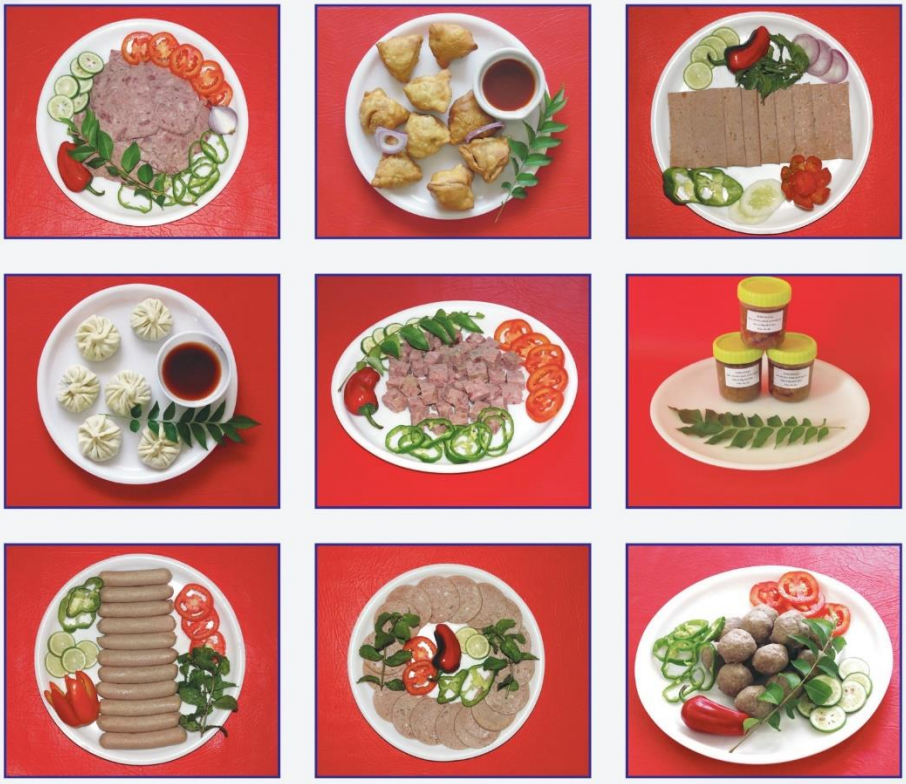
ISO 9000 standards should be viewed as a set of minimum quality system requirements for TQM programmes to build upon. To put it another way, the standards can be considered the lowest common denominator of quality system requirements for all industry and service groups. Therefore, TQM and HACCP should go beyond ISO 9000 in respect to incorporating specific technological and competitive elements.

V. Good Manufacturing Practices and Good Hygienic Practices

Current food safety management systems are based on prerequisite programmes like good manufacturing practices (GMPs) and good hygiene practices (GHPs). Good Manufacturing Practices provide the basis for the regulations and plans required. GMPs are designed to assure that the foods are produced under hygienic conditions and that microbiological, chemical and physical hazards are prevented. These are the control factors relating to the entire manufacturing operation, not just processes used, and include programmes for facilities and grounds, equipment and utensils, pest control, receiving and storage, process control, product recall and personnel training. Prior to development and implementation of TQM and HACCP plans, a company should first review existing programmes to verify that all GMPs are in place and are effective.

GMPs are similar to any policy programme of a firm and require a written programme, an appropriate training programme and schedule, a maintenance schedule and management commitment. The written programme applies to all areas covered under the GMPs. It will include who, what, where, when, why and how actions or procedures are put into place. The written programme explains the scope of the GMPs, responsible individuals, parameters, monitoring activities and records, corrective actions and records of those and verification activities. Programs should be written by teams of employees from various areas of the company that can bring technical and operational expertise to the table.

Within the GMP programme, cleaning and hygiene are given their own sub-section referred to as GHPs. This may be defined as those operations involved in providing a clean sanitary environment for the preparation, handling and storage of meat. In other words, the GHPs define what has to be done in relation to cleaning and hygiene, when it has to be done and by whom. Areas covered by the GHP programme include cleaning of plant and equipment, staff health in relation to food handling and staff cleanliness, the cleanliness of the raw materials including live animals, ensuring all detergents, sanitizers and other non-food chemicals are properly packaged, labeled, comply with their specifications and are stored correctly. The following guidelines for developing Good Manufacturing Practices for abattoir operations are recommended for voluntary consideration and use in developing plant-specific procedures. These GMPs are not designed to control specific hazards, but are intended to provide guidelines to help processors' produce safe and wholesome products.



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Cleaner Production Practices in Pork Processing

As mentioned earlier, meat processing typically consumes large quantities of water and energy, discharges significant quantities of effluent and generates by-products. For this reason, cleaner production opportunities shall focus on reducing the consumption of resources (water and energy), increasing product yields and reducing the volume and pollutant load of effluent discharges. Although many processes in the food sector can be automated, it is difficult to automate many of the processes within an abattoir because of the irregular shape and weight of the animal carcasses. This means that individual operators' practices have a significant impact on the overall performance. Therefore, many of the cleaner production opportunities in abattoirs shall relate to housekeeping practices, work procedures, maintenance regimes and resource handling, as opposed to technological changes. Some of the possible cleaner production opportunities in pig abattoirs are listed hereunder.

Reducing water consumption: The first step is to analyze water use patterns carefully, by installing water meters and regularly recording water consumption. Water consumption data should be collected during production hours, especially during periods of cleaning. Some data should also be collected outside normal working hours to identify leaks and other areas of unnecessary waste. The next step is to undertake a survey of all process area and ancillary operations to identify wasteful practices. Once water use for essential operations has been optimized, water reuse can be considered. However, wastewater reuse should not compromise product quality and hygiene, and reuse systems should be carefully installed so that reused wastewater lines cannot be mistaken for fresh water lines, and any reuse plans should be approved by all food safety officers.

