वार्षिक प्रतिवेदन
Annual Report
2013-14

राष्ट्रीय शूकर अनुसंधान केन्द्र
भारतीय कृषि अनुसंधान परिषद
राणी, गुवाहाटी-781131, असम

NATIONAL RESEARCH CENTRE ON PIG
INDIAN COUNCIL OF AGRICULTURAL RESEARCH
RANI, GUWAHATI-781131

Annual Report, 2013-14

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PREFACE

It gives me immense pleasure to bring out the Annual Report of the NRC on Pig for the year 2013-14. National Research Centre on Pig is committed to bring in excellence in all the frontier areas of research on pig production, health and product development and productivity enhancement to increase socio-economic status of the pig rearers of the country.

This institute, since its inception, is in the forefront for all-round development of the piggery sub-sector. The salient achievements of the Institute along with its sub-schemes viz, AICRP on Pig and Mega seed on pig and the KVK, Goalpara during the reported year are presented in this report.

This institute has developed three cross bred pig varieties, out of which Hampshire and Ghungroo cross is found to be superior in terms of piglet production and growth rate. The three breed cross (Duroc + Hampshire + Ghungroo) developed in the institute is suitable for fattening purpose for its higher growth rate and lean meat production. More than 7000 crossbred piglets of the developed varieties were produced at the institute and farmers' field. Besides, studies on the genetic basis of seasonal variation in reproduction in pigs, production of piglets through non-surgical embryo transfer, use of non-conventional feed stuffs for economic swine production, standardization and preservation of boar semen for artificial insemination(AI) as well as wide scale use of AI in pigs at farmers field, hormonal and nutritional interventions for improving reproductive performance of pigs, endocrine profiles of indigenous pigs, biophysical characterisation of fibres from pigs and development of utility products, development of various value added prok products and development of DNA-based methods for reliable and rapid diagnosis of economically important diseases of pigs were successfully conducted during the period.

Scientists of the institute have published more than 30 research papers in peer reviewed journals and presented several papers in national and international conferences during the year.

In terms of physical infrastructure, the Institute got a new leap with the inauguration of administrative building and associated infrastructure of its KVK at Dudhnoi, Dist. Goalpara (Assam) on 26 March 2014, by the Hon'ble Director General, ICAR. The referred state-of-the-art infrastructure has been made ready within a record one year time.

The Institute has been able to attract fund from reputed organizations like DBT and APEDA for different R&D projects. In addition, this institute is successful of getting a collaborating centre of the mega project on "DBT-NER Centre for Advanced Animal Diagnostics and Services on Animal Health and Diseases (ADSHAD)" funded by DBT during the reported year.

AIRCP on Pig along with Mega seed project on Pig, the sub schemes of the Institute, have been the pillar of developing region-specific package of practices, cost-effective and affordable technologies for small-holder production system, source of quality pig germplasm and entrepreneurship development in different parts of the country.

The KVK of the Institute is actively engaged in transfer of technologies in field condition and organized 59 need-based trainings under various disciplines, where 1958 trainees attended the trainings in Goalpara district of Assam.

I wish to express my sincere thanks and gratitude to Dr. S. Ayyappan, Secretary, DARE and Director General, ICAR and Dr. K.M.L. Pathak, Deputy Director General (Animal Science), ICAR for their continued support and keen interest in the activities of the Institute. I am thankful to Dr. R. S. Gandhi. Assistant Director General (AP&B), Dr. Gaya Prasad, Assistant Director General (Animal Health), Dr. B.S. Prakash, ADG(ANP) and Dr. V. Bhasin, PS (AGB), ICAR, New Delhi and other staff members of the Animal Science Division, ICAR, Krishi Bhawan, New Delhi for their continuous support in facilitating the activities at headquarters.

I also express my sincere thanks to the administrative and accounts staffs, scientists and technical staffs of the Institute and especially to the members of the editorial board for their cooperation and help to bring out this publication in time. Thanks are also due to the staffs of the KVK for their cooperation. I hope that the information and data provided in this report will be useful to researchers, policy makers, extension personnel and other stakeholders.

(DILIP KUMAR SARMA)
DIRECTOR

June, 2014

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EXECUTIVE SUMMARY

Animal Genetics and Breeding

During the reported year Animal Genetics & Breeding section of the institute was involved in evaluation of economically important traits of three crossbred varieties [Crossbred Variety I ($H_{50}G_{50}$), Crossbred Variety II ($H_{50}M_{50}$) and Crossbred Variety III ($D_{50}H_{25}M_{25}$)] developed in the institute by selective breeding. Birth of piglets through non-surgical embryo transfer technique has been achieved during the reported period. Hormonal profile (namely T3, T4, Testosterone and Cortisol) of various age groups of pigs under different THIs as well as gene (GH, FSH, ESR and HSP70) expression studies for different genetic groups (namely indigenous, crossbred and exotic) have also been carried out.

Animal Nutrition

Studies pertaining to inclusion of non-conventional feed stuffs in swine ration in order to reduce the cost of ration have been undertaken. Experiments involving replacement of maize with bakery waste, water hyacinth (*Eichhornia crassipes*) foliage and feeding of tapioca meal on growth performance of crossbred pigs have been conducted and results were found to be encouraging.

Animal Reproduction

Studies on preservation of boar semen using different extenders and the effect of additives on boar semen preservation were undertaken by this section of the institute during the period reported upon. A total of 1107 piglets were born from 84 sows and 27 gilts at the institute farm out of 362 nos of AI and a total of 7032 piglets were born from 881 nos of females out of 1475 nos of AI in the farmer's field. In addition, under NAIP, three training programmes were conducted in regards to the scientific piggery management, two at farmers' field and the 3rd one at the institute involving farmers from the neighboring states.

Animal Physiology

Baseline data on hormonal parameters (T3, T4, cortisol and testosterone) in blood of indigenous pigs (Niang Megha and Ghungroo) have been generated. As one of the important by-products of pig farming is the hair or bristle fibres, a study on biophysical characterisation of fibres from pigs and development of different utility products has been undertaken by this section of the institute during the period reported upon. Studies involving lipid based technique (s) for improved preservation of boar semen have also been undertaken.

Livestock Products Technology

During the reported period this section of the institute was involved in the evaluation of effects of incorporation of fermented bamboo shoot (*Bambusa polymorpha*) mince in pork nuggets, its characteristics and physico-chemical characteristics of pork nuggets with fermented bamboo shoot mince. Different value added pork products such as pork slice, hot dogs, samosa, momo, salami and cocktail were prepared and in addition, studies pertaining to yield of meat and

byproducts of cattle, goat, pig and poultry in the state of Assam have also been carried out.

Animal Health

Diseases that commonly occur in pigs managed under intensive as well as semi-intensive/scavenging system of management and have economic impact on swine production were studied. Seroprevalence of some viral diseases of pigs (such as PRRS, PCV) which might have tremendous economic impact on pig production have been undertaken. Developed novel molecular diagnostic method for detection of toxigenic strains of *Pasteurella multocida*, the causative agent of progressive atrophic rhinitis (PAR) in pigs, novel multiplex PCR for reliable, rapid and simultaneous detection of three most important *E.coli* pathotypes from diarrhoeic piglets and novel PCRs for detection of 10 most important virulence associated genes (VAGs) of *P. multocida* from pigs. Besides, remedial measures for some important diseases of pigs have been formulated.

AICRP and Mega seed Project on Pig

Nine AICRP on pig centres and four mega seed on pig centres distributed in different parts of the country and functioning under the supervision of NRC on Pig, Rani, Guwahati were actively monitored for their activities as assigned by the Institute. Production performances of pigs maintained by each centre, management practices adopted by those centres and achievements made by them were also reflected in this Annual Report.

KVK

During the reported period KVK located at Dudhnoi, Goalpara has conducted 59 need based trainings involving different areas of agriculture and allied activities. A total of 1958 trainees attended the trainings out of which 1188 were male and 770 were female trainees. Again the total trainee population comprised of 17 nos. of SC, 1650 nos. of ST, 258 nos. of OBC and 33 nos. from other communities. Seven On Farm Testing (OFT) and two Front Line Demonstration (FLD) were also undertaken by this KVK. In addition, other activities such as organization of workshops, farmers Scientist interaction meeting, exhibitions, Hindi divas etc. were also undertaken during the reported year.

INTRODUCTION

The challenges faced by our country in securing the food as well as nutritional security to fast growing population need an integrated approach for livestock farming. Among the various livestock species, pig is the most potential source of meat and more efficient feed converter after the broiler. Apart from providing meat, it is also a source of bristles and manure.

Pig husbandry has been playing a pivotal role in the socio-economic development of large population in India in general and North-Eastern states in particular. For the majority tribal population, livestock keeping – especially pig keeping - is integral to their way of life, with 4.46 million pigs (over 40% of the pigs in India) in the NE Region. There is a growing demand for pork due to increasing per capita income, urbanization and changes in lifestyle and food habits. Much of this demand is met from imports from other states in India and from Myanmar.

India posses a total pig population of 11.13 million of which NE region is having 4.4 million. More than 40% of the total pig population of the country is in the North Eastern (NE) states. Although the pig farming constitutes the livelihood of rural poor belonging to the lowest socio-economic strata, this section of the society do not have means to undertake scientific pig farming with improved foundation stock, proper housing, feeding and management. In order to modernize the Indian pig sector and to improve the productivity of small sized rural pig farms adequate financial provisions are necessary. In view of the importance of pig farming in terms of it's contribution to rural economy and possible potentials for pig rearing in our country, National Research Centre on Pig (ICAR), Rani, Guwahati has been trying its level best for popularizing the scientific pig production and post harvest management in the country since its inception as well as all round development of the piggery sector along with its affiliation units, namely Krishi Vigyan Kendra (KVK), nine centres of All India Coordinated Research Project on Pig, and four centres of Megaseed Project on Pig, spread over different parts of the country. All India Coordinated Research Project on Pig and Megaseed Project on Pig are the flagship programmes for which the Institute acts as a nodal agency. Development of region-specific pig production technologies and filling the critical gap of demand for superior pig genetics are the focus of the two programmes respectively. The large network of research and development along with matching extension covering different agro-climatic zones and production systems of the country have been able to significantly contribute to the all round development of pig husbandry in general.

The Mandate of NRC on Pig

- 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.

- To act as a repository of information house on pig production and health for regional, national and global policy planning and implementation

Vision

To bring in excellence in pig production, health and product processing through innovative research in order to provide technology backstopping for enhanced pork production, employment generation and poverty reduction among socially and economically weaker sections through the medium of pig husbandry.

Mission

Performance appraisal and genetic cataloguing of indigenous pigs, development of improved pig variety together with production, health, product processing and pig based integrated farming system technologies to facilitate the pig rearers of the country for achieving household food, nutritional and economic security.

Budget allocation and utilization

Budget 2013-14

Name of main scheme/sub scheme		W	EQP	LIB	FUR	LIV	VEH	OTH	ESTT.	CONT	TA	HRD	TOTAL
Main Scheme	BUDGET FOR THE YEAR	**19.00**	**30.00**	**5.00**	**3.00**	**3.00**	**0.00**	**5.00**	**0.00**	**220.00**	**8.00**	**2.00**	**295.00**
	EXPENDITURE	**18.18**	**28.70**	**5.00**	**3.00**	**3.00**	**0.00**	**4.94**	**0.00**	**220.00**	**8.00**	**1.98**	**292.80**
AICRP on Pig	BUDGET FOR THE YEAR	**80.00**	**15.00**	**0.00**	**5.00**	**6.00**	**0.00**	**0.00**	**107.90**	**176.10**	**10.00**	**0.00**	**400.00**
	EXPENDITURE	**80.00**	**15.00**	**0.00**	**5.00**	**6.00**	**0.00**	**0.00**	**107.90**	**176.10**	**10.00**	**0.00**	**400.00**
Mega Seed on Pig	BUDGET FOR THE YEAR	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**125.00**	**4.00**	**0.00**	**129.00**
	EXPENDITURE	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**125.00**	**4.00**	**0.00**	**129.00**

W: works, EQP: Equipments, LIB: Library, FUR: Furniture, LIV: Livestock, VEH: Vehicle, OTH: Others, CONT: Contingency

NON-PLAN BUDGET VISAVIS EXPENDITURE DURING 2013-14

HEAD	CAPITAL	PAY & ALLOW.	PENSION & OTHER RETIREMENT BENEFITS	TA	CONTG.	MISC.	TOTAL
BUDGET OF THE YEAR	20.00	246.50	2.50	2.50	53.50	4.50	329.50
EXPENDITURE	19.96	246.40	2.36	2.50	53.50	4.35	329.07

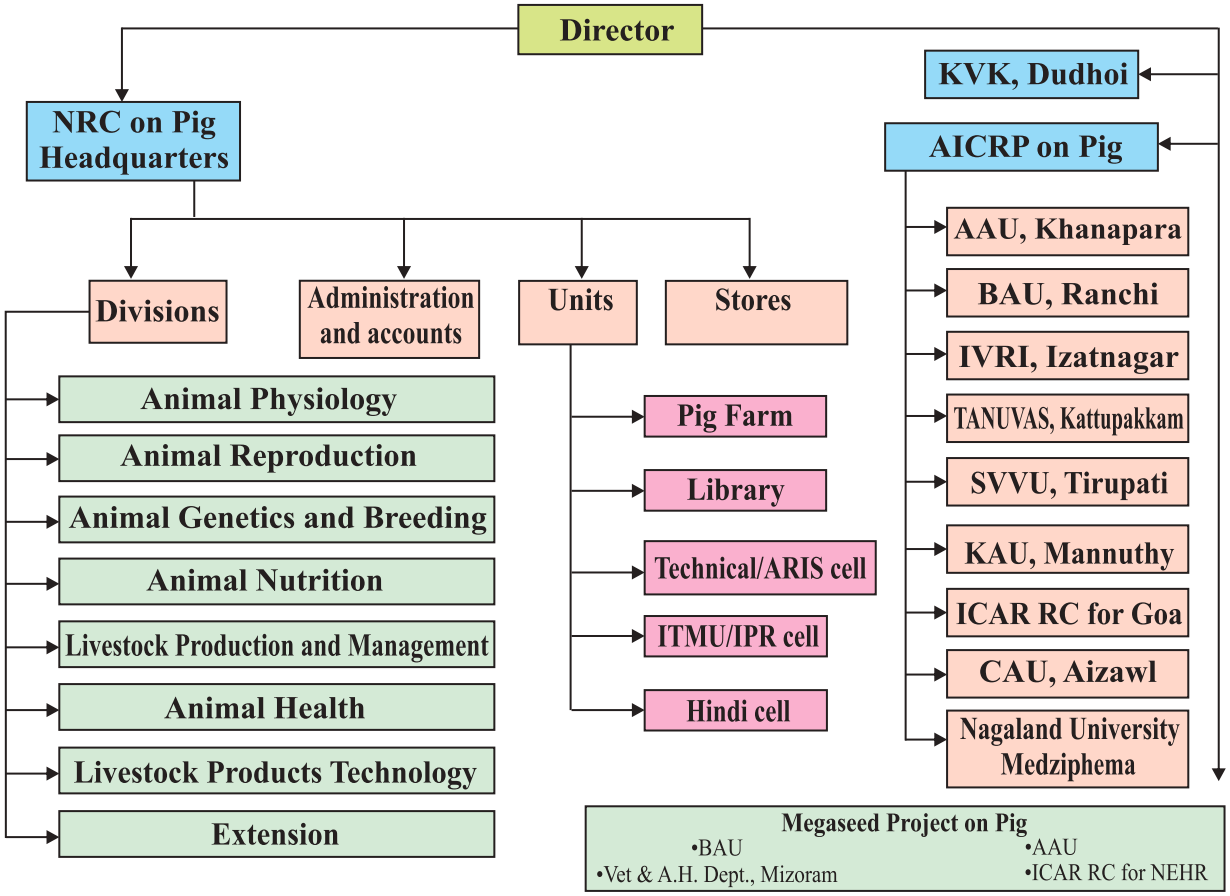
Revenue Generation during 2013-14

Name of the Institute	Year	Target(Rs. In lakh)	Revenue generated (Rs. In lakh)
NATIONAL RESEARCH CENTRE ON PIG, Guwahati	2013-14	38.00	46.64