Effluent generation and management: Opportunities for reducing the pollutant load of abattoir effluent principally focus on avoiding the discharge of polluting substances, such as blood, undigested stomach contents, fat and scraps of meat, to the effluent stream. This means capturing materials before they enter drains and utilizing dry cleaning methods wherever possible. Since blood is one of the major sources of organic pollution for abattoirs, its recovery is an important cleaner production initiative.

Optimization of use of energy: Energy is often an area where simple plant optimization efforts can provide substantial savings almost immediately

with no capital investment. Some of the possible options are: implementing switch-off programmes and install sensors to turn off or power down lights and equipment when not in use, improving insulation on heating and cooling systems and pipe work, recovering evaporative energy in the rendering process, using multi-effect evaporators, maintain optimal combustion efficiencies on boilers etc.

Optimal use of by-products: Almost all animal by-products can potentially be used to produce a useful commodity. It may not always be possible, however, to find economic markets for all by-products. Some of the options for maximizing the use of by-products are: proper segregation all by-products, ensuring that by-products are not contaminated with water or materials that would limit or prevent their reuse and storing of by-products correctly to maintain quality and maximize the viability of reuse opportunities.

Practices in pig reception area: Dirty pigs should be segregated on arrival and given a preliminary wash before joining the rest of the herd. This will reduce the amount of washing required for the herd as a whole. Water troughs should be designed and located to avoid overflowing and production of muddy areas. For truck washing, water should be used only after dry cleaning has been undertaken. Recycled water from other areas of the plant, such as cooling systems and vacuum pumps, can be use for washing trucks.

Stunning and bleeding practices: Every effort should be made to maximize raw blood collection and its subsequent processing into blood meal or other value-added by-products. Design of the bleeding area should ensure that all blood is directed to the blood collection facility. To avoid cross contamination of blood and wastewater, two-way drain diversion systems can be used in the bleeding area. Two drain outlets are provided in the blood collection area, one to the blood tank and the other to the effluent system.

Optimizing the scalding, de-hairing, singeing and evisceration practices: Scalding tanks shall be insulated and covered by a lid to avoid heat and evaporation losses. This will save both energy and water. To reduce water consumption for cleaning of the scalding tank, the tank bottom should have a steep gradient towards the outlets. Where ever possible, the waste water should pass through a sedimentation tank, interceptor trap or sand trap before discharge. Water consumption for de-hairing can be minimized by applying water only as required and ensuring that water pressure and the number, placement and size of water nozzles are optimal. Also, there are a number of opportunities for water reuse in this area. The de-hairing process results in substantial quantities of hair collecting on the floor where it can

enter the drainage system. Strainers should be fitted to floor drain outlets to collect the hair and avoid blockages. Gas consumption in singeing ovens can be reduced by using solenoid switches to initiate the singeing flame only when carcasses are passing through and to regulate flame intensity in line with line speed. Fasting of animals for a period of 12 to 24 hours prior to slaughter reduces the quantity of undigested materials in the intestinal tract, making the evisceration process easier. By-products shall be transported dry on conveyors or in small containers with wheels.

Rendering practices: Since the rendering process converts 'waste' materials into useful, value-added products, rendering in itself is a cleaner production option. Raw materials for rendering should be received at the rendering plant as soon as possible, and processed promptly to avoid odour. Delays in processing result in poor quality raw materials which lead to lower yields, lower quality products, and difficulties in processing the raw materials. The heat contained in the vapour from the cookers can also be recovered in multiple effect evaporators etc. and used to pre-heat raw materials.

Abattoir cleaning practices: The best way to reduce water consumption in cleaning is to undertake dry cleaning before washing with water. Solid materials should first be scraped and swept from all surfaces, including boning, slicing and packing tables, cutting boards, work platforms and floors. After thorough dry cleaning, work surfaces, walls and floors can be washed down in preparation for cleaning with detergents. Detergents and disinfectants can be a significant source of pollution if the amounts used are too great. It is very important, therefore, to monitor their consumption.

Table 1. Products and by-products from the slaughter of an 80 kg pig

	Weight (kg)	Percentage of LW
Live weight (LW)	80	100
Boned meat	51.2	64
Inedible material for rendering		
(bones, fat, head, hair, condemned offal etc.)	16	20
Edible material (tongue, liver, heart, kidneys, trotters)	8	10
Blood	2.4	3
Miscellaneous (stomach contents, blood loss etc.)	2.4	3

Source: Internal research data, ICAR-NRC on Pig, Guwahati

Table 2. Indicative figures of breakdown of water consumption in pig abattoirs

Purpose	Percentage of water consumption
Pig receipt and holding	6-8%
Slaughter, evisceration and boning	30-35%
Casings processing	5-8%
Scalding	12-16%
Hair removal	6-8%
Inedible and edible offal processing	8-10%
Rendering	8-10%
Chillers	2-4%
Boiler losses	1-3%
Cleaning	20-25%

Source: Internal research data, ICAR-NRC on Pig, Guwahati

Table 3. Indicative figures of concentrations of pollutants in pig abattoir effluent

Parameter (unit)	Effluent level
BOD5 (mg/L)	1100-1250
COD (mg/L)	2200-2500
Suspended Solids (mg/L)	600-750
Total nitrogen (mg/L)	120-150
Total phosphorus (mg/L)	20-30
Oil and grease(fat) (mg/L)	135-170
pH	7.1-7.2

Source: Internal research data, ICAR-NRC on Pig, Guwahati

Table 4. Pollution loads in pig abattoir effluent per head

Parameter (unit)	Pig slaughtering (average 80 kg)
BODs (kg/head)	0.45-1.90
Total nitrogen (kg/head)	0.070-0.20
Total phosphorus (kg/head)	0.010-0.02

Source: Internal research data, ICAR-NRC on Pig, Guwahati

Table 5. Breakdown of thermal energy consumption in a pig abattoir

Purpose	Percentage of total
Rendering/ Incineration	33-35%
Boiler losses	20-25%
Hot water	20-23%
Pig scalding	15-18%
Blood coagulation	2-3%
Blood drying	2-3%
Others	8-10%

Source: Internal research data, ICAR-NRC on Pig, Guwahati

Table 6. Breakdown of electricity consumption in a pig abattoir

Purpose	Percentage of total
	33-35%
Refrigeration	46-50%
Boiler room	8-11%
Incineration/ rendering	13-16%
By product processing	6-9%
Slaughter area	10-15%
Compressed air	5-7%
Boning room	2-3%
Others	10-14%

Source: Internal research data, ICAR-NRC on Pig, Guwahati

Table 7. Benchmarks for pig abattoirs (80 kg pigs)

	Unit	Tradition-al tech-nology	Average technol-ogy	Best avail-able Tech-nology
Water	L/animal	1400	700	300
Heat and electricity	Kw.h/animal	125	50	30
BOD5	g/animal	2500	1000	500

Source: UNEP, 1996

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Traceability in Piggery Sector

Pigs play a pivotal role in meeting the nutritional security owing to its unique attributes like high fecundity, early maturity and low production cost. However, piggery sector is much unorganized and demand of pork is exponentially increasing over the decades. To mitigate the gap of about 62% deficiency of pork in the country, there is a need of digitization of pork value chain with proper traceability, so that different developmental policies can reach to the stakeholders. Profitability and operational efficiency for all stakeholders in the pork value chain can be increased many folds by providing assured quality pork while working under a traceable value chain.

Traceability is defined as the ability to discern, identify and follow the movement of a food or substance intended to be or expected to be incorporated into a food, through all stages of production, processing and distribution. Traceability involves documenting and linking the production, processing, and distribution chain of food products and ingredients. Tractability is a key precondition for the universal acceptability of any food system and on which the national responsibility of providing safe food stands.

Components of livestock traceability

Livestock value chain is a very complex network of livestock rearers, traders, veterinary authorities, abattoir managers, retailers, consumers etc. Networking of all the players of the value chain is the basic requirement for implementing livestock traceability. Advances in communication technology can support efforts in networking of all stakeholders. Enabling tracing back of ownership details and place of slaughter requires collection and maintenance of data related to each animal in common database which can be retrieved by consumers and producers in times of necessity. Conceptualization and understanding of different components of livestock value chain of importance in traceability system is prerequisite for conceptualizing and implementing the traceability. Different components and extent of their required involvement for establishment of traceability system are as follows:

(a) **Traceability implementation agency:** A centralized agencywhich can work for studying the value chain, customizing the traceability system based on the International requirements and ground realities of the country, setting up identification standards, issuing identification codes, application on to animals and maintaining the centralized database maintaining the information will be the. Agency needs to work in close

contact with stakeholders to implement the system.

(b) **Livestock owner:** Animal and its identification is the basic building block for the traceability system. Willingness of livestock owner and his active involvement is crucial for successful system. Owner needs to tag his animal, report birth, death and movement of animals to concerned authorities. Keeping in mind the overall level of education among livestock holders system devised must be easily understandable and implementable. Adequate support system must be put in place make livestock owner to understand the system and hand hold him in implementation. Delivery of ear tags and registration facility must be easily accessible to owner. Financial support in terms of taking care of cost of the consumable involved must be provided by government at least in initial stages. Utilization of the system for range of service delivery like insurance, subsidies, loans, health management etc will encourages owner and makes him work actively for the success of the system.

(c) **Meat processors:** Abattoir is the critical link in traceability system. Animals are received from various sources for slaughter and meat production. If the animals received are tagged and registered, they need to be slaughtered and identity needs to be maintained during slaughtering, dressing and packaging. Traceability code need to be put on the label which will enable consumer to trace back the details and that completes the system. System developed for traceability must take in to account the complexities of slaughtering and dressing, number of persons involved, lower education level of personnel involved, speed of the processing time, convenience and cost. Adequate checks and balances need to be put in place to ensure that labelling is appropriate and there are no errors in coding system. Recording of quality of the meat and carcass against the identification code can work as valuable feedback for livestock owners to modify their rearing system.

(d) **Traders and transporters:** Ideal traceability system requires that traders and transporters maintain record of the animals received and sold by them. They need to provide the animal transaction information and corresponding details on regular intervals to concerned authorities. Transporters must ensure that information regarding the animals which are transported are communicated to authorities before transporting them.

(e) **Consumers:** Enhancing awareness regarding quality issues and utility of traceability among consumers will ensure that they pay extra for the

traceable livestock products in the interest of their health. Traceability involves cost and definitely its implementation will add on to the price of the products. If the consumers are ready to pay extra price for the traceable meat industry will try to meet the requirements and will sustain the traceability initiatives in long term. At present awareness of the consumers on quality issues is minimal.

(f) **Legislation:** Question of whether to make the traceability system mandatory or voluntary needs to be answered before initiating implementation. Voluntary systems are driven by consumer interest or importing country requirements. Whereas, mandatory systems require legislative backing. EU went in mandatory system as a consequence of incidences of BSE and corresponding drop in export demand which seriously affected the profitability in the sector. Many countries are following voluntary system or restricted them to export meat sector only. It is suggestible to make it voluntary initially and once the critical awareness is reached make it mandatory. To justify the cost of implementation of traceability system applications in all its form need to be exploited from the traceability system.

Application of traceability system in Indian piggery sector

Traceability system has multiple applications in piggery sector. Some of the applications are as follows:

a) Aids efficient monitoring of safety issues by food regulatory agencies.