SANCTIONED POSTS OF THE INSTITUTE AS ON 31.03.2014

Sl. No.	Discipline	Approved	In position	Vacant
A.	**RMP**	**1**	**1**	**0**
B.	**Scientific**			
1.	PS	2	1	1
2.	Sr. Scientist	6	4	2
3.	Scientists	12	6	6
Total		**20**	**11**	**9**
C. Administration & Supporting		**Approved**	**In position**	**Vacant**
1.	Administrative Officer	1	1	0
2.	AAO	1	0	1
3.	AF & AO	1	1	0
4.	Assistant	4	2	2
5.	Personal Assistant	1	0	1
6.	Junior Steno	1	1	0
7.	UDC	1	1	0
8.	LDC	1	1	0
9.	Skilled Supporting	3	2	1
Total		**14**	**9**	**5**
D. Technical		**Approved**	**In position**	**Vacant**
1.	T-3/T-4	4	3	1
2.	T-1	2	2	0
3.	T-1/T-2 (Driver)	1	1	0
Total		**7**	**6**	**1**

ORGANIZATIONAL SETUP



Physical Progress

1. Modern boar shed

During the reported year one number of pig shed has been constructed in addition to the existing 11 numbers to accommodate the increasing number of pig germplasm of the Institute. The new shed has better facilities to address the management and welfare issues of the pigs especially boars.

Views of newly constructed modern boar shed

2. Model unit for integrated pig cum fish culture

A model low cost unit has been designed and constructed to study the feasibility of integration of piggery with pisciculture. The unit can accommodate up to 15 pigs, which is an ideal size for replicating in the farmer's field.

Model unit for integrated pig cum fish culture

3. Computer centre

A new computer centre has been established in the Institute under NAIP programme with 25 numbers of computers. The unit has wireless LAN, interactive display board, LCD projector etc. and could be very well used for training purposes.

Newly established computer centre in the institute under NAIP Programme

4. Library

The well equipped Institute library, with more than 4000 books caters the needs of not only the researchers of this institute but also the students/researchers from neighboring Institutes. Besides the library has a good number of collections of various magazines, news papers, etc. During the reported period 8 numbers of international journals have been procured.

RESEARCH ACHIEVEMENTS

ANIMAL GENETICS AND BREEDING

Development of suitable crossbred pig

S. Banik, A. Das, S. Naskar, M. K. Tamuli and R. Thomas

A systemic crossbreeding programme was initiated by using parental lines of Hampshire and Duroc (male), and Ghungroo and Niang Megha (female) pigs, maintained at pig breeding farm of National Research Centre on Pig, Guwahati, as exotic and indigenous germplasm, respectively. Ghungroo breed is famous for superior reproductive performance, tolerance to disease challenges prevalent in tropical hot and humid agro-climatic condition and well adaptable. Niang Megha breed is famous for early sexual maturity, prominent bristle characteristics and well adapted to sub-tropical agro-climatic condition. Hampshire pig, on other hand, is known for its higher growth rate and better carcass traits and found to be widely accepted in Indian scenario. Duroc has been widely been used as terminal sire for its lean meat production and better mothering ability.

Pedigreed parental line of Hampshire and Ghungroo pigs were mated to produce F_1, followed by inter-se mating for five generations to stabilize the heterosis effect. A total of 11 and 17 number of sire and dam lines has been used for the

breeding programme with a mating ratio of 1:2.5. Top 3 and 8 percent of male and female were selected for producing subsequent generation based on performance traits. Animals were carefully selected to avoid inbreeding. The selected boars were trained for semen collection and all the mating was done by artificial insemination with pre-evaluated semen at the institute farm. Same plan was also followed for production of Hampshire and Niang Megha crosses. Animals of Hampshire-Ghungroo crosses showed better performance with respect to production, reproduction, adaptive and carcass traits than Hampshire-Niang Megha crosses at organized farm as well as farmers' field.

Salient findings of the project:

Crossbred Variety I ($H_{50}G_{50}$)

There is a huge potential as per demand of pork in north eastern India. A breeding programme was initiated by using Ghungroo as indigenous germplasm and Hampshire as exotic germplasm with the objective to develop a suitable crossbred line of pigs for breeding purpose to mitigate the lack of quality pig germplasm in the area.

Intensive selection pressure was implied to both male and female lines of pigs to select best Hampshire sires and Ghungroo dams on the basis of previous records maintained at the institute farm. First generation crossbreeding of Ghungroo with Hampshire was carried out by natural mating or artificial insemination. Half of the males of F_1 generation ($H_{50}G_{50}$) were castrated for growth, development and pork characteristics study; while selection was practiced in other males for inter-se-mating. Intense selection was practiced in un-castrated males and female pigs of F_1 generation to develop inter-se-mated F_2 population. Subsequently, inter-se-mating was practice to stabilize the characteristics of the developed line. The performance of different productive, reproductive, adaptive and carcass characteristics was evaluated.

The average litter size of birth and weaning for the developed variety was observed as 9.86±0.25 and 8.81±0.54, respectively. The corresponding litter weight and individual weight at birth and weaning was 10.89±0.26 and 1.14±0.03 kg and 59.88±1.92 and 6.93±0.27 kg, respectively. Age at first heat and age at first service was found to be 201.65±6.65 and 239.78±5.56 days, respectively. Pre and post weaning growth rate was 142.59±0.52 and 331.17±16.4 g/day. Slaughter weight at 8 months age was 71.555±1.057 kg. Pre and post-weaning mortality was found to be 5.2 and 4.83%, respectively. Diarrhoea, septicemia, lung congestion and fever were major cause of preweaning mortality. Among the carcass traits; hot carcass weight, dressing percentage, carcass length, loin eye area and back fat thickness at 10^{th} rib was observed as 66.47 ±4.22 kg, 74.00 ±0.98%, 92.88 ±4.44 cm, 4.63 ±0.32 sq. inch and 1.98 ±0.27 cm, respectively.

Fig. 1. Crossbred Variety I female pig

Crossbred Variety I Piglets

Crossbred Variety I Grower

The developed variety was also distributed in different Government and privet organization including farmers' field. The productive, reproductive and adaptive characteristics of the developed variety were found promising in different agro-climatic condition as a breeding animal.

Crossbred Variety II ($H_{50}M_{50}$)

For backyard rearing as well as pork industry, the pig farmers needs to be provided with suitable number of quality pigs for better economic return. In northeastern part of country, the desi pigs are having smaller body size, less growth rate; causing the pig farmers less economic benefit which discourages pig rearing. To address this problem a breeding programme was initiated at the institute farm to develop suitable pig adaptable to local climatic condition by using Niang Megha as indigenous germplasm and Hampshire as exotic germplasm.

Intensive selection pressure was implied to both male and female lines of pigs to select best Hampshire sires and Niang Megha dams on the basis of previous records maintained at the institute farm. First generation crossbreeding of Niang Megha with Hampshire was carried out by natural mating or artificial insemination. Half of the males of F_1 generation ($H_{50}M_{50}$) were castrated for growth, development and pork characteristics study; while selection was practiced in other males for inter-se-mating. Intense selection was practiced in un-castrated males and female pigs of F_1 generation to develop inter-se-mated F_2 population. Subsequently, inter-se-mating was practice to stabilize the characteristics of the developed line. The performance of different productive, reproductive, adaptive and carcass characteristics was evaluated.

The average litter size of birth and weaning for this crossbred variety was observed as 6.94±0.61 and 6.63±0.61 kg, respectively. The corresponding litter weight and individual weight at birth and weaning was 5.89±0.61 and 0.84±0.06 kg and 38.68±4.03 and 5.97±0.35 kg, respectively. Age at first heat and age at first service was found to be 270.52±6.85 and 311.51±7.96 days, respectively. Pre and post weaning growth rate was 122.45±6.31 and 240.87±20.35 g/day. Slaughter weight at 8 months age was 57.488±1.624 kg. Pre and post weaning mortality was found to be 2.63% and 2.22%, respectively. Diarrhoea was the major cause of preweaning mortality. Among the carcass traits; hot carcass weight, dressing percentage, carcass length, loin eye area and back fat thickness at 10th rib was observed as 54.24 ±3.26 kg, 75.70 ±0.60%, 87.00 ±6.54 cm, 3.20 ±0.25 sq. inch and 2.92 ±0.37 cm, respectively.

Fig. 2. Crossbred Variety II male pig

Crossbred Variety II Piglets

Crossbred Variety II female pig

The productive, reproductive and adaptive characteristics of the developed variety-II were also found promising but it was observed as significantly lower than variety I.

Crossbred Variety III ($D_{50}H_{25}M_{25}$)

To mitigate the gap between demand and supply of quality pork and pork products, a breeding programme was initiated at the institute farm to develop fattener pig by crossing with developed variety-I by using Duroc as terminal sire.

The productive, reproductive and adaptive characters of developed population of Variety-I ($H_{50}M_{50}$) was stabilized by few generation of inter-*se-mating*. Selection of superior Variety-I female pigs were carried out in the institute farm. Subsequently, selected population was crossed with Duroc males available at the institute. Duroc was used as terminal sire in this breeding programme due to its high potential of lean meat production with superior growth rate. As a fattener pig, the developed three breed cross ($H_{25}G_{25}$ D_{50}) was evaluated for growth, adaptive and carcass characteristics.

This variety showed prominent pre and post weaning growth rate. The pre and post weaning growth rare was observed as 173.19±9.19 and 379.23±22.15 g/d, respectively. Weaning and slaughter weight at 8 months of age was observed as 8.03±0.40 and 76.26±5.02 kg, respectively. Pre and post weaning mortality was observed as 2.0 and 4.0 percent respectively. Diarrhoea was the major cause of mortality. The hot carcass weight, dressing percentage, carcass length, back fat thickness and loin eye area of the developed variety was observed as 70.26 ±1.28 kg, 75.74 ±0.63%, 113.8 ±3.52 cm, 2.346 ±0.08 cm and 4.72 ±0.51 sq. inch, respectively.

Fig. 3. Crossbred Variety III piglets Crossbred Variety III grower Pig Crossbred Variety III adult Pig

Variety-III pigs were sold to farmers' field and slaughter house. The animals showed significantly higher body weight and high preweaning and post weaning growth rate than developed Varity-I and Variety-II. Mass scale production of Variety III animals is has been initiated at the Institute farm.

Regulation of Fatty Acid Synthesis by RNA Interference in Pig (Co-operating Center; NFBSFARA)

S. Naskar, M K Tamuli, R Thomas and Gokuldas PP.

Successful birth of piglets “Rani C-I” through non-surgical embryo transfer has been achieved for the first time in the country at National Research Centre on Pig, Guwahati. The in-vivo derived embryos were transferred to the synchronized recipient using a deep intra-uterine transfer catheter without sedation. The recipient Ghungroo (indigenous pig) gilt gave birth to 11 piglets on Feb 07, 2014. Out of 11 piglets born, seven are growing healthy in the Institute pig breeding farm, two were stillborn and two piglets died few days after birth. The encouraging result

reveals that the use of this cost effective technology will be helpful for multiplication and propagation of endangered indigenous pig germplasm as well as conservation of critically endangered species like pygmy hog (*Porcula salvania*) with the additional standardization for cryopreservation of embryos. The project team acknowledged the guidance and technical inputs received from Prof. B. C. Sarmah, College of Veterinary Science, Guwahati.

Fig. 4. Surrogate Ghungroo sow with piglets born through non-surgical embryo transfer

Fig. 5. Piglets born through non-surgical embryo transfer

Deciphering effect of environmental stressors on pig growth and reproduction through bio-molecular means and development of seasonally required support system for piggery sector (Lead Centre; DBT's Twinning Programme for the NE)

S. Naskar, R. K. Mahapatra and S. Banik

The project aims at documenting traditional pig husbandry practices in the north eastern part of India, critical evaluation and documentation of constraints faced by pig rearers and effect of seasonal change on overall productivity, studying bio-molecular expression of related endocrinal and genetic factors with respect to variable micro-climatic conditions under field conditions, and developing a comprehensive seasonal support system for pig rearing farmers.

For the reported year, analysis of feed samples offered to pigs was made. Hormonal profile (namely T3, T4, Testosterone and Cortisol) of various age groups of pigs under different THIs have been studied which was found to vary significantly. Gene (GH, FSH, ESR and HSP70) expression studies for different genetic groups of pig (namely native, crossbred and exotic) during winter season were found to vary.

Hormonal profile

Based on micro-climatic conditions of animal shelters (Reference Farm: Institute Pig Breeding Farm, NRC on Pig, Guwahati), three seasons were classified: Season I (Nov-Feb), Season II (Mar-Jun) and Season III (Jul-Oct). Pig serum samples collected through survey by project lead centre were analyzed by RIA at College of Veterinary Science, Guwahati (project collaborating centre) for the hormones namely T3, T4, Testosterone and Cortisol.

The hormonal profile varied significantly ($P<0.05$) during different season among the different genetic groups of pigs. Average cortisol level (nmol/L) in native grower pigs was 238.36±19.59, 189.00±36.16 and 282.2±22.82 during Season I, II and III respectively as compared to 238.25±36.05 and 88.26±18.29 in crossbred grower pigs during Season I and II, and 258.42±25.28 in exotic grower pigs during Season II. Average T3 level (nmol/L) in native grower pigs was 0.92±0.06, 1.30±0.60 and 1.28±0.10 during Season I, II and III respectively as compared to 2.15±0.33 and 1.03±0.28 in crossbred grower pigs during Season I and II. Average T4 level (nmol/L) in native grower pigs

was 28.27±5.73, 51.19±7.27 and 34.64±4.65 during Season I, II and III respectively as compared to 23.46±8.08 and 26.89±7.04 in crossbred grower pigs during Season I and II. Similar variability was also found with respect to finisher and adult pigs. For example, cortisol level (nmol/L) was 9.24±1.09, 176.27±53.23 and 35.18±3.24 in native, crossbred and exotic finisher pig respectively during Season II. For adult pigs, cortisol level (nmol/L) was 107.12±20.81, 383.15±66.45 and 125.41±15.20 in native, crossbred and exotic pigs respectively during Season II.

Genetic profiling

Molecular characterization of GH, GHRH, FSH and ESR genes was done. For GH gene, a PCR amplicon of 607 bp, spanning over exon 1 and 2, interspersed by intron, was amplified. The amplified products were digested with REs *Apa*I, *Hae*II, *Dde*I and *Msp*I, revealing 3, 3, 3 and 1 genotyopes, respectively. For GHRH gene, a PCR amplicon of 467 bp, spanning over exon 2 and 3, interspersed by intron, was amplified. The amplified products were digested with RE *Alu*I revealing one genotype only (225/110/62/22/15/7 bp). For FSH gene, a PCR amplicon of 624 bp was amplified from Intron 1. The PCR-RFLP study using *Hae*III enzyme revealed two alleles, arbitrarily designated as *allele 1* (208, 173, 159 and 84 bp) and *2* (332, 208 and 84 bp). With regard to the PCR based SINE detection in FSH gene, three types of genotypes were obtained depending on the absence or presence of retrotransposon. The homozygous SINE -/-, +/+, and heterozygous -/+ genotypes were represented by 220, 500, and 220/500 bp PCR products respectively. It was also observed that animals with SINE -/- and -/+ genotypes mostly had *allele 2*. Further, a retrotranposon of 285 bp (SINE) was detected in the sequence with three *Alu*I restriction sites in SINE -/+ and +/+ genotypes. With respect to ESR gene, a PCR amplicon of 120 bp was amplified and digested with *Pvu* II restriction enzyme which revealed presence of *two alleles (A 120/B 65,55 bp)*. In absence of sufficient performance records of animals maintained under field conditions, association studies could not be carried out.

Relative expression of genes (GH, FSH, ESR and HSP70) for different genetic groups of pig during winter season

Among grower pigs, expression level of GH gene was 0.371 times higher in exotic (Exo) and 1.948 times lower in crossbred (CB) compared to native (Ind) pigs. Similar trend was also observed in adult female pigs with 1.4 fold higher expression in Exo and 1.088 fold lower expressions in CB as compared to Ind pigs.

With respect to FSH gene, 1.636 times higher expression was observed in Exo and 1.616 times lower expression in CB compared to Ind grower pigs. Similarly, higher level of FSH gene expression in Exo (2.563) and lower level of expression in CB (0.847) as compared to Ind adult female pigs were observed.

Exotic grower pigs had 1.704 fold higher and CB grower pigs had 3.459 times lower expression of ESR gene than Ind grower pigs. In case of adult female pigs, Exo had 1.691 fold higher and CB had 0.48 fold lower expression than Ind.

Relative expression (RE) of HSP70 gene in CB and Exo grower pigs were 1.146 and 2.274 times lower than that of Ind pigs respectively. In contrast, it was 13.415 times higher in CB adult female pigs than that of Ind pigs. Further, level of expression of HSP70 gene in exotic adult female pigs was lower than Ind pigs.

ANIMAL NUTRITION

Dietary manipulation and feeding management for economic swine production

K. Barman, M.K. Tamuli and R. Thomas

i) Effect of replacing maize with bakery waste on the performance of growing crossbred (Hampshire x Ghungroo) pigs

Feed costs represent 65 to 75% of the variable costs of swine production thereby playing a major role in determining the profitability of a piggery farm. Conventional diet of pig contains 30-60 % of cereals. Pigs directly compete with humans for cereals. In order to reduce this competition, proportion of cereals in the swine ration need to be replaced with other locally available feed resources. Bakery waste is one of such feed resource which can easily be incorporated in the diet of pigs. Therefore, this study was conducted to ascertain the suitable level of bakery waste that can easily replace maize in the diet of crossbred pigs without any adverse effect on production performances.

Sixteen crossbred (HS x NM) grower pigs (about 2 months age, weighing from 5.95 ±0.33 to 6.03±0.53 kg) were divided into four groups of four each in a randomized block design. The pigs were fed on three different experimental diets by replacing maize with bakery waste (@ 0, 25 and 50% inT_1, T_2 and T_3 groups respectively (Table 1). The pigs were fed on the experimental grower rations twice daily. The average dry matter intake (g/d) ranged from 630.21 in T_1 to 636.16 in T_3 respectively. Digestibility coefficients of dry matter, organic matter, crude protein, ether extract, crude fiber and nitrogen free extracts were similar ($P>0.05$) across all treatments. The average body weight gain (g/day) was 227.55±15.5, 217.86±5.02 and 192.86±17.13 respectively, in T_1, T_2 and T_3 groups. The average daily gain (g/day) was similar in all groups. Similarly, feed conversion ratio was also found similar across all the treatments. The cost of production per kg live weight (Rs.) ranged from 54.91±1.78 in T_2 to 57.75±4.53 in T_3 group which was similar across all the treatments. The cost of production per kg live weight was reduced ($P>0.05$) by Rs. 2.67 in T_2 group in comparison to T_1 group. It is concluded that maize can be replaced up to 25 % with bakery waste without affecting the growth, nutrient utilization, FCR and economy of feeding.

Table 1: Percent ingredient composition of concentrate mixture

Ingredients	T_1	T_2	T_3
Maize crush	56.0	42.0	28.0
Wheat bran	14.5	14.5	14.5
Soyabean meal	15.0	15.0	15.0
GN cake	12.0	12.0	12.0
Bakery waste	0.0	14.0	28.0
Mineral mix	2.0	2.0	2.0
Salt	0.50	0.50	0.50
Total	**100.0**	**100.0**	**100.0**
Lysine	0.04	0.04	0.04
Methionine	0.01	0.01	0.01
Phytase enzyme, g	40	40	40
Feed cost, Rs/quintal	1843	1736	1628

T_1= 0 % replacement of maize with BW; T_2= 25 % replacement of maize with BW; T_3= 50 % replacement of maize with BW; BW=Bakery waste

Table 2: Effect of substituting maize with bakery waste on nutrient utilization in crossbred pigs

Parameters	Groups			Level of significance	P Value
	T_1	T_2	T_3		
Feed intake, g/d	630.21	634.13	636.16	NS	-
Average gain, g/day	227.55 ±15.05	217.86 ±5.02	192.86±17.13	NS	0.22
FCR	3.12 ±0.17	3.30 ±0.11	3.88 ±0.3	NS	0.07
Feed cost/kg gain	57.58 ±3.08	54.91 ±1.78	57.75 ±4.53	NS	0.821

T1= Control; T2= 25 % replacement of maize with bakery waste; T3= 50 % replacement of maize with bakery waste; NS = non significant

ii) Effect of replacement of maize with water hyacinth (*Eichhornia crassipes*) foliage on nutrient utilization in crossbred (Hampshire X Ghungroo) grower pigs

In conventional fattening system, pigs directly compete with human being for cereals like maize, wheat, rice etc. Farmers unable to go for intensive pig farming because of high cost of feed ingredients. As a result, farmers traditionally go for new feed resources which are available locally and economically viable for livestock production. Water hyacinth (*Eichhornia crassipes*) is one of such new feed resource for pig. Water hyacinth foliage is commonly used as a supplementary feeding for pigs. A maximum inclusion rate of 6-7% (on DM) has been considered economically viable because of presence of anti-nutritional factors in it. In the present studies, water hyacinth foliage was used at different levels by replacing

maize on growth and nutrient utilization in crossbred grower pigs.

Eighteen crossbred (Hampshire X Ghungroo) grower male pigs (3.5 months old; body weight ranged from 30.05±4.70 to 30.83±1.60 kg) were divided into three groups of six each in a randomized block design. The pigs were fed as per BIS (1986) feeding standard on three different types of grower rations supplemented with three different levels of water hyacinth foliage (*Eichhornia crassipes*) @ 0, 5 and 10 % by replacing (DM basis) the maize namely T_1 (maize- 60.0, wheat bran- 10.5, soyabean meal- 14.0, groundnut- 13.0, water hyacinth foliage 0.0, mineral mixture- 2.0, common salt-0.50); T_2 (maize- 55.0, wheat bran-10.5, soyabean meal- 14.0, groundnut- 13.0, water hyacinth foliage 5.0; mineral mixture- 2.0, common salt-0.50) and T_3 (maize- 50.0, wheat bran-10.5, soyabean meal- 14.0, groundnut- 13.0, water hyacinth foliage 10.0, mineral mixture 2, common salt-0.5). Additionally, 40g phytase enzyme, 0.04 % lysine and 0.01 % methionine was added to all diets. Water hyacinth (*Eichhornia crassipes*) foliage was supplemented on fresh basis. The pigs were fed on the experimental rations twice daily in the morning and evening. The experiment was conducted for a period of three months. Digestibility trial was conducted at the middle of the experiment.

The chemical composition of the experimental feeds and water hyacinth is given in Table 3. The digestibility coefficient of dry matter, organic matter, crude protein, ether extract and nitrogen free extract was similar in T_1, T_2 and T_3 groups (Table 4) while digestibility coefficient of crude fiber was reduced significantly ($P<0.01$) in T_3 group. Although there was no significant difference in digestibility of nutrients between T_1 and T_2 groups, but digestibility of CP and CF were partially lower ($P>0.05$) in T_2 group (Table 4) which might be due to the presence of hydrolysable and condensed tannins as well as its high fibre content.

Average feed intake (kg/d) was ranged from 1.13±0.03, 1.11±0.03 and 1.14±0.03 in T_1, T_2 and T_3 groups respectively and found similar across all treatment groups. Average growth rate (g/day) was ranged from 260.6 ±48.2 to 365.9 ±85.6 in T_3 and T_2 group respectively and the value for other group is within this range of variation. There was no any significant difference on growth among treatments.

From this study, it is concluded that water hyacinth *(Eichhornia crassipes)* foliage could replace 5 % maize in ration of crossbred grower pigs without any adverse effect on nutrient utilization.

Table 3. Proximate composition of experimental rations

Ration	OM %	CP %	CF%	EE %	Ash %	NFE %
T_1	93.72 ± 0.60	18.44±0.31	8.33±0.64	2.35±0.34	6.28±0.60	64.61±1.88
T_2	94.21±0.12	18.42±0.25	7.39±0.45	1.55±0.02	5.67±0.24	66.98±0.46
T_3	91.79±0.60	18.40±0.27	6.74±0.07	2.27±0.09	8.21±0.60	64.38±0.31
WH	91.70±0.51	9.45±0.03	18.38±0.20	3.16±0.11	8.61±0.46	60.41±0.74

T_1= Control; T_2= 5 % replacement of maize with WH; T_3= 10 % replacement of maize with WH; WH=Water hyacinth

Table 4. Effect of replacement of maize with water hyacinth foliage on digestibility coefficient of nutrients

Group	DM	OM	CP	EE	CF	NFE
T_1	82.34±2.71	84.11±2.44	88.95±1.69	62.49±5.74	60.48±1.20	86.49±2.07
T_2	82.54±1.90	84.20±1.72	83.87±1.76	63.58±3.96	59.38±1.51	88.29±1.29
T_3	79.90±1.84	81.32±1.72	83.88±1.48	60.60±3.62	42.69±1.26	85.18±1.33
P-Value	0.67	0.57	0.18	0.89	0.004**	0.48

T_1= Control; T_2= 5 % replacement of maize with WH; T_3= 10 % replacement of maize with WH; WH=Water hyacinth, ** (P<0.01)

Fig 1. Water hyacinth (*Eichhornia crassipes*)

iii) Effect of feeding tapioca meal on growth and nutrient utilization in crossbred (Hampshire x Ghungroo) grower pigs.

In swine production, feed alone represent 70-75% of total cost of production. In intensive pig production, pig directly compete with human being for feeding, since conventional fattening is based on the feeding of cereals like maize, wheat, oats, barley etc. along with other protein, mineral and vitamin supplements. Farmers are unable to support costly feeding program because of high cost of cereals and oil cakes. As a result, animal nutritionist used to search for new feed resources especially unconventional feeds in order to design economic feeding programme for swine and other livestock. Tapioca (*Manihot esculenta*) is one of such unconventional feed resource used by farmers for feeding of pigs. In the present study different levels of tapioca meal was used to ascertain the effect of replacement of maize on growth and nutrient utilization in crossbred grower pigs.

Eighteen crossbred (Hampshire x Ghungroo) grower pig (about 3 months, 8.6 ±0.04 to 8.7±0.02 kg BW) of either sex were divided into three groups of six each in a randomized block design. The pigs were fed as per Bureau of Indian Standard (BIS). Tapiopca meal (*Manihot esculenta*) was used @ 0, 10 and 15 % by replacing the maize ingredients in T_1, T_2 and T_3 groups, respectively.

The crude protein content (% DM) of the composite ration was ranged from 19.33±0.39 to 19.78±0.03. The average DM intake (g/d) was ranged from 920.1 T3 to 927.9 in T2 groups respectively and other fall within this range of variation which was found similar (P>0.05) across the groups. Digestibility coefficients of DM, OM, CP, CF, EE and NFE were similar (P>0.05) across all the groups. The average daily gain in body weight was 253.22±18.71, 256.28±10.63 and 296.25±11.22 in T_1, T_2 and T_3 groups, respectively, which was similar (P>0.05) across the groups. The feed conversion ratio ranged from 3.74±0.13 in T3

group to 80.42±5.73 in T1 group respectively and other parameters fall within this range of variation which was similar across the groups. The cost (Rs/kg gain) of production per kg live weight reduced significantly with increased level of tapioca in the diets. It is concluded that maize can be replaced by 15% with tapioca meal without affecting the growth, nutrient utilization, feed conversion efficiency and production cost in grower crossbred pigs.

Table 5: Effect of different levels of tapioca meal on nutrient utilization in crossbred pigs

Parameters	Groups			Level of significance	P Value
	T_1	T_2	T_3		
DM intake, g/d	926.6	927.9	920.1	NS	-
Average gain, g/d	253.22±18.71	256.28±10.63	296.25±11.22	NS	0.104
Feed conversion ratio	4.43±0.32	4.33±0.18	3.74±0.13	NS	0.115
Feed cost/kg gain	80.42^{c}±5.73	75.45^{b}±3.13	63.81^{a}±2.28	*	0.042

T_1=0 % replacement of maize with tapioca meal; T_2=10 % replacement of maize with tapioca meal; T_3=15 % replacement of maize with tapioca meal; ^{abc} different superscript in a row differ significantly (P<0.05).