Food traceability systems allow supply chain actors and regulatory authorities to identify the source of a food safety or quality problem and initiate procedures to remedy it. Traceability can also help identify a product at any specified stage of the supply chain: where the food came from (one step back) and where the food went (one step forward). When traceability systems are combined with safety and quality management systems, they can make associated food safety measures more effective and efficient. By providing information on suppliers or customers involved in potential food safety issues, traceability can enable targeted product recalls or withdrawals.

b) Health management of animals

Without having centralized real time information on farms and animals, veterinarians face the problem in planning the vaccination dosage requirement, requirement of personnel for implementing prevention

programmes and communicating all the stakeholders in the wake of disease outbreaks. Online software system generated as part of traceability system will help in communicating disease outbreak information to farmers of the affected region thereby helping to intensify bio-security measures & initiate disease prevention strategies.

c) Registration and centralized availability of information on farms

Traceability system will enable enrolment of farms, issue of farm/ premises card, storing of contract address and mobile numbers of the farmers in the database. Availability of all the existing pig farmers in single source will help developmental agencies to plan, target and implement developmental programmes.

d) Registration and centralized availability of information on abattoirs

Hygienic harvesting of pigs is prerequisite for producing quality and hygienic pork production. Infrastructure available for hygienic slaughter of pigs is limited. Local bodies do provide a place for slaughter but often such places do not have adequate infrastructure for ensuring clean meat production. Traceability system enables registration of abattoirs, storing of contact details of the in-charges, capacity of slaughter etc. Once the information on number of slaughter places and facilities available are pooled, systematic intervention to increase the basic minimum facility can be planned.

e) Effective service delivery through E- governance

Traceability system provides an interface wherein real time farm activities like vaccination, medication, deworming etc can be updated onto database. Enrolment of animals, tagging with internationally approved ear tag numbers will enable targeted delivery of schemes, reduces duplication of efforts and will help in monitoring the impact of the scheme after its implementation.

f) Performance recording of livestock

Recording of performance will help in selecting the appropriate breeding animals. In the absence of performance recording system enhancing genetic potential through selective breeding will be constrained by lack of information on availability of breeding animals. Traceability system provides add-on scientific pig management system which will help in efficient management of the piggery farm and recording of all the farm activities, generating customized alerts and will help farmer manage his farm on scientific lines.

21
Policy Recommendations

Among the various livestock species, pig is the most potential source of meat production and more efficient feed converter after the poultry. Pork sector in India is valued at about Rs. 6,200 crores. India is home for over 20 indigenous and 08 exotic pig breeds. Around 150 meat processing plants are functioning on small scale in the private sector in India. Pig producers' cooperative federations are coming up in some of the states. The total requirement of pork in India would be around 0.93 million tons by 2030 against the present pork production of 0.40 million tons. Thus, the present shortfall of pork in the country is about 0.53 million tons.

Driven by the changing economic conditions, ongoing transition of the production and processing infrastructure,and growing demand for pork, the national pork production is expected to show high growth rates in the near future. While smallholder pig producers contribute the major part of the production, the share of large-scale state and private farms is increasing. Accordingly, the infrastructure for production, processing and marketing is in a state of transformation. The need of smallholder producers is increasingly recognized, and a variety of regional and production-system-specific solutions are evolving constantly. In parallel, support systems for developing large-scale farms within the country need to be developed. However, this transformation process needs high degree of coordination and integration among the stakeholders.

Future developments in the sector need to be shaped by the state specific policies, but will also be driven by the growing consumer demand. A focus on the domestic market seems, therefore, justified, considering that India does not have an advantage of international market in pork production and faces many trade barriers. Further diversification of the domestic market is expected along the lines of the traditional wet markets, modern retail formats inurban areas selling meat of high quality and guaranteed safety, niche markets for specialty products from local breeds, as well as vendors for processed pork products fulfilling new quality and food safety requirements. The central as well as state governments are expected to further promote industrialization of specialized production, modernization, andintegration of the domestic livestock productionin order to contribute to the world economy, and to remain committed to pro-poor policies and poverty alleviation. Integration and coordination of smallholder producers to build up a power position in the marketing chain seems to be a pre-requisite, so that a sizeable part of them

will be able to benefit from the development of the sector.

For augmentation of piggery sector in India, following areas need special attention:

1. **Implementation of"Pig Breeding Policy" -** it is essential for State specific/region specific breed improvement and to streamline the indiscriminate breeding practices by produces. The over-arching goals of such policy framework shall be to enhance growth of piggery sector by improving efficiency in production, service delivery systems, marketing and processing to build up a self-sustained economy that enhances income and employment opportunities, and food and nutrition security of the large masses. It shall also focus on empowering the underprivileged, especially women and resource poor rural households to participate in the livestock production process to reduce poverty and social economic inequalities.
2. **Conservation of indigenous germplasm:** Use of available indigenous breeds for low-income rural communities could be helpful because they require low inputs. Improvement of pigs through cross breeding could be carried out in commercial and large-scale farms, as most of these farms have capacity to provide continuous intensive inputs. The genetic makeup of the pig will have the highest impact on its ability to grow muscle. Since the characteristics related to meat production (body weight gains, efficiency of feed conversion, and dressing percentage) are moderate to highly heritable, selection of breeding stock can bring about considerable improvement. The aim is to increase the frequency of desired genes in the stock, thus increasing superior germplasm in the base population at the expense of the undesired genes. Countries that have developed livestock industries, maintain special breeding flocks to supply superior germplasm to commercial flocks. The exotic breeds of pigs like Large Black, Hampshire, Large White Yorkshire, Landrace and Duroc have shown a good performance under the local conditions and thus they can be raised on the basis of selective breeding. In case of free range rearing, attempts in grading up of the local non-descript with exotic can be a feasible approach. However, it is important to ensure that simultaneous improvement of feeding and management shall also be taken care of.
3. **Production of improved germplasm:** In order to ensure profitable pig production, there is need to promote specific breeds, which must produce fast and efficient growing young ones. The majority of the

pig population in India is usually indigenous type and has low growth rate and productivity parameters. However, these indigenous pig breeds are very well adapted to the harsh climate and poor plane of nutrition in tropical climate. The major reasons for low productivity of the indigenous animals is the poor exploitation of genetic potential, little stress on selection of animals used for breeding and frequent intermixing among the breeds.

4. **Efficient Breeding system:** The productive and reproductive traits of pigs are the major criteria for selection of pigs by entrepreneurs. The daily weight gain, feed conversion efficiency and better fertility rates are the other associated parameters. Selection of individual animals from a herd is more important than the selection of a particular breed for breeding purposes. The primary traits of reproduction that are normally recorded in a pig farm are litter size at birth, strength and vigour of litters, litter size at weaning, milking ability and temperament of sow. Importance shall be given to the sow with large number of survivable litter and which can attain marketable weight at an age of 8 months or less, while selecting for breeding. Producer must ensure the purchase of pigs from a reliable disease free herd with pedigree records. Once the herd is established the selection of the gilts and boars for replacement in the breeding herd should be based on the types and performance. In order to ensure economic viability, judicious culling and replacement of animals in a herd is necessary. If optimal managemental conditions are followed in the farm, it could easily lead to two farrowings in a year. It is important that, for every 10 -15 sows, two boars must be maintained for maximum fertility. The consumer desire for healthy pork products in the recent past has directed the breeders to evolve designer pigs with lower back fat thickness and lower fat percent of retail carcass weight.

5. **Balanced nutritional approaches:** It is well established that nutrition is the key non-genetic factor which can influence pig production. Studies have revealed that even genes are expressed in the presence of optimum nutrition. Pigs, being monogastric animals, are able to transfer nutrients and feed additives directly to muscle and tissue. The animal industry has been aware of the need for better nutritional intake of the animal to maximize lean growth. In order to maximize the muscle development, feed with specified amino acid ratio is essential. It has been usually seen that the availability of feed and fodder is not commensurate with their requirements. A gap

of about 44% concentrate, and 36% each of green fodder and dry roughages exists between the demand and supply of feed resources in the country. Therefore, there exist, a clear need to look beyond the traditional feed resources to alleviate the demand. Development of feeding strategies based on cheap feed stuffs available locally such as leaf meals, oil cakes, grain by-products and root tubers like tapioca and sweet potato, is must for low income pig rearing communities. Exploitation of un-conventional feed resources viz., leftover from kitchen / hotel / cold storage in replacing the balance rations will help in minimize the cost of production. Improving the digestibility of the local feed resources has a direct effect on feed requirement by the pig industry.

6. **Exploring alternate feed resources -** Feeding of pigs is the single most expensive aspect of pork production. As a result, feed costs play a major role in determining the profitability of a swine enterprise. Many alternative feeds that may be cost effective and useful in swine diets are produced by the industries involved in grain milling, brewing, distilling, fruit and vegetable processing and vegetable oil refining. Many of the by-products from these processes can readily substitute a portion of the protein and energy in a complete feed. The appropriate amount to use will depend on the cost, nutrient availability, palatability, presence of anti-nutritional factors, storage life and age of the pig for which the feed is intended. Focus shall be on producing protein rich grasses (e.g. Berssem, leucerne) as alternate protein and fibre source. Also, one can explore the options of effectively using jackfruit, tapioca and sweet potato among others.

7. **Popularizing cheaper housing patterns and scientific managemental practices:** While designing the housing for the pigs, it is essential to give importance to those designs which could give maximum comfort to pig, in turn to achieve optimum growth. Dampness and overheating may be avoided. Dissemination of simple, relevant designed pig houses affordable for poor rural population. This may include low cost houses with ample sanitation, proper ventilation and better hygiene conditions to control parasites and pathogens affecting pigs is a major intervention in the production of wholesome meat production. In order to protect the animals from common diseases, periodical deworming and timely vaccination must be planned. Feeding of the sows during pregnancy is most important for increase in litter size. The studies indicate that providing a good grower ration to sows and gilts, 7 to 10 days before

breeding could significantly increase the ovulation rates. Breeding sows and gilts should be fed balanced ration until the last six weeks of pregnancy. Pigs should be vaccinated against foot and mouth disease and classical swine fever at the age of 2-4 weeks and breeding pigs should be tested invariably for circovirus, brucellosis and leptospirosis. As a routine farm practice, all the piglets at the time of weaning should be vaccinated against classical swine fever. Piglet anemia can be prevented and cured by timely supplying iron either orally or by injection. Animals purchased for the farm should be purchased from disease free herds and the newly purchased animals should be quarantined for a period of three to four weeks.

8. **Promoting intensive pig farming:** The existing system of rearing pigs in most part of the country as a subsidiary farm activity in backyard with minimum shelter to utilize garbage and leftover grains available to produce meat for family use, should move towards intensive system of production involving good breeding stocks and better nutritional input to produce marketable quality pork and pork products. In areas with shortage of land to grow feeds and in large cities, the intensive swine production system is economically viable because of availability of industrial by-products.

9. **Promoting integrated pig farming:** Integrated pig production system is based on the concept that "there is no waste" and "waste is the misplaced resource". This system utilizes the common property resource like forest to obtain feed ingredients for feeding pigs. The system also recycles the excreta of pig in the form of manure or compost for production of feed ingredients for pigs as well as food for human. The practice of compost making with the bedding material of pig is quite common in the system.This mode of pig production is very pertinent to India as the individual animal productivity is either stagnating or decreasing while the input resources are depleting or getting costlier over the time.

10. **Establishing "Liquid Boar Semen processing labs"-** Artificial insemination provides unique opportunity to the pig farmers with the opportunity to introduce superior genes from top performing boars into the herd. Additionally, it offers most economically sound method of maintaining genetic variability in a positive direction. As the timing and technique are two key factors in the successful use of AI using chilled boar semen, it essential to establish liquid boar semen labs at multiple points to promote Artificial Insemination and planned breed improvement in the country.