Fig. 2. Tapioca tubers *(Manihot esculenta)*

ANIMAL REPRODUCTION

Standardization and Preservation of Boar Semen for Artificial Insemination Technology

M. K. Tamuli, N. H. Mohan, P. P. Gokuldas, S. Banik and S. Naskar.

Training of boars

Out of twenty boars, 5 boars were replaced with 2 Hampshire and 3 Duroc. These 5 boars were successfully trained over the Dummy sow for regular collection of semen.

Semen evaluation

Altogether 603 nos. of semen ejaculates were collected and evaluated for important parameters related to fertility viz. Motility of spermatozoa, concentration of spermatozoa, percentage of live spermatozoa with normal acrosome (LIA) before and after cold shock.

Preservation of boar semen at 5ºC

Two boars from each of Hampshire, Ghungoo Hampshire crossbred and Duroc breeds were selected and from each boar, at least 5 semen ejaculates were collected at weekly interval. Collected semen samples were subjected to incubation at 24ºC for 7 hours for acquisition of sperm cell resistance and later diluted with GEPS, Modena and Androheps at 1:3 i.e. 4 times. Aliquots of 10 ml were preserved up to 72 hours and examined for sperm motility and percentage of normal acrosome in live cells using Nigrosin-Eosin-Giemsa stain. After preservation, only Androheps could give 32.00 ± 3.34 percent LIA with motility percent of 22.29 ± 5.19 which is not fit for artificial insemination. However, after 24 hours of preservation with GEPS extender that gave 35.71 ± 5.21 per cent motility and 48.86 ± 2.74 per cent of LIA were subjected to artificial insemination. The fertility percentage was recorded as 52.6% out of 38 nos. of inseminated sows and average litter size was recorded as 8.2.

Effect of $KMnO_4$ on quality of boar spermatozoa

Since long time, $KMnO_4$ solution at 0.1% level has been used to wash the hand before collection of boar semen. Because, palm often gets soiled with slippery prostate gland secretion as the glans penis retracts from the palm fist before it gets locked. Thus, the boar semen in GEPS at micromolar concentration of $KMnO_4$ from 62 µm to 7.7 µm were studied and revealed that with higher concentration, the ingredient has cascade effect while at lower concentration after 72 hours of preservation at 15ºC, sperm per cent motility was found to be 12.25 ± 1.71 and LIA was found to be 44.84 ± 1.99. Using a concentration of 11.5 µm in GEPS extender without the presence of antibiotic, artificial inseminations were performed with 45 Nos. of sows within 48 hours of preservation at 15ºC and fertility was recorded as 53.3 per cent with average litter size at birth of 8.04.

Effect of additives on boar semen preservation

As long term semen extender, GEPS and Modena were compared for preservation of boar semen at 15ºC and 5ºC up to 96 hours of preservation in presence of additives *viz.* $KMnO_4$, Vitamin E, Butylated hydroxitolune (BTH) and Trehalose. LIA percentage was recorded as 42.06 ± 3.33, 39.33 ± 3.23, 39.67 ± 3.47 and 33.45 ± 3.10 in GEPS extender with $KMnO_4$, Vitamin E, BTH and Trehalose respectively at 15ºC temperature of

preservation. The relative values at 5ºC temperature of preservation were recorded as 39.29 ± 3.97, 36.42 ± 3.15, 36.83 ± 3.23 and 32.75 ± 3.15 in GEPS extender.

Alternatively, LIA percentage was recorded as 45.67 ± 4.74, 43.25 ± 4.14, 52.46 ± 3.95 and 38.58 ± 4.21 in Modena extender with $KMnO_4$, Vitamin E, BTH and Trehalose respectively at 15ºC temperature of preservation. The relative values at 5ºC temperature of preservation were recorded as 43.17 ± 3.29, 42.89 ± 3.10, 49.58 ± 4.24 and 37.83 ± 3.94 in Modena extender.

Artificial insemination with GEPS extender

A total of 1107 piglets were born from 84 sows and 27 gilts at the institute out of 362 nos of AI and in the farmers' sties, a total of 7032 piglets were born from 881 nos of females out of 1475 nos of AI.

In farmers field 40.27% of pigs failed to conceive at first AI and < 1% of pigs were sold and slaughtered while they were pregnant. This failure is due to ignorance of farmers. The new farmers inducted to farming are not aware of the time of insemination. Thus the shortfall demands location specific farmers's training at field level for improvement of fertility.

Value Chain on Novelty Pork Products under Organized Pig Farming System- NAIP

M. K. Tamuli, Mohan, N.H. and R. Thomas

Artificial Insemination: A total of 166 nos of semen doses were supplied to the NAIP Lead Centre located in the College of Veterinary Science, Khanapara at a distance of 42 Km. Out of 25 nos. of sows, until May'13, 205 nos. of piglets were born.

Edible Product Development :In regards to meat product development in ethnic food pattern, *Chunga* Minced Pork was prepared using hollow bamboo stem with nutraceutical approach incorporating herbs of *Murraya koenigii*, *Centella asiatica* and *Paederia foetida* independently and cocktail of all three. These herbs are of high medicinal value for the gastrointestinal tract disorder in human and commonly used in villages in the form of curry. Also, *Centella asiatica* increases the memory power. All the products were proved very tasty while the cocktail remained as superior in taste. However, the keeping quality at room temperature for long term consumption has not been tested.

Farmers' Training Programme : Three training programmes were conducted in regards to the scientific piggery management, two at farmers' field and the 3rd one for 3 days Artificial insemination training in the institute calling farmers from the neighbouring states. The attendance of farmers in the training programmes was 45%, 65% and 100% respectively.

Hormonal and nutritional interventions for improving reproductive performance in pigs

P. P. Gokuldas, M. K.Tamuli, K. Barman, N. H. Mohan, S. Naskar and R. Thomas

Effects of dietary omega-3 fatty acid supplementation on endocrine response in sows

The present study was carried out to evaluate the endocrine response to dietary omega-3 fatty acid supplementation during early gestation in sows. A total of eighteen healthy crossbred sows were selected to assess the effects of dietary n-3 polyunsaturated fatty acid (*n-3 PUFA*) supplementation on various hormonal profiles during pre-mating period and early gestation. The experimental diet was characterized by elevated levels of omega-3 fatty acids. The selected sows were randomized to receive diets containing 4% (wt/wt) cold-pressed flaxseed oil as n-3 PUFA source [Treatment (TRT) group] or standard control diet i.e. Maize-Wheat

bran-Soyabean meal diet containing 3.22 Mcal ME/kg, iso-nitrogenous and iso-caloric to treatment diet [Control (CON) group]. Animals were fed n-3 PUFA diet or control diet (2.5 kg/day) starting from first day of detected estrus up to 35 days and they were artificially bred on the second estrus with liquid boar semen. Sows were catheterized in jugular vein on first day of estrus, mid-luteal phase, second estrus and 10 days interval in post-breeding period. The levels of different hormones viz. progesterone, estradiol-17β and IGF-1 (Insulin like Growth Factor-1) were assayed in the plasma samples using standard enzyme immunoassay kits. Mean plasma progesterone levels in both TRT and CON group over a period of 40 days (from the day of first detected estrus) are presented in Table 1.

Table 1: Plasma progesterone levels (Mean±SEM) in sows fed diet supplemented with n-3 PUFA diet or control diet

Stage of estrous cycle	Progesterone concentration in ng/ml		*p*-value
	TRT Group (n=10)	CON Group (n=8)	
First estrus	1.09±0.01^{a}	1.11±0.01^{a}	0.916
Mid-luteal phase	24.40±2.44^{b}	24.57±1.36^{b}	0.954
Second estrus	1.09±0.01^{a}	1.05±0.01^{a}	0.700
10 days post-breeding	26.90±1.65^{b}	21.03±1.82^{b}	0.057
20 days post-breeding	34.28±2.26^{c}	15.35±2.45^{d}	0.001*

*means in the same row differ statistically significant at 0.01 percent level of significance
(^{a,b}) Superscripts indicate statistically significant differences within the column ($p \leqslant 0.05$)

Plasma progesterone levels during first and second estrus were not significantly different (p>0.05) between the groups (Table 1). However, significant rise in maternal plasma progesterone concentrations could be observed during early gestation period in omega-3 PUFA supplemented sows as compared to sow of the control group (34.28±2.26 vs. 15.35±2.45 ng/ml, p<0.05). There was, nevertheless, no overall significant difference (p>0.05) observed in progesterone levels between the groups during the entire dietary period. Estrus stage-related differences in plasma concentrations of progesterone were also observed within each group. Sows of both groups had significantly lower (p<0.05) levels of plasma progesterone during estrus phases than during luteal phases. Dietary inclusion of n-3 PUFA alters systemic progesterone levels during early gestation and this may have positive influence on subsequent reproductive response and fertility in sows.

The systemic concentrations of plasma estradiol-17β in both treatment as well as control groups over a period of 40 days (from the day of first detected estrus) are illustrated in Figure 1. The estradiol-17β levels were not significantly different (p>0.05) between TRT and CON groups during first estrus (45.23±2.28 vs. 50.49±1.66 pg/ml). Further, plasma estradiol concentrations during mid-luteal phase and second estrus were also similar (p>0.05) in TRT group compared to CON group.

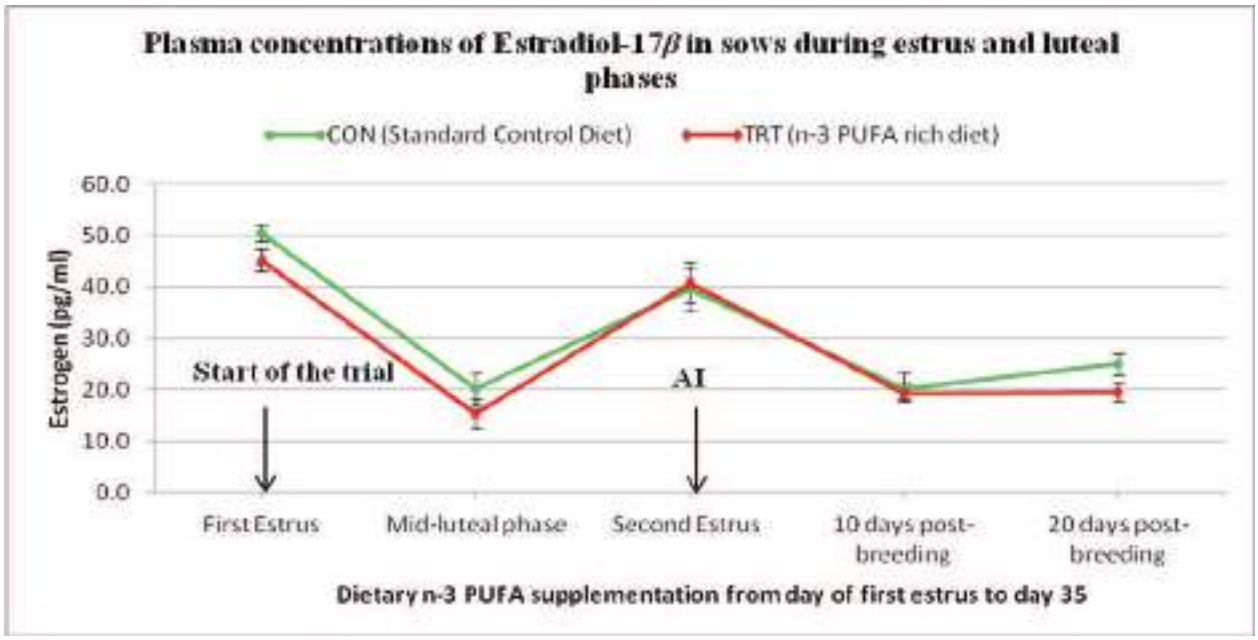


Fig. 1: Mean values and Standard error (bar) for plasma concentrations of estradiol-17β (pg/ml) in multiparous crossbred sows fed diet supplemented with n-3 PUFA (TRT) or standard control (CON) diet.

Plasma estradiol concentrations in *n-3* PUFA supplemented sows on day 20 post-breeding were numerically lower but not statistically different ($p>0.05$) from those of the animals in control diet group. Estrus stage-related differences in plasma concentrations were observed within each group. Sows of both the groups had significantly ($p<0.05$) higher levels of plasma estradiol-17β during estrus compared to mid-luteal phases. Relatively similar plasma estradiol-17β levels were observed in sows of both the groups at all intervals with no significant difference (p>0.05) in overall means.

The systemic concentrations of plasma IGF-1 in both treatment as well as control groups over a period of 40 days (from the day of first detected estrus) are illustrated in Figure 2. Plasma IGF-1 concentrations did not alter significantly during first estrus between CON and TRT groups (65.93±4.66 vs. 64.02±4.85 ng/ml, $p>0.05$). However, plasma concentrations were significantly higher ($p<0.05$) in TRT group as compared to control group both during mid-luteal phase (30.39±2.58 vs. 20.10±1.91 ng/ml) and second estrus (90.31±5.26 vs. 60.41±6.50 ng/ml). Sows of both groups had significantly higher ($p<0.05$) levels of plasma IGF-1 during estrus than mid-luteal phases. Further, dietary inclusion of omega-3 fatty acids elicited significant rise ($p<0.05$) in maternal plasma IGF-I concentrations during post-breeding period (Fig 2).

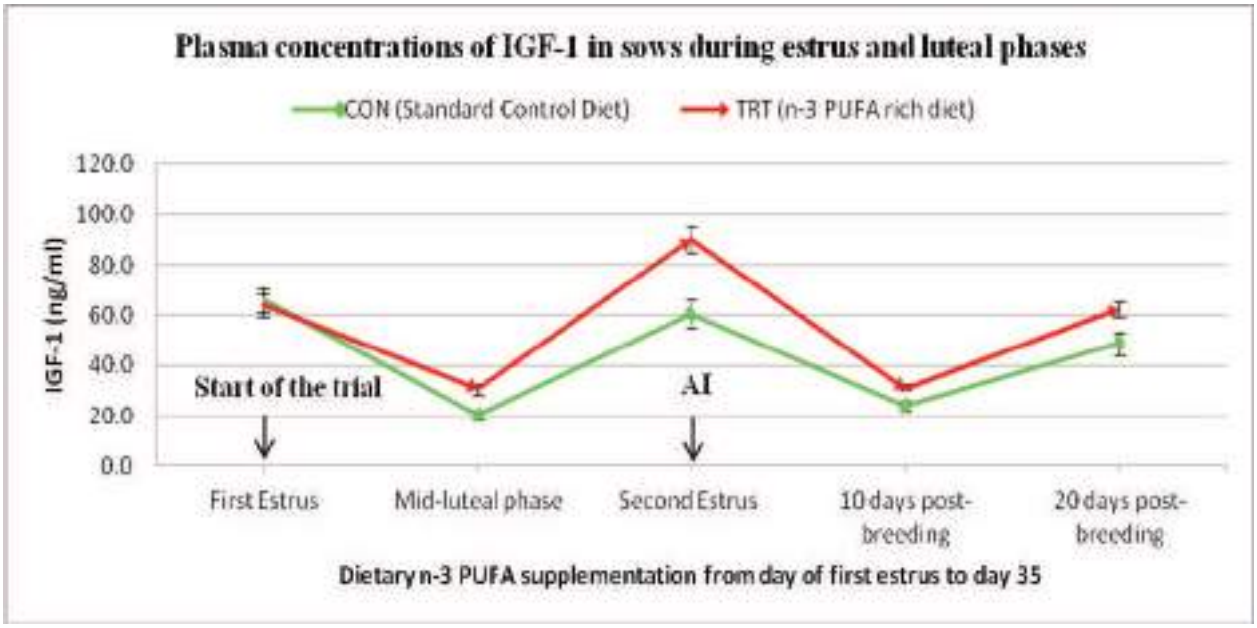


Fig. 2: Mean values and Standard Error (bar) for plasma concentrations of IGF-1 (ng/ml) during estrus and luteal phases in multiparous crossbred sows fed diet supplemented with n-3 PUFA (TRT) or standard control (CON) diet.