11. **Setting up pig villages/ nucleus herd:** Community or cluster-based systems need to be developed. Private-sector investments shall be encouraged to meet the demand for improved breeding stock and quality piglets in the country. It is also important to encourage artificial insemination in sows. Need-based training programme for smallholders on the care and management of breeding stock must be ensured. For example, ICAR- National Research Centre on Pig has launched 'Mega seed project' with the aim to incorporate highly prolific germplasm under field condition and distribute the improved germplasm to the farmers from the nucleus herd.
12. **Shifting the developmental focus to 'cluster oriented' approaches –** The pig farming in India is still can be termed as 'production by masses' compared to 'mass production by a few' as in many of the developed countries. Shifting the development focus to 'cluster oriented approach' will definitely help to implement common production practices in a locality and to develop comprehensive database for particular clusters, which will in turn help to ensure uniformity in the produce (pigs).
13. **Strengthening the disease monitoring, diagnostic and reporting systems –** It is the high time to strengthen the disease surveillance systems in the country, especially in the remote rural areas, so as to improve the piggery sector associated with the vast majority of low- and middle-income families in these regions.
14. **Bringing pig vaccinations under 'compulsory vaccination' schemes –** Bringing the most common pig vaccinations viz. Classical Swine Fever and Foot and Mouth Disease vaccinations under compulsory vaccination schemes as in lines of dairy sector will facilitate in establishing designated Disease Free Zones (DFZ) for animal sourcing.
15. **Strengthening monitoring of pig transport through the state borders –**The epidemics of a few infectious diseases during the past decade (e.g. African Swine Fever and Porcine Reproductive and Respiratory Syndrome) have accentuated the need for a better surveillance system across the state borders. Furthermore, the emergence of new viral diseases/infections, such as Nipah virus and swine influenza A (H1N1) virus, from time to time is a glaring example threatening adversely both piggery and public health globally.

16. **Creation of essential facilities for vaccine production and supply –** Although pig vaccination is considered as an important aspect of commercial pig production in the Indian piggery sector, the rate of adoption and diffusion of vaccination technology is very low at field level.Vaccinating pigs helps in stimulating an immune response without causing the disease itself. This creates early exposure to disease-causing organisms, where the animals' immune system is able to recall the infectious agent to which the animal is vaccinated. Under these circumstances, it is essential to create essential facilities for vaccine production, especially against CSF and FMD to meet the nation's requirement.

17. **Focus on improving bio-security measures in the farms –** Biosecurity embraces all aspects of the prevention of pathogens entering and spreading within a group of animals. Proactive steps are essential for introducing biosecurity measures in the pig farms to reduce the probability of the introduction (external biosecurity) and further spread of pathogens within the farm (internal biosecurity). In recent years, with the emergence and re-emergence of difficult-to-control diseases such as African swine fever or PRRS, the perception of the critical importance of pig health and its relationship with biosecurity has increased. While designing the bio-security plan, one shall focus on how diseases are transmitted, the risks and their importance, which mitigation measures are thought to be more effective and how to evaluate the biosecurity and its improvements.

18. **Focus on proper waste disposal from the farms -** Keeping the farm clean is the key to raise healthy and thriving pigs. One must daily remove the waste from the shelters and pig pens, as they attract flies and insects. Waste disposal system shall have facilities for collection, storage, treatment and distribution of wastes appropriately and effectively. The waste disposal aims at reduction of the volume of waste, stabilization of the organic substances of waste, elimination of the malodour of waste and protection of public hygiene. Furthermore, high efficiency of purification, low-cost for facilities and operation, and simple management which needs no special skill are strongly desired. Such a measure is necessary not only to tackle the public resistance but also for environment protection.

19. **Dissemination of improved germplasm to the beneficiaries –** The crossbred/exotic pig varieties need better infrastructure and

managemental facilities to obtain the expected growth outputs. Rearing under the backyard system with unconventional feed resources will negatively affect their growth prospects. Thus, utmost care shall be taken while distributing such improved germplasm to the beneficiaries under different schemes. They shall be distributed to those beneficiaries where provisions exist for better options for feeding and management so as to meet the required growth prospects and operational constrains, and thereby improving efficiency and ensuring sustainability and equity in the piggery sector.

20. **Understanding the commercial pig production –** Considering the fact that the pig rearing system in India is passing through a transition phase from being mostly a backyard activity to a semi-commercial system, it is essential to provide exposure visits for the stakeholders to those places where it is present. Thus, before entering into the commercial piggery business, one must know the facts about scientific management practices for profitable piggery business.

21. **Establishing 'premise identification' and 'group/lot identification' for ensuring traceability –** It is the need of the hour in the country to have a robust traceability system with the ability to discern, identify and follow the movement of pig or pork or pork products through all stages of production, processing and distribution. The system shall have the facilities for documenting and linking the production, processing, and distribution chain of pig/pork/pork products and will be the key precondition for the universal acceptability of Indian pork and on which the national responsibility of providing safe food stands.

22. **Designing and implementing a risk assessment and monitoring system -** With respect to the risk factors associated with production and marketing of pigs and pork. The data thus generated can be transformed into useful information to improve decision making and maximizing the productivity. It will also be useful in interpreting what kind of risk factors are associated with disease occurrence and production losses, and the kind of standard operating procedures should the producers follow to improve the farm outputs.

23. **Augmenting value addition in pork products:** Currently the value addition of meat is very much limited in the country and less than 2 % of total meat is processed into products for trade as compared

to more than 60 % in developed countries. However, the demand for processed meat is increasing in the country and hence, there exist substantial scope in the pork processing and value addition. A new trend has emerged in the recent past that apart from poor and a section of elite urban people, the middle class are also gradually developing taste for pork and pork products. In order to process pork to meet consumer requirement with sustained demand, quality of pork is an important consideration. The palatability factors that determine acceptability of pork and pork products are colour, aroma, tenderness, juiciness and flavor. Desirable quality pork has a firm, dry surface with a pinkish red colour. In order to make good quality meat products the following factors are very essential viz. careful selection of raw material, proper handling, hygiene and suitable equipments. In order to tap the potential of traditional pork products, processing technologies need to be refined/standardized and validated.

24. **Setting up hygienic and affordable pig slaughter houses and retail pork shops:** Even though pork and pork products are acceptable to a section of population, they are not finding widespread acceptance, since the existing production, processing and marketing conditions are very unsatisfactory. Meat spoils and become unacceptable for human consumption in a matter of hours particularly in hot, unhygienic conditions. There exists no routine pre- or post-mortem inspection of slaughter pigs, especially in the rural areas, because of inadequate manpower and the absence of physical infrastructure for slaughtering and selling of pork. This condition has deterred many pork consumers from eating pork. The need of the hour is wholesome meat production through addressing the above-mentioned deficiencies in public health measures through a risk assessment along the production-to-consumption value chain, establishing required infrastructure and inspection (manpower and physical resources) facilities and training all the stakeholders in meat hygiene and food safety.

25. **Establishing 'Micro pig abattoirs' -** having highly fragmented livestock production and meat shops present in every nook and corner, one could easily figure it out that the concept of 'municipal slaughterhouse' does not hold good in most part of India, especially in the rural/village areas. In order to materialize hygienic slaughter process, the meat personnel/ butchers in such places have to transport the animals to far away located 'municipal

slaughterhouses' to get the slaughter done, which in turn requires additional investments with respect to time, money and manpower, which may not be feasible for a person who handles only one or two animals per day. However, establishment of multiple micro/ tiny abattoirs at affordable costs could support local production of pork, benefitting animal welfare with shorter journeys and enabling vendors to carry out hygienic slaughter operations, and providing clean and wholesome meat to the people. Micro abattoirs could also build trust in the local community between the livestock producers, processors, retailers, and consumers.

26. **Adoption of smarter tools and approaches for food safety in pork value chain –** There exist the need for enhancing the use of new knowledge from traceback, data streams and tools for rapidly analyzing the data. The ability to use new data analysis tools and predictive analytics will help the regulatory bodies and stakeholders better identify and mitigate potential food safety risks associated with the pork value chain and advance the preventive controls framework.

27. **Ensuring micro credit facilities:** Lack of sufficient working capital is a recurring constraint among pig farmers and traders in the country. Pork and piglet traders mostly depend on local money-lenders to run their business. Most of the government-sponsored schemes extend credit to Self Help Groups (SHGs) but not to individual members. Thus, extension of micro-credit through NGOs may be a viable alternative. In the same way, insurance coverage for the pigs of small-scale producers may be possible through the Group Insurance Schemes of insurance companies, which will ensure an effective, farmer-oriented extension service.

Suggestions for development of piggery value chain in NER

The presence of over 80% non-vegetarian people in the region with high demand for meat, remarkable growth in livestock population, strategic location with an extensive high export potential international border, the NER offers tremendous scope for development of pork industry. Following strategies are suggested to improve the pork industry in NER.

1. Programmes to increase production and productivity of indigenous pigs must be encouraged to achieve higher carcass weight and meat yield. Cross-breeding programme to upgrade the non-descript animals with high yielding exotic breeds suiting the agro-climatic

condition of this region need to be taken up on priority basis.

2. Efforts must be made to produce quality feed and fodder. The vast unused, barren and fallow land should be brought under fodder cultivation. The open grazing system of management should be discouraged. The wide marshy land and water bodies may be utilized for production of aquatic grasses. Small feed mills may be set up with govt. patronage in remote places to compute ration with locally available feed materials.
3. Existing service type slaughter houses may be upgraded in a phase wise manner. At least one or two modern centralized slaughter houses should be established in each state of NER with high value by-product processing plants. Tanneries and ancillary industries may be set up in nearby areas.
4. Adequate marketing infrastructure for live animals and meat should be created in each town and cities. Cold storage and refrigerated vans and small trucks need to be arranged to transport meat products to remote places.
5. There is a need of incentivising for setting up of ethnic meat products manufacturing units which have huge demand in the region and South East Asian countries.
6. Extension services should be strengthened to educate butchers, NGOs, meat co-operatives, farmers' organisations and self-help groups about slaughter, processing, value addition and marketing.
7. "Special Economic Zone" may be set up to encourage industrialists to start meat industries in NER.
8. Contingency plan for disaster management viz. feed, fodder and medicine etc. should be made to tackle the situation during natural calamities.
9. Institutes for natural farming/ organic pork food production and certification may be established to boost the pork industry.
10. International border may be opened in few strategic regions under look east policy to boost meat trade and control unauthorised smuggling of live animals and meat.
11. There shall be specific focus on capacity building on scientific pig production practices for Veterinarians and para vets towards developing qualified and trained human resources.

Further Readings

Abraham, J. 2003. Anxieties, concerns and facts about meat consumption and health. In: Souvenir and Abstracts, IMSACON-I, December 11-12, pp-3-11.

Anjaneyulu, A.S.R. and Henning, D.S. 1986. Effect of modified packaging on the shelf life of pork chops. Journal of Food Science and Technology,23:88-90.

Banik, S., Barman, K., Das, P.J., Kumar, S. and Rajkhowa, S. 2019. Pig farmers' manual. ICAR-Nationalresearch Center on Pig, Rani, Guwahati, Assam.

Banik, S., Naskar, S., Barman, K., Das, P.J., Kumar, S.and Rajkhowa, S. 2021. Nonlinear predictionmodels for estimation of pre-weaning bodyweight of pigs using morphometrictraits.Indian Journal of Animal Research.55(11): 1383-1386.

Barman, K., Banik, S., Thomas, R., Das, A. K., Dutta, K. and Rajkhowa, S. 2020. Effect of replacinggroundnut cake with dried Moringa oleifera leaves on growth and nutrientutilization incrossbred (Hampshire x Ghungroo) grower pigs. Indian Journal of Animal Science, 90(8): 1155-1158.

Das Anubrata and Bujarbaruah, K. M. 2005. Pig for Meat Production. Indian Journal of Animal Science, 75 (12): 1448 – 1452.

DasAnubrata, Tamuli, M.K., Mohan, N.H., Thomas, R. 2013. Handbook of pig husbandry. Today & Tomorrow's Printers and Publishers. New Delhi. ISBN:9788179194767.

Gupta, J.J.and Bujarbaruah, K.M. 2005. Promising non-conventional feed and forages for feeding to ruminant and non-ruminant in NEH Region. Technical Bulletin No. 16, Published by ICAR Res. Complex for NEH Region, Umiam- 793103, Meghalaya. pp. 27.