ANIMAL PHYSIOLOGY

Study of endocrine profile in indigenous pigs

R.K. Mahapatra, R. Pourouchottamane, P. K. Pankaj and J. Goswami

Under this project animals of Niang Megha and Ghungroo breeds were taken for the study. The animals selected were of good health and normal physiological status. For hormonal profiling, blood samples were collected for each group of animals representing weaner, grower, finisher and breedable animals. The estimation of hormones (T3, T4 and testosterone) were done by RIA. Every month blood sample collection was done from five animals of both the sexes and two breeds (Niang Megha and Ghungroo) when the animals reach 2 months of age till the animals attain the age of six months.For monitoring sexual status in case of males, blood samples were collected and analyzed for testosterone levels. The baseline data of different hormonal parameters is presented in the following tables.

- T3, T4, cortisol and testosterone levels in the blood varied significantly in different age groups.
- There was an increasing trend of triiodothyronin levels as the age advances in both the sexes and breeds of pigs, however, no significant difference was observed between the breeds, sex and age.
- There was an increasing trend of thyroxin levels as the age advances in both the sexes and breeds of pigs. Significant difference was also observed in different ages of the pigs. However, no significant difference was observed between the breeds and sexes.
- There was an increasing trend of testosterone levels as the age advances in both the sexes and breeds of pigs. Significant difference was also observed in different ages of the pigs. However, no significant difference was observed between the breeds and sexes.

Table 1: T3 profile in indigenous breeds of pigs (nmol/L)

Breed	Sex	Age in months					Average	Significance
		2	3	4	5	6		
Niang Megha	Male	0.428	0.501	0.579	0.794	0.412	0.543	Breed = 0.052
	Female	0.464	0.694	0.737	0.850	0.753	0.700	Sex = 0.136
	Average	0.446	0.597	0.658	0.822	0.582	0.621	Age = 0.114
Ghungroo	Male	0.795	1.194	0.700	0.777	0.911	0.876	BxS = .000
	Female	0.518	0.378	0.574	0.628	0.733	0.566	BxA = 0.102
	Average	0.657	0.786	0.637	0.703	0.822	0.721	SxA = 0.139
Overall	Male	0.612	0.847	0.640	0.786	0.662	0.709	BxSxA = 0.094
	Female	0.491	0.536	0.656	0.739	0.743	0.633	
	Average	0.551	0.692	0.648	0.763	0.702	0.671	

Table 2: T4 profile in indigenous breeds of pigs (nmol/L)

Breed	Sex	Age in months					Average	Significance
		2	3	4	5	6		
Niang Megha	Male	39.034	32.606	29.442	39.352	46.916	37.470	Breed = 0.014 Sex = 0.024 Age = 0.000 BxS = .002 BxA = 0.367 SxA = 0.007 BxSxA = 0.050
	Female	29.212	31.642	42.532	45.134	44.356	38.575	
	Average	34.123	32.124	35.987	42.243	45.636	38.023	
Ghungroo	Male	44.554	43.630	44.770	42.202	48.152	44.662	
	Female	35.292	29.804	37.610	40.008	45.952	37.733	
	Average	39.923	36.717	41.190	41.105	47.052	41.197	
Overall	Male	41.794	38.118	37.106	40.777	47.534	41.066	
	Female	32.252	30.723	40.071	42.571	45.154	38.154	
	Average	37.023	34.421	38.589	41.674	46.344	39.610	

Table 3: Testosterone profile in indigenous breeds of pigs (ng/ml)

Breed	Age in months					Average	Significance
	2	3	4	5	6		
Niang Megha	4.754	6.134	7.738	9.012	10.072	7.542	Breed = 0.007 Age = 0.000 BxA = 0.202
Ghungroo	2.712	6.028	7.736	8.080	8.894	6.690	
Average	3.733	6.081	7.737	8.546	9.483	7.116	

Biophysical characterisation of fibres from pigs and development of utility products (Project code IXX10595) Inter-institutional Collaborative project

N. H. Mohan, S. Debnath, L. Ammayappan and L. K. Nayak.

A key by-product of pig farming is the hair or bristle fibres (Fig. 1A) obtained at the time of slaughter. Data on physical properties of pig hair fibres is sparse, restricting its diversified industrial application. First time studies were conducted under this project to biophysically characterise the pig hair fibres using various methods, generating novel results, which are presented below.

Growth, tensile and flexural properties

A study was conducted to analyse the variations in the tensile properties of the pig hair fibres with respect to breed (Ghungroo, Ninag Megha, Hampshire and Duroc) and location on the body. The tensile properties (breaking tenacity, extension at break, initial modulus and work of rupture) of pig hair fibres were estimated using a Universal Tensile Tester (Tinius Olsen Inc, USA, Model H50KS). A friction tester with an inclined plane principle was used to measure the coefficient of fibre-to-metal (steel) static friction. The flexural rigidity of the fibre was evaluated using a specially designed mandrel which will enable to defined distortion after loading.

Details of the length, colour, diameter, and density and growth rate of the pig hair fibres are presented in Table 4. The colour of individual fibres varied between shades of black, cream, white or brown depending upon the breed of pig. The average length of hair fibre varied from 56.8 mm in the Duroc to 127.1 mm in the Niang Megha breeds and was significantly different between breeds. The hair fibres obtained from the neck were thicker than those obtained from back region (significant $P<0.05$) of Niang Megha and Ghungroo breeds of pigs, apparently indicating a breed specific difference. The difference of diameter of hair fibre with respect to location in the body in exotic breeds of pigs (Hampshire and Duroc) could not be observed. The density of fibres in the body surface ranged between 0.079 and 0.154, number per mm^2. The average growth rate of hair fibres between two consecutive clippings was 0.16 mm day^{-1}.

The fineness and tensile properties of the fibres obtained from different breeds of pigs is shown in Table 5. The fineness of pig hair fibres ranged between 29.10 and 124.24 tex. The breaking tenacity of the fibres ranged between 11.9 and 17.0 cN tex^{-1} and there was insignificant difference between different breeds of pigs. The overall mean breaking tenacity, or the tensile strength of the pig hair fibre, was 14.05 cN tex^{-1}. The extensibility of the fibres ranged between 21.1 and 39.5%, with an overall mean of 31.53%. The typical stress-strain behaviour of pig hair fibres is shown in Fig. 1B. The overall mean work of rupture and initial modulus for pig hair fibre was 3.61×10^{-2} Jm^{-1} tex^{-1} and 317.8 cN tex^{-1} respectively. The Young`s modulus (mean±SE) of the fibres obtained from Hampshire, Duroc, Ghungroo and Niang Megha breeds of pigs was 7.68±0.08, 4.25±0.19, 5.95±0.17 and 7.70±0.32 GPa respectively. The overall mean flexural rigidity of the pig hair fibre was 1059.17 ± 321.37 mN mm^2 mm^{-1}. The coefficient of static friction of hair fibres to metal was similar (0.45) among different breeds of pigs irrespective of its location in the animal body.

Fig. 1A: Hair or bristle fibres of different pig breeds

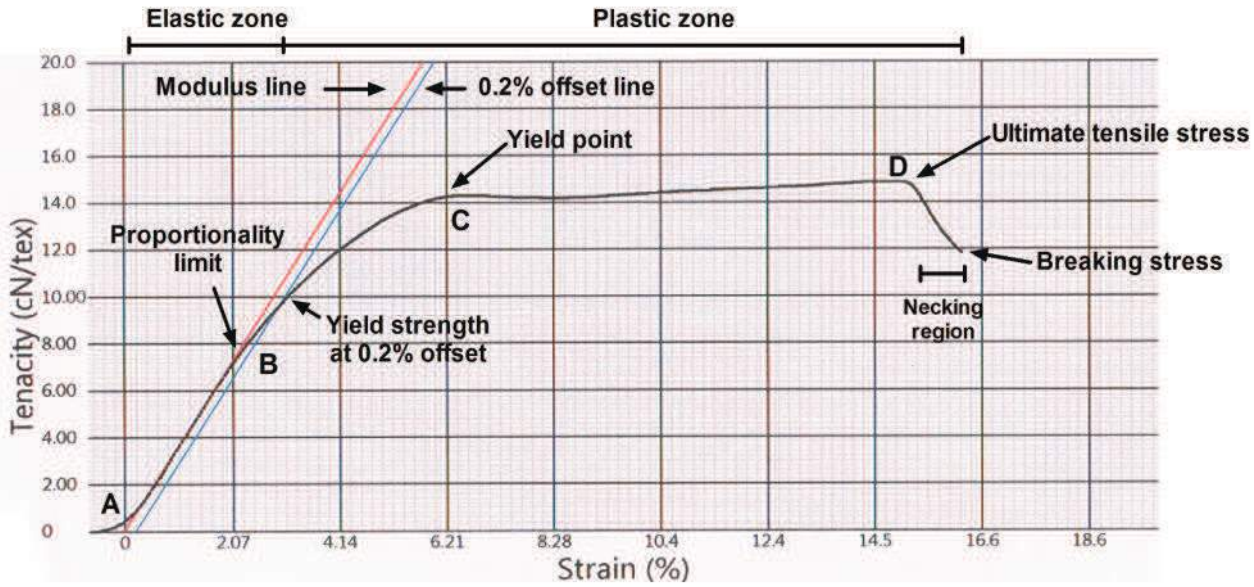


Fig. 1B: Typical stress-strain behaviour of pig hair fibres

Table 4. Characteristics of the hair fibres obtained from different breeds of pigs

Parameter / Breed	Location in the body	Diameter (μm)	Colour	Length (mm)	Weight (mg)	Density (number of fibres per mm^2)	Growth rate (mm day^{-1})
Hampshire	Neck	191.7[a]	White, cream, black	69.4[bc]	4.45[a]	0.096[a]	0.12[a]
	Back	190.6[a]	White, cream, black	72.7[c]	4.42[a]	0.124[a]	0.17[b]
Duroc	Neck	276.9[b]	Brown, Tan	56.8[a]	4.33[a]	0.138[a]	0.22[c]
	Back	264.7[b]	Brown, Tan	57.6[a]	5.08[ab]	0.154[a]	0.16[b]
Ghungroo	Neck	330.3[c]	Black	68.6[b]	11.49[c]	0.089[a]	0.11[a]
	Back	204.6[a]	Black	62.4[ab]	6.87[b]	0.096[a]	0.17[b]
Niang Megha	Neck	316.4[c]	Black	127.1[c]	5.23[ab]	0.079[a]	0.16[b]
	Back	185.7[a]	Black	108.3[d]	3.81[a]	0.085[a]	0.15[b]
RSD[1]		3.5	-	6.1	1.22	0.0084	0.03
P values							
Breed		<0.0001	-	<0.0001	0.0021	0.0740	<0.0001
Location in the body		<0.0001	-	0.0003	0.1736	0.4234	0.0492
Breed X location interaction		<0.0001	-	<0.0001	0.2222	0.9687	<0.0001

[a-c] Values within a column with different superscripts differ significantly at P<0.05. [1]RSD is the root mean square of the error that applies to the whole model.

Table 5. Tensile, frictional and flexural properties of hair fibres obtained from different breeds of pigs

Parameter / Breed	Location in the body	Linear density (Tex)	Tenacity at break (cN tex^{-1})	Extension at break (%)	Initial modulus (cN tex^{-1})	Work of rupture (Jm^{-1} tex^{-1} X10^{-2})	Co-efficient of static friction (μ)	Flexural rigidity (mN.mm^2 mm^{-1})	Specific Flexural rigidity (mN (mm tex^{-1})^2 x 10^{-4})
Hampshire	Neck	74.70^{e}	15.51^{ab}	33.40^{bc}	345.7^{ab}	4.26^{b}	0.42^{a}	1561^{e}	0.28^{bc}
	Back	36.45^{b}	14.43^{ab}	31.22^{b}	339.5^{ab}	3.56^{b}	0.38^{a}	466^{ab}	0.35^{cd}
Duroc	Neck	85.71^{f}	16.98^{b}	30.51^{b}	374.4^{b}	4.29^{b}	0.41^{a}	1166^{d}	0.16^{a}
	Back	57.30^{d}	14.56^{ab}	39.51^{c}	304.3^{a}	4.32^{b}	0.50^{b}	647	0.20^{ab}
Ghungroo	Neck	47.18^{c}	13.33^{ab}	35.13^{bc}	278.7^{a}	3.63^{b}	0.47^{b}	912^{c}	0.41^{d}
	Back	29.10^{a}	11.94^{a}	21.14^{a}	314.7^{ab}	2.10^{a}	0.42^{a}	350^{b}	0.40^{d}
Niang Megha	Neck	124.24^{g}	12.80^{a}	33.62^{bc}	284.0^{a}	3.36^{ab}	0.50^{b}	3045^{f}	0.20^{ab}
	Back	35.34^{b}	12.86^{a}	27.76^{ab}	302.3^{a}	2.92^{ab}	0.50^{b}	325^{a}	0.26^{abc}
RSD[1]		1.81	1.19	2.66	20.9	0.01	0.02	96	0.03
P values									
Breed		<0.0001	0.0206	0.0342	0.0265	0.0039	<0.0001	<0.0001	<0.0001
Location in the body		<0.0001	0.1593	0.0593	0.7249	0.0370	0.0135	<0.0001	0.0991
Breed X location interaction		<0.0001	0.8295	0.0001	0.1427	0.2819	0.0035	<0.0001	0.4175

[a-f] Values within a column with different superscripts differ significantly at P<0.05. [1]RSD is the root mean square of the error that applies to the whole model.

Scanning electron microscopy (SEM) of the fibres

SEM studies of representative fibres were carried out with Zeiss Evo-Maio scanning electron microscope at 3KV and 10 Pa after 24 nm thick palladium coating following standard methods at the Network Project On Insect Biosystematics, Division of Entomology, Indian Agricultural Research Institute, New Delhi, India.

The surface of pig hairs revealed presence of scales similar to wool, human hair, rabbit hair, horse and felines. The SEM appearance of the pig hair fibre showing the arrangement of cuticles was similar to that of human hair. The scales were arranged as layers, one overlapping the other (Fig. 2), separated by a span of 4.58±0.24µm. The mean scale thickness was 0.39±0.02µm and on an average 17.19±1.65 scales (range, 14.76 to 20.42) could observed per 100µm. The elliptical modelling of fibre cross section was done to analyse the mean semi-major and semi-minor axis length, which was measured it to be 316.15±23.24 and 236.71±27.31µm respectively. The average eccentricity, flattening, focus, area and angular eccentricities of the pig hair fibre were 0.60±0.09, 0.25±0.07, 195.16±33.68µm, 0.06±0.01mm^2 and 38.24±6.61° respectively. The results of the present study indicate that the pig hair fibre has an elliptical outline, similar to other protein fibres. The morphological structure of cross-section of fibres is considered important for the measurement of fibre diameter and the evaluation of fibre strength.

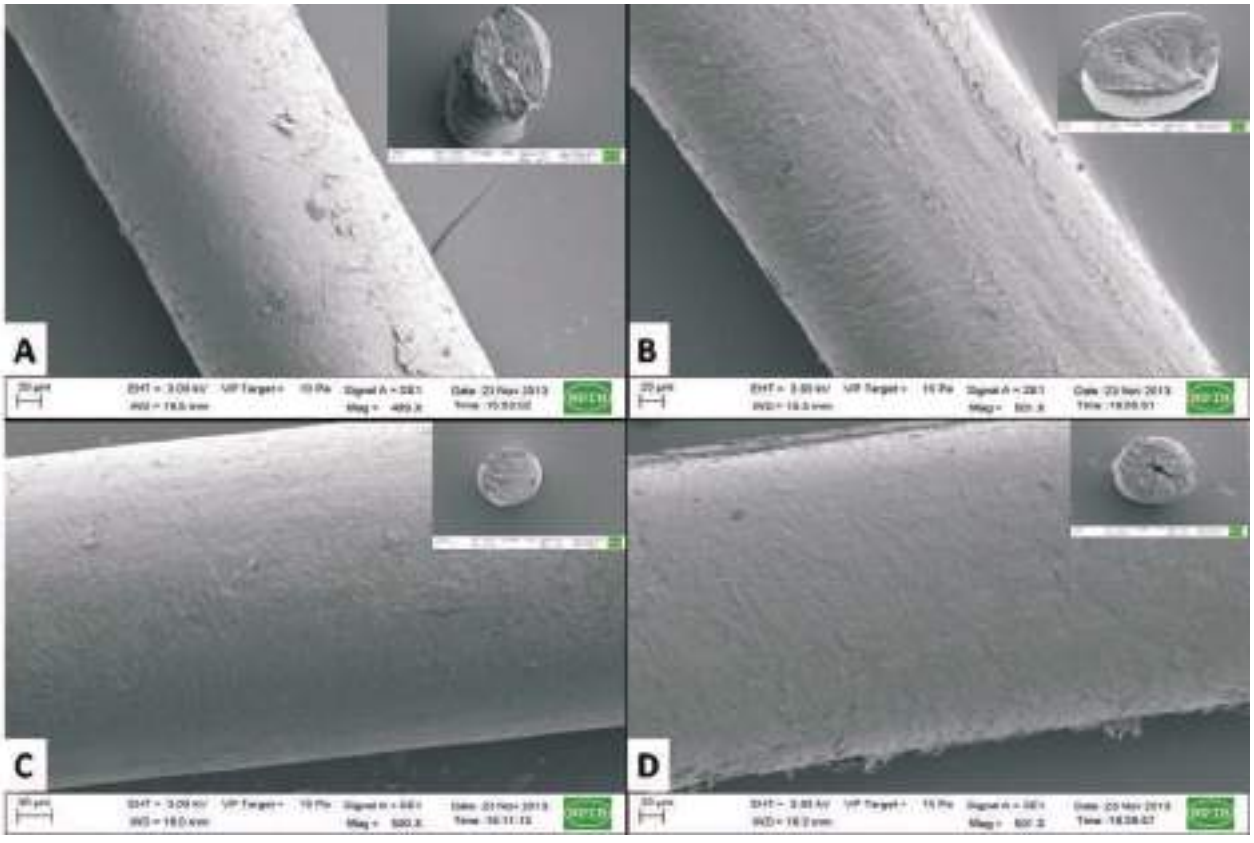


Fig. 2: SEM appearance of the pig hair fibres

X-Ray diffraction characteristics

The X-Ray diffraction (XRD) studies were carried out using a X-ray Diffractometer (D8Advance, Bruker) using CuKα radiation (40 kV, 35 mA) over a range of 10 to 70º (2theta values) with a step of 0.02º and 32.8s step time. The hair fibre samples were cut into small pieces of about 1.5cm length and mounted into the sample holder of X-ray diffractometer. The data was analysed using Diffrac suite and Topas softwares supplied along with the x-ray diffractometer. The preliminary data analysis shows that the fibre has 32.6% crystalline and 67.4% amorphous fractions. The figures 3 and 4 show the representative XRD pattern without background correction and crystallinity analysis respectively.

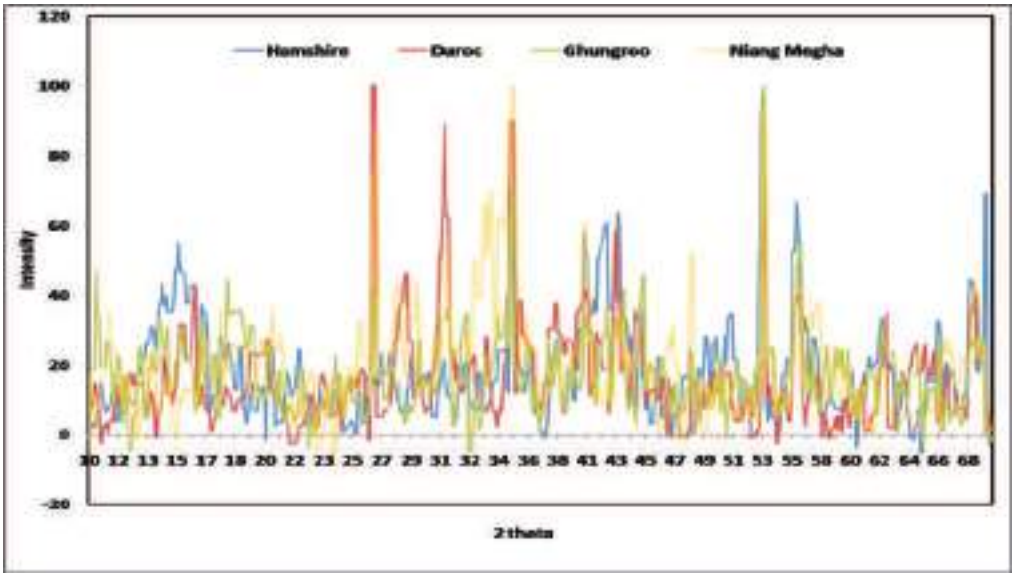


Fig.3: Representative XRD pattern without background correction

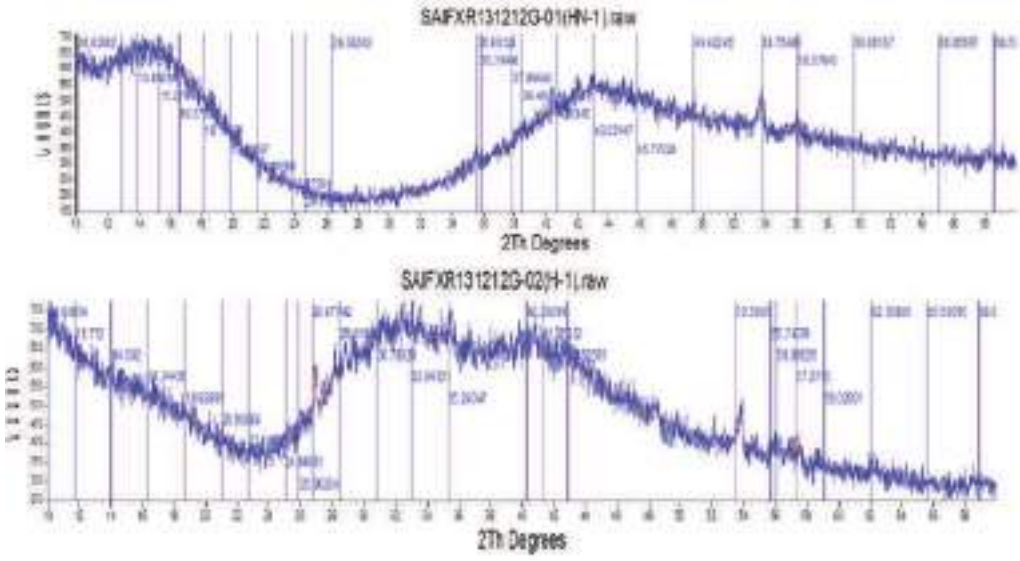


Fig. 4: Crystallinity analysis

Differential scanning calorimetry (DSC) and thermo-gravimetric analysis (TGA)

The experiments were conducted using a heat flux type DSC (Mettler-Toledo model-DSC822e, Switzerland) pre-calibrated with indium. The samples were heated in an aluminium pan from 40ºC to 400ºC at the rate of 10ºC/minute. The glass transition temperature (Tg) was calculated as per standard methods. The TGA experiments were conducted with a Perkin Elmer TGA system (Model, STA 6000) over a temperature range of 40ºC to 700ºC. The temperature was increased at the rate of 10ºC/minute in a nitrogen atmosphere with a purge rate of 100ml/minute. The results were analysed in the as the weight loss with reference to temperature change as well as derivative with reference to time. The DSC and TGA experiments were performed at Sophisticated Test and Instrumentation Centre, Cochin University of Science & Technology, Kerala, India.

Based on the behaviour during DSC using an open pan, various thermal characteristics of pig hair fibres were documented for the first time (Fig. 5). The DSC curve of pig hair fibre showed a broad endoderm between 50-80°C, which is generally attributed to the loss of moisture from the fibres. The endotherm was followed by a glass transition phase (between 78 and 86°C) with a T_g of 83.86°C In case of hair fibres obtained from Hampshire and Duroc breeds of pigs. The fibres obtained from Niang Megha showed a glass transition at a relatively higher temperature (between 105 and 115°C). In the fibres obtained from Ghungroo breeds of pigs a typical glass transition phase in DSC curves could not be observed. In the DSC curve, the glass transition was followed by an exothermic phase, which is suggestive of crystallization in the fibres components prior to the melting endotherm. Two prominent endotherm peaks of melting around 229°C and 239°C could be seen in all the pig hair fibres studied. The two peaks appear to be quite consistent and can be considered as signature melting or denaturation peaks for the pig hair fibre. Since almost all the water has evaporated at around 230°C, the presence of consistent melting The melting peak indicates denaturation of α-helical components of the keratin fibre.

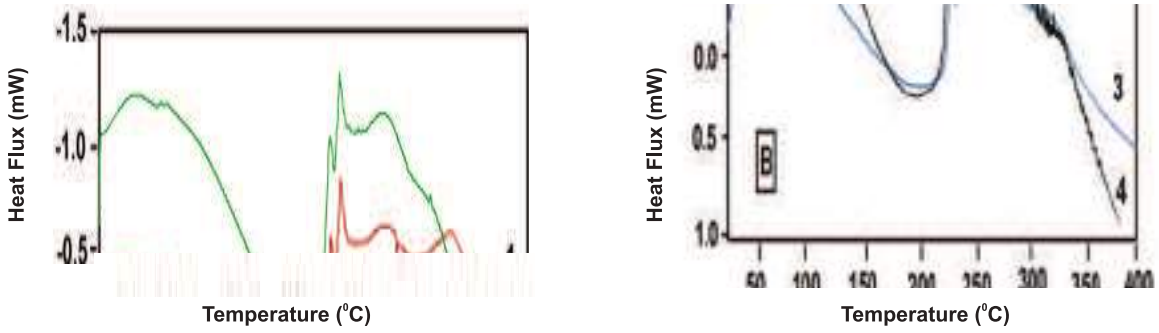


Fig. 5: Thermal characteristics of pig hair fibres

The TGA was conducted to analyse the pyrolysis behaviour of the pig hair fibre, the results are shown in Fig. 6. There was a progressive decrease in the weight upto 100ºC due to loss of moisture from the samples. The thermal degradation of hair protein started around 238-240ºC in samples from different pig breeds, indicated by rapid decrease in the weight of sample. This thermal degradation coincided with the peak melting temperature of the DSC curve. Even though the progressive weight losses in the fibres obtained from all the four breeds were similar, the derivative curves (weight loss/minute/ºC) some variation with respect to

thermal behaviour of fibres. The fibres from Duroc breed showed a single denaturation peak at 238 ºC followed by a steep decrease in the weight, and another peak around 302ºC, probably due to denaturation of th fibres in two phases. In case of fibres from all other breeds (Hampshire, Niang Megha and Ghungroo), in addition to the denaturation peak around 240ºC, the complete denaturation involved bi-modal peak around 280 and 325 ºC.

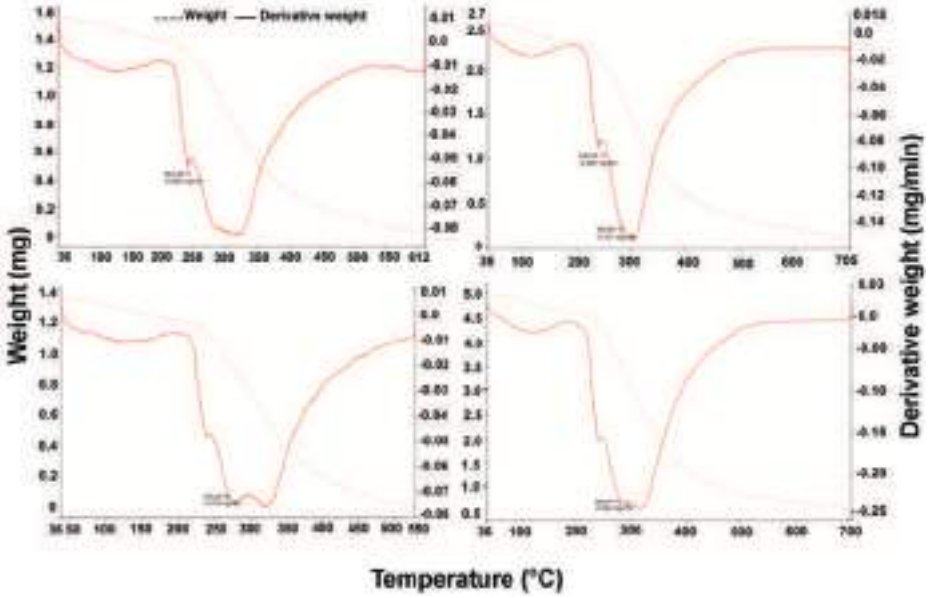


Fig. 6: Thermo-gravimetric analysis (TGA) of pig hair fibre

***Development of lipid based technique(s) for improved preservation of boar semen* (Project code IXX08854)**

N. H. Mohan, R. K. Mahapatra, M. K. Tamuli, and P. P. Gokuldas.

In the present project, lipid microparticles were prepared using asolectin, a commercially available lipids obtained from soyabean lipids. Asolectin comprises roughly equal proportions of lecithin, cephalin and phosphatidylinositol along with minor amounts of other phospholipids and polar lipids. The lipid particles were prepared in GEPS semen extender by mixing in defined proportions and homogenizing at 13000rpm using a fine dispersing element. Another trial was also conducted to incorporate n-3 fatty acids into the lipid particles by addition of eicosapentanoic acid and docosahexanoid acids. The procedure for preparation of emulsions/particles is still under standardisation and work is under progress.