Gupta, J.J., Bardoloi, R.K., Reddy, P.B. and Bujarbaruah K.M. 2007. Performance of crossbred pigs fed on boiled sweet potato supplemented with soybean meal. Indian Journal of Animal Nutrition, 24(1): 44-46.

Gupta, V.K., Thomas, R., Banik, S et. al. 2022. A-Z of Pig Farming. Today & Tomorrow's Printers and Publishers. New Delhi. ISBN: 9789391734077.

Further Readings

Gurunathan, K., Thomas, R., Gadekar, Y. 2022. Abattoir practices and animal products technology. Brillion Publishing, New Delhi. ISBN: 9789392725845.

Joshi, B.P. 1994. Meat hygiene for developing countries. Shree Almora Book Depot, U.P. Hills, India.

Kondaiah, N., Rao, V.K. and Abraham, R.J.J. 2008. In. VCI Training module on introduction to food safety standards. Creative graphics, New Delhi.

Kumar, S. Islam, R.., Barman, K., Mohan N.H., Banik, S. and Rajkhowa S. 2020. Effect of supplementationof Vitamin E and Selenium during Transition Period on Productive Performance in Sows.Veterinary Research International, 8 (3): 170-172.

Kumaresan, A., Bujarbaruah, K.M., Venkatasubramanian, V. and Pourouchottamane, R. 2008. Technology inventory for livestock and poultry production in north-eastern region. Zonal coordinating unit-III, ICAR, Umiam. Pp.53-55.

Mohan NH, Ankit Nath, R. Thomas, S. Kumar, S. Banik, A. K. Das, R. K. Das and D. K. Sarma. 2020.Relationship between plasma, saliva, urinary and faecal cortisol levels in pigs. Indian Journal of Animal Sciences, 90 (5): 768–772.

Mohan, N. H., Madhavan, M. and Gupta, V.K. 2021.Consequences of AfricanswinefeverinIndia:Beyond economic implications. Transboundaryand Emerging Diseases.68, 3009-11.

Naidu, S.A. and Kondaiah, N. 2004. Livestock production and post production system – Need for pragmatic approach. Indian Journal of Agricultural Marketing, 18 (3) : 91-109.

Padda GS and Sharma N 1984. Prospects of comminuted meat products in India. Indian Food Industry, 3:9-110.

Rajkhowa C.1996. Incidence of different gastrointestinal parasites of pigs in Meghalaya. Journal of Veterinary Parasitology, 10: 91–93.

Rajkhowa, S., Sarma, D. K. and Pegu, S. R. 2017. Virulence markers and antimicrobial resistance of Streptococcus suis isolated from diseased pigs. Indian Journal of Animal Sciences, 87 (5): 581-583.

Ranjhan, S.K.; Gupta, B.S.; Chabra, S.S. and Dhudapkar, B.S. 1971. Effect

Further Readings

of various levels of crude fibre and digestible energy on growth rate of middle white Yorkshire pigs. Indian Journal of Animal Sciences, 41(5) : 313.

Sahoo, N.R., Rajkhowa, S., Anubrata Das and Tamuli, M.K. 2012. Phenotypic attributes of Ghungroo breed of pig. Indian Veterinary Journal, 89:155-159.

Sarma, D.K. 2007. Occurrence of classical swine fever in vaccinated pigs. The Vets Communications, 1:32-33.

Sarma, D.K. and Bostami, B. 2008. Isolation and growth characteristics of classical swine fever in PK-15 cell line. Journal of Appl. Bioscience and Biotechnology, 3:29-32.

Thomas, R, S. Singha and M. Saikia. 2020. Food safety- A farm to fork risk based approach. ICAR-National Research Centre on Pig, Guwahati. ISBN:9788193186497.

Thomas, R., George, S.K., Sunil, B. and Anjaneyulu, A.S.R. 2006. GMPs for meat product processing plants. Processed Food Industry, 9(6):20-25.

Thomas, R., Gupta, V.K., Nitin, M. 2022. Entrepreneurial guide for scientific pig production and pork processing. ICAR-NRC on Pig, Rani, Guwahati. ISBN:9788193186473.

Thomas, R., Sarma, D.K. 2017. Pig production and pork processing -Indian perspective. Jaya Publishing House, Delhi. ISBN: 9789386110640.

Thomas, R., Singh, V and V.K. Gupta. 2021. Currentstatus and development prospects of India's pig industry. Indian Journal of Animal Sciences. 91 (4): 255–268.

Thomas, R., Sunil, B., Anjaneyulu, A.S.R. and Kondaiah, N.(2006). Guidelines for developing good manufacturing practices in meat plants. Indian Food Industry, 25:46-51.

Thomas. R., Anubrata Das. 2013. Clean meat production with special reference to pork. Today & Tomorrow's Printers and Publishers. New Delhi. ISBN:9788170194750.

indPOtrace stands for 'Indian Pork Traceability'. This softwarehas distinct components for 'traceability', 'real time meat inspection' as well as 'Pig help line' to cater the specific needs of stakeholders. It provides specific interaction platforms for pig produces, pork processors, traders, feed suppliers, transporters etc. This Software has been developed to act as the basic platform to document the data pertinent to pig production, management conditions, health management, real time inspection of pork as well as a live interactive platform for stakeholders associated with pig value chain.

The policy paper addresses the rapidly evolving commercial piggery sector of India and their growth potential as a means to achieve doubling farmers' income at a much faster pace. We put the development of this sector within the context of the complex social and policy environment in India and illustrate the key issues that confront the future development of this sector. The paper assesses the broad ramifications of the rapid and large-scale development of commercial piggery sector in India with the objective of identifying production potential and constraints in pig rearing. It covers the range of breeding and feeding stocks, new and emerging trans-boundary diseases, postharvest management, etc. that are being considered currently very important by the stakeholders, and discusses their current growth potential, as well as the economic factors that enhance or limit their future growth. Besides, addressing a number of issues related to the competitiveness of the different sectors associated with the piggery value chain, it also highlights some policy reforms and interventions that seem to be necessary to the future efficiency and continued viability of this sector.

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