***Evaluation of physio-genomic responses to heat stress and development of potential marker(s) for assessment of stress in pigs* (DBT funded project) Inter institutional collaborative project.**

N. H. Mohan, R. K. Mahapatra, M. K. Tamuli, P. P. Gokuldas, B. C. Das, S. Naskar and A. K. Das.

The project was initiated on 24th march, 2013. The project intends to undertake indepth analysis of physiogenomics of heat stress and develop stress markers to quantify stress, keeping in view of impending climate change due to global warming.

LIVESTOCK PRODUCTS TECHNOLOGY

Augmenting clean pork production and value addition in North Eastern India

R. Thomas, K. Barman and P. P. Gokuldas.

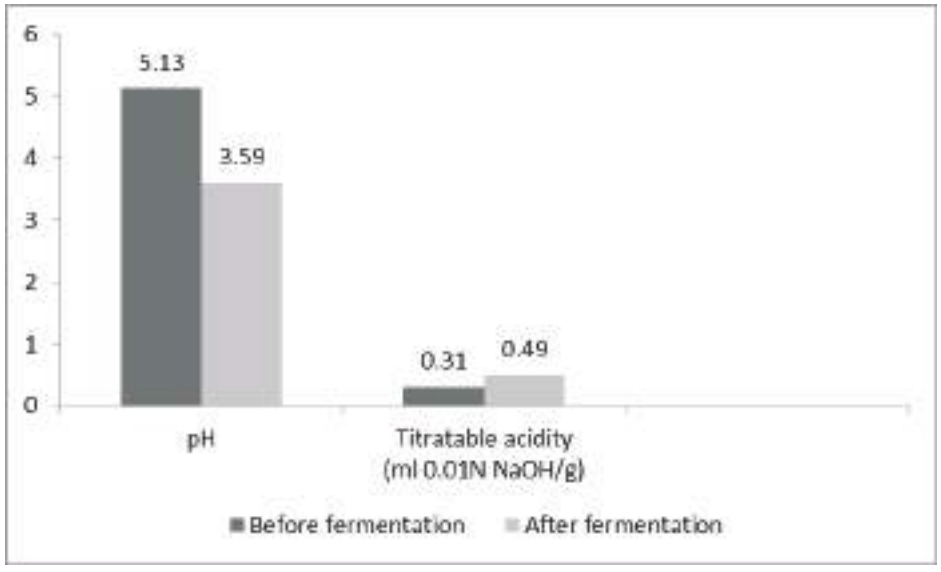
(i) Effects of incorporation of fermented bamboo shoot (Bambusa polymorpha) mince in pork nuggets

In view of the limited information on the effects of addition of fermented bamboo shoot in the processed meat products, a project was undertaken with the financial assistance from Department of Biotechnology to process pork nuggets containing fermented bamboo shoot mince with good consumer acceptability, with an objective to increase the utilization of bamboo shoot in functional meat products, and thereby to provide variety to the pork consumers. The products thus developed were stored at refrigeration temperature (4±1°C) and the various quality changes viz. physico-chemical, microbiological and sensory attributes, were evaluated in detail during the storage period.

Characteristics of fermented bamboo shoot

The sealed earthen pots, in which the bamboo shoot pieces were stored to facilitate their fermentation, were opened after 6 months and the contents were transferred in to clean glass jars. The finished products were whitish in colour with faint aroma and sour taste. The pH of the bamboo shoot was decreased to 3.59 after the fermentation (pH before fermentation, 5.13) while the titratable acidity was increased to 0.49 ml 0.01N NaOH/g from 0.31 ml 0.01N NaOH/g. The conventional microbial analysis of the fermented bamboo shoot by pour plate method indicated that the mixture contains a total plate count in the range of 10^5-10^8 cfu/g and lactic acid bacteria in the range of 10^3-10^5 cfu/g.

Figure1. pH and titratable acidity of bamboo shoot (*Bambusa polymorpha)* before and after fermentation)



Physico-chemical characteristics of pork nuggets with fermented bamboo shoot mince

The pH of both the raw emulsion and cooked pork nuggets decreased significantly (P<0.01) with increasing levels of fermented bamboo shoot mince (FBSM) in the formulation (Table 1). Also, the pH of cooked pork nuggets in each group was significantly (P<0.05) higher compared to the respective raw emulsions. The raw emulsion and cooked nuggets with 8% & 6% FBSM had a pH of 5.63 & 5.89 and 5.71 & 5.96 respectively while that of control group was 6.11 & 6.29. Similarly, the emulsion stability and cooking yield was significantly (P<0.05) lower in the formulations with higher levels of FBSM. However, it was evident from the results that even at 8% level of addition of FBSM, both the emulsion stability (93.08%) and the cooking yield (94.20%) were well above the range required for profitable meat product processing i.e. more than 90% yield after cooking.

Proximate analysis of the cooked nuggets indicated a significant decrease in the moisture (P<0.01) and fat (P<0.05) percentage in the products with increase in the level of addition of FBSM (Table 1), while a corresponding proportionate increase was observed in the percentage of protein (P<0.01), fibre (P<0.01) and ash (P<0.01) contents. The nuggets with 8% FBSM had a moisture and fat percentage of 61.50% and 10.12% respectively while the corresponding values of the control nuggets were 65.84% and 11.37%. The significant increase in protein, fibre and ash contents observed in products with higher levels of FBSM might be attributed to the higher moisture and fat loss occurred with decrease in pH at higher levels of FBSM.

Addition of FBSM significantly affected P<0.01) the instrumental colour values of the nuggets (Table 1). Lightness (L*) increased, while redness (a*) and yellowness (b*) values decreased significantly with increase in level of addition of FBSM. Hue angle and chroma, which measures the saturation of light, were also affected significantly (P<0.01) with increase in the level of FBSM in the products. This effect was more pronounced in nuggets made from emulsions with higher FBSM i.e. 6% and 8%. Texture profile analysis (TPA) indicated a significant reduction (P<0.01) in all the textural parameters of the pork nuggets, except cohesiveness, with increase in the level of addition of FBSM (Table 1) and it could be related to the low emulsion and product pH observed with increased level of addition of FBSM . The effect was more distinct in nuggets with 6% and 8% FBSM.

Table 1: Effects of addition of fermented bamboo shoot mince (FBSM) on the physico-chemical parameters of pork emulsion and cooked pork nuggets

Parameter	Treatment				
	Control	FBSM - 2%	FBSM - 4%	FBSM- 6%	FBSM - 8%
Physico-chemical parameters					
Emulsion pH	6.11±0.07^{a}	6.03±0.03^{b}	5.89±0.05^{c}	5.71±0.01^{d}	5.63±0.01^{e}
Product pH	6.29±0.08^{a}	6.17±0.05^{b}	6.04±0.08^{c}	5.96±0.01^{c}	5.89±0.03^{d}
Emulsion stability (%)	96.17±0.11^{a}	96.03±0.41^{a}	95.18±0.29^{b}	93.96±0.18^{c}	93.08±0.13^{d}
Cooking yield (%)#	97.69±0.73^{a}	97.16±0.21^{ab}	96.84±0.77^{b}	95.27±0.15^{c}	94.20±0.33^{d}
Moisture (%)	65.84±0.13^{a}	65.21±0.16^{a}	64.69±0.15^{b}	62.79±0.10^{c}	61.50±0.20^{d}
Protein (%)	21.11±0.09^{a}	21.97±0.06^{b}	22.41±0.08^{c}	24.56±0.02^{d}	25.77±0.02^{e}
Fat (%)	11.37±0.05^{a}	11.08±0.02^{ab}	10.81±0.09^{b}	10.20±0.06^{c}	10.12±0.05^{c}
Fibre (%)	0.20±0.02^{a}	0.21±0.09^{a}	0.27±0.09^{b}	0.34±0.07^{c}	0.45±0.07^{d}
Ash (%)	1.18±0.09^{a}	1.33±0.06^{b}	1.52±0.02^{c}	1.79±0.05^{d}	1.94±0.03^{e}
Instrumental colour scores					
L*	47.65±0.09^{a}	47.71±0.06^{a}	51.14±0.06^{b}	53.40±0.09^{c}	60.39±0.05^{d}
a*	12.43±0.09^{a}	11.78±0.05^{a}	10.25±0.09^{b}	9.15±0.07^{c}	8.67±0.09^{d}
b*	24.49±0.05^{a}	23.14±0.02^{bc}	22.48±0.07^{cd}	21.84±0.02^{d}	19.81±0.09^{e}
Chroma	66.08±0.09^{a}	63.01±0.09^{a}	65.48±0.05^{b}	67.26±0.06^{c}	66.36±0.09^{d}
Hue	27.46±0.02^{a}	25.97±0.09^{b}	24.71±0.06^{c}	23.68±0.09^{e}	21.68±0.09^{d}
Texture profiles					
Hardness (N/cm^2)	17.90±0.05^{a}	17.47±0.06^{a}	16.29±0.05^{b}	14.90±0.09^{c}	14.46±0.06^{c}
Adhesiveness (Ns)	-0.053±0.06^{a}	-0.056±0.06^{b}	-0.059±0.09^{c}	-0.077±0.01^{d}	-0.086±0.07^{e}
Springiness (cm)	0.882±0.02^{a}	0.882±0.09^{a}	0.816±0.09^{b}	0.703±0.05^{d}	0.798±0.03^{c}
Cohesiveness (Ratio)	0.295±0.06^{a}	0.291±0.09^{a}	0.302±0.06^{b}	0.320±0.09^{c}	0.305±0.09^{b}
Gumminess (N/cm^2)	52.15±0.09^{a}	51.52±0.02^{b}	49.30±0.05^{c}	47.79±0.09^{d}	44.41±0.08^{e}
Chewiness (N/cm)	46.02±0.09^{a}	44.06±0.04^{b}	40.35±0.07^{c}	33.50±0.09^{e}	35.86±0.09^{d}
Fracturability (N)	0.221±0.06^{a}	0.213±0.09^{a}	0.175±0.06^{b}	0.134±0.03^{c}	0.122±0.02^{c}
Shear force (N)	28.64±0.07^{a}	26.64±0.07^{b}	24.26±0.09^{c}	20.90±0.05^{d}	18.87±0.06^{e}
Work of shearing (Ns)	46.30±0.02^{a}	43.30±0.08^{b}	39.01±0.09^{c}	35.98±0.09^{d}	31.45±0.05^{e}

n=9; #n=3

Means with different superscripts in the same row indicate significant difference (P<0.05)

Table 2: Effect of addition of fermented bamboo shoot mince (FBSM) on the physico-chemical parameters of cooked pork nuggets during refrigeration storage

Treatment/ Parameter	Storage period (days)					
	0	7	14	21	28	35
pH						
Control	6.29±0.03^{a1}	6.31±0.08^{a1}	6.37±0.03^{b1}	6.40±0.09^{b1}	6.45±0.02^{c1}	6.47±0.03^{c1}
FBSM – 2%	6.17±0.05^{a2}	6.20±0.19^{a2}	6.24±0.02^{b2}	6.31±0.08^{c2}	6.37±0.03^{d2}	6.41±0.08^{e2}
FBSM – 4%	6.04±0.08^{a3}	6.07±0.10^{a3}	6.13±0.09^{b3}	6.21±0.08^{c3}	6.29±0.03^{d3}	6.35±0.08^{e3}
FBSM – 6%	5.96±0.02^{a4}	6.04±0.04^{a4}	6.09±0.08^{b3}	6.14±0.03^{c4}	6.19±0.09^{d4}	6.29±0.10^{e4}
FBSM – 8%	5.89±0.03^{a5}	5.93±0.09^{b5}	6.01±0.08^{c4}	6.07±0.04^{d5}	6.11±0.08^{e5}	6.18±0.02^{f5}
TBARS value (mg malonaldehyde/kg)						
Control	0.198±0.09^{a1}	0.269±0.03^{b1}	0.388±0.08^{c1}	0.573±0.09^{d1}	0.683±0.08^{e1}	0.837±0.08^{f1}
FBSM – 2%	0.193±0.05^{a1}	0.241±0.10^{b2}	0.313±0.05^{c2}	0.469±0.08^{d2}	0.649±0.10^{e2}	0.816±0.08^{f2}
FBSM – 4%	0.189±0.08^{a1}	0.210±0.08^{b3}	0.297±0.08^{c3}	0.384±0.03^{c3}	0.465±0.03^{d3}	0.615±0.08^{e3}
FBSM – 6%	0.171±0.09^{2}	0.196±0.08^{b4}	0.261±0.03^{c4}	0.278±0.02^{c4}	0.297±0.09^{d4}	0.388±0.07^{e4}
FBSM – 8%	0.159±0.08^{a3}	0.173±0.06^{b5}	0.232±0.09^{d5}	0.252±0.08^{c5}	0.270±0.10^{e5}	0.332±0.09^{f5}
Tyrosine value (mg/g)						
Control	0.313±0.09^{f5}	0.429±0.08^{e1}	0.551±0.08^{d1}	0.597±0.09^{c1}	0.682±0.03^{b1}	0.870±0.10^{a1}
FBSM – 2%	0.331±0.06^{f4}	0.406±0.06^{e4}	0.489±0.03^{d2}	0.552±0.07^{c2}	0.618±0.09^{b2}	0.747±0.08^{a2}
FBSM – 4%	0.350±0.02^{f3}	0.417±0.09^{e3}	0.477±0.02^{d3}	0.531±0.08^{c3}	0.591±0.03^{b3}	0.675±0.09^{a3}
FBSM – 6%	0.373±0.10^{f2}	0.423±0.08^{e2}	0.481±0.10^{d2}	0.517±0.03^{c4}	0.569±0.08^{b4}	0.610±0.08^{a4}
FBSM – 8%	0.388±0.08^{f1}	0.421±0.08^{e2}	0.453±0.09^{d4}	0.483±0.08^{c5}	0.512±0.09^{b5}	0.583±0.08^{a5}
Titratable acidity (ml 0.01N NaOH/g)						
Control	0.290±0.02^{a5}	0.255±0.03^{b5}	0.257±0.08^{c5}	0.230±0.03^{d5}	0.165±0.08^{e5}	0.100±0.09^{f5}
FBSM – 2%	0.325±0.08^{a4}	0.270±0.09^{b4}	0.274±0.03^{c4}	0.245±0.09^{d4}	0.165±0.02^{e4}	0.120±0.08^{f4}
FBSM – 4%	0.360±0.03^{a3}	0.300±0.08^{b3}	0.315±0.10^{c3}	0.215±0.08^{d3}	0.190±0.09^{e3}	0.135±0.02^{f3}
FBSM – 6%	0.395±0.08^{a2}	0.335±0.08^{b2}	0.370±0.02^{c2}	0.331±0.10^{d2}	0.263±0.08^{e2}	0.180±0.08^{f2}
FBSM – 8%	0.410±0.08^{a1}	0.370±0.09^{b1}	0.398±0.08^{c1}	0.350±0.09^{d1}	0.290±0.08^{e1}	0.217±0.08^{f1}

n=9; FBSM- Fermented bamboo shoot mince Means with different superscripts (letters in the same row and numbers in the same column) indicate significant difference (P<0.05)

Microbiological characteristics

Microbiological changes in pork nuggets containing FBSM during refrigeration temperature storage (4±1°C) are presented in Table 3. Addition of FBSM at 8% level has resulted in about 1.30 log reduction in total plate count (TPC) in the nuggets compared to control. TPC increased significantly in all samples throughout storage period, but addition of FBSM at higher levels significantly lowered the rate of increase of TPC in treatment groups. It reached about 7 log cfu/g in the control nuggets on day 35,

while it was only about 4.5 log cfu/g in nuggets containing FBSM at 6% & 8% levels. This could be due to a combined effect of initial cell injury resulted from low pH and subsequent prolongation of lag phase by antimicrobial substances present in FBSM. Sliminess was detected in control group and nuggets with 2% FBSM on day 28 while those with 4% FBSM had sliminess on day 35. However, no such sliminess was observed in nuggets containing 6% & 8% FBSM.

Psychrotropic organisms were detected only in control group and nuggets with 2% FBSM on the day of processing. The pattern of changes in psychrotropic counts during the storage period in all the groups were similar to that observed for TPC. Coliforms, considered as an indicator of post processing contamination, were detected during storage. They were detected only in control and nuggets with 2% & 4% FBSM on the day of processing. The occurrence of coliforms in nuggets with 6% & 8% FBSM were not only occasional in nature but was also significantly ($P<0.01$) less at any interval during the entire length of 35 days storage period, which clearly indicated the benefit of addition of FBSM at higher levels. Addition of FBSM has significantly decreased ($P<0.05$) the *Staphylococcus aureus*, *Lactobacillus* sp. and yeast and mold counts in pork nuggets on the day of processing.

Sensory attributes

The results indicated that the nuggets prepared with the addition of FBSM had better appearance & colour and flavor characteristics on the day of processing. Incorporation of FBSM has resulted in an initial reduction in juiciness, texture and binding attributes, however, they maintained these attributes for a longer time compared to control. The reduction in textural properties could be attributed to the increased denaturation of proteins and subsequent decrease in fat and water binding properties at low pH resulted from FBSM addition and to the changes in disulphide bonds due to increased protein denaturation as a result of increased microbial activity. A high degree of correlation was observed between the sensory and instrumental analysis of texture. Sensory evaluation of the control group and nuggets with 2% FBSM were done only up to 21st day of storage due to the development of off-odour and sliminess on the 28th day.

Incorporation of FBSM significantly improved ($P<0.01$) the desirable flavour of pork nuggets on the day of processing and the scores were higher for the nuggets processed with higher levels of FBSM addition. Further, overall acceptability of the nuggets with FBSM followed the same pattern observed for that of flavor and a significant decrease ($P<0.05$) in the overall acceptance of all types of nuggets was found towards the end of storage period. However, the sensory attributes of pork nuggets with 8% FBSM was in the 'very good' to 'good' category of acceptability even on 35th day of storage and thus had a shelf life of at least 35days at refrigeration storage (4±1^{o}C). Further, despite good quality characteristics on the 35th day, but due to the development of slight off-flavour and sliminess, it was concluded that the nuggets with 6% FBSM had a shelf life of 28 days at 4±1^{o}C, while the control group and nuggets with 2% & 4% FBSM were acceptable up to 21st day at refrigeration storage.

Table 3: Effect of addition of fermented bamboo shoot mince (FBSM) on the microbiological parameters of cooked pork nuggets during refrigeration storage

Treatment/ Parameter	Storage period (days)					
	0	7	14	21	28	35
Total plate count (log cfu/g)						
Control	4.43±0.11^{f1}	4.71±0.07^{e1}	4.83±0.09^{d1}	4.98±0.09^{c1}	5.44±0.11^{b2}	7.18±0.11^{a1}
FBSM – 2%	4.27±0.08^{e2}	4.39±0.06^{e2}	4.52±0.12^{d2}	4.76±0.11^{c2}	5.78±0.17^{b1}	6.97±0.14^{a2}
FBSM – 4%	4.01±0.30^{e3}	4.18±0.09^{d3}	4.33±0.09^{c3}	4.41±0.04^{c3}	5.40±0.04^{b3}	6.88±0.20^{a3}
FBSM – 6%	3.71±0.08^{d4}	3.92±0.06^{c4}	4.06±0.04^{b4}	4.12±0.07^{b4}	4.90±0.12^{b4}	5.34±0.19^{a4}
FBSM – 8%	3.13±0.09^{f5}	3.34±0.10^{e5}	3.62±0.09^{d5}	3.77±0.11^{c5}	4.22±0.10^{b5}	5.07±0.11^{a5}
Psychrotropic count (log cfu/g)						
Control	1.63±0.09^{e1}	2.07±0.10^{d1}	2.69±0.10^{c1}	3.12±0.09^{b1}	3.17±0.14^{b3}	4.81±0.11^{a1}
FBSM – 2%	1.04±0.11^{f2}	1.53±0.12^{e2}	2.21±0.17^{d2}	2.95±1.01^{c2}	3.66±0.14^{b1}	4.49±0.19^{a2}
FBSM – 4%	ND*	1.12±0.09^{e3}	1.80±0.11^{d4}	2.11±0.22^{c3}	3.37±0.19^{b2}	4.20±0.20^{a3}
FBSM – 6%	ND	1.46±0.29^{e4}	2.07±0.14^{d3}	2.87±0.20^{c2}	3.39±0.11^{b2}	3.77±0.24^{a4}
FBSM – 8%	ND	ND	1.62±0.14^{d5}	2.03±0.19^{c4}	2.42±0.17^{b4}	3.16±0.29^{a5}
Coliform count (log cfu/g)						
Control	1.35±1.04^{e1}	1.53±0.29^{d1}	1.80±0.29^{c1}	1.94±0.10^{b1}	1.98±0.17^{b2}	2.29±0.29^{a2}
FBSM – 2%	1.29±0.90^{f2}	1.42±0.14^{e2}	1.67±0.12^{d2}	1.88±0.11^{c1}	2.08±0.20^{b1}	2.37±0.11^{a1}
FBSM – 4%	1.24±0.11^{e3}	1.39±0.17^{d2}	1.59±0.14^{c3}	1.64±0.11^{bc2}	1.69±0.14^{b3}	1.88±0.10^{a3}
FBSM – 6%	ND	1.21±0.19^{c3}	ND	1.38±0.07^{b3}	1.43±0.10^{b4}	1.71±0.20^{a4}
FBSM – 8%	ND	ND	1.16±0.10^{c4}	1.21±0.19^{c4}	1.35±0.12^{b4}	1.52±0.14^{a5}
Lactobacillus count (log cfu/g)						
Control	1.54±0.10^{d1}	1.60±0.07^{d1}	1.77±0.10^{c1}	1.80±0.04^{c1}	2.17±0.07^{b1}	2.38±0.06^{a1}
FBSM – 2%	1.49±0.04^{e1}	1.57±0.09^{de1}	1.62±0.02^{d2}	1.83±0.09^{c1}	1.93±0.11^{b2}	2.11±0.12^{a2}
FBSM – 4%	1.20±0.10^{d2}	1.24±0.07^{d2}	1.50±0.11^{c3}	1.53±0.11^{c2}	1.61±0.09^{b3}	1.83±0.10^{a3}
FBSM – 6%	1.11±0.04^{f3}	1.18±0.02^{e3}	1.27±0.04^{d4}	1.38±0.07^{c3}	1.47±0.04^{b4}	1.57±0.08^{a4}
FBSM – 8%	1.07±0.09^{d3}	1.13±0.05^{d4}	1.25±0.03^{c4}	1.34±0.06^{b3}	1.39±0.04^{b5}	1.52±0.09^{a4}
Staphylococcus aureus count (log cfu/g)						
Control	1.83±0.04^{f1}	2.02±0.07^{e1}	2.14±0.04^{d1}	2.67±0.14^{c1}	2.91±0.12^{b1}	3.18±0.08^{a2}
FBSM – 2%	1.66±0.11^{f2}	1.96±0.10^{e1}	2.12±0.04^{d1}	2.24±0.16^{c2}	2.44±0.11^{b2}	3.59±0.17^{a1}
FBSM – 4%	1.05±0.09^{f3}	1.42±0.19^{c2}	1.14±0.11^{e2}	1.27±0.12^{d3}	1.81±0.09^{b3}	1.98±0.09^{a3}
FBSM – 6%	ND	ND	1.12±0.07^{d2}	1.24±0.07^{c3}	1.44±0.07^{b4}	1.59±0.06^{a4}
FBSM – 8%	ND	ND	ND	1.20±0.14^{c3}	1.47±0.14^{b4}	1.61±0.11^{a4}
Yeast and mold count (log cfu/g)						
Control	1.35±0.11^{f1}	1.56±0.07^{e1}	1.62±0.07^{d1}	1.96±0.14^{c1}	2.61±0.12^{b1}	2.92±0.14^{a1}
FBSM – 2%	1.39±0.09^{f1}	1.52±0.11^{e1}	1.67±0.12^{d1}	1.89±0.10^{c2}	2.47±0.11^{b2}	2.85±0.09^{a1}
FBSM – 4%	1.35±0.03^{e1}	1.46±0.07^{d2}	1.42±0.10^{d2}	1.59±0.90^{c3}	1.91±0.29^{b3}	2.32±1.11^{a2}
FBSM – 6%	1.17±0.04^{e2}	1.30±0.09^{d3}	1.37±0.04^{d3}	1.59±0.10^{c3}	1.77±0.12^{b4}	1.95±0.17^{a3}
FBSM – 8%	1.15±0.05^{e2}	1.33±0.07^{d3}	1.33±0.10^{d3}	1.53±0.09^{c4}	1.63±0.05^{b5}	1.87±0.12^{a3}

n=9; *ND- Not Detected; FBSM- Fermented bamboo shoot mince Means with different superscripts (letters in the same row and numbers in the same column) indicate significant difference ($P<0.05$)

VALUE ADDED PORK PRODUCTS

Fig. 2: Pork slice

Fig. 3:Hot dogs

Fig. 4: Samosa

Fig.5: Momo

Fig. 6: Salami

Fig. 7: Cocktail

Study on yield of meat and byproducts of cattle, goat, pig and poultry in the state of Assam

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Though India is bestowed with huge livestock population, the quantum of meat production is less. The evaluation of carcass traits in terms of dressing percentage and yield of meat and byproducts is essential for assessing meat production potential of food animals. Efforts have been taken to document the yield of meat and byproducts of cattle, goat, pig and poultry in the state of Assam in collaboration with National Research Centre on Meat, Hyderabad and Ministry of Statistics. The data on different carcass traits provide valuable information on the type and kind of animals slaughtered, their live and carcass weight and yield of various byproducts. The carcass traits assessment will definitely help the animal breeders and entrepreneurs to know the production potentials of animals. Based on these baseline data, measures could be formulated to increase the production of meat through integrated approach such as optimizing nutritional and managemental inputs with adequate disease control measures in order to express the genetic merit of indigenous animal for bringing gainful advantages in body weight gains and carcass yield.

Carcass and byproduct data were collected for 364 numbers of cattle; 300 numbers of goats; 556 numbers of chicken and 160 numbers of pigs. Compiled information on yield of meat and byproducts of cattle, goat, pig and poultry in the state of Assam is mentioned in Table 4-7.

Table 4: Yield of meat and byproducts of cattle in the state of Assam

Sl. No.	Parameter	Body weight			
		<100 kg	100 -150 kg	150-200 kg	>200 kg
1	Slaughter weight(kg)	93.28	123.62	182.19	208
2	Blood weight	5.20	6.90	9.75	13.0
3	Head weight(kg)	7.98	10.53	15.56	18.5
4	Skin weight(kg)	8.39	10.98	15.72	16.0
5	Stomach weight with content(kg)	7.93	10.85	15.76	18.0
6	Intestine weight with content(kg)	5.37	7.16	10.71	10.8
7	Heart weight(g)	0.96	1.15	1.68	2.1
8	Liver weight(g)	4.18	5.68	8.00	7.5
9	Trachea weight including with lungs (kg)	1.24	3.91	5.30	5.0
10	Lungs weight(kg)	2.45	3.45	4.77	4.3
11	Oesophagus weight(kg)	1.04	1.50	1.95	1.5
12	Kidney weight(kg)	0.67	0.96	1.25	8.0
13	Separable fat weight(kg)	2.43	3.11	4.71	6.6
14	Fore feet	1.80	2.42	3.58	4.1
15	Hind feet	1.94	2.53	3.78	4.2
16	Trimmings weight(kg)	1.67	1.64	2.37	2.4
17	Testicles/udder weight(kg)	2.20	2.94	3.97	4.3
18	Dressed Carcass weight(kg)	40.38	51.35	78.09	86.0
19	Dressing percentage	43.28	41.53	42.81	41.35

Table 5: Yield of meat and byproducts of goat in the state of Assam

Sl. No.	Parameter	Body weight			
		<15 kg	15-20 kg	20-25 kg	>25 kg
1	Slaughter weight(kg)	11.96	17.56	22.35	28.14
2	Blood weight(kg)	0.29	0.39	0.49	0.61
3	Head weight(kg)	0.79	1.21	1.55	1.84
4	Skin weight(kg)	1.00	1.41	1.76	2.24
5	Stomach weight with content(kg)	2.13	3.21	3.85	4.66
6	Stomach weight without content(kg)	0.45	0.67	0.85	1.10
7	Intestine weight with content(kg)	0.76	1.20	1.58	2.00
8	Intestine weight without content(kg)	4.22	0.45	0.57	0.72
9	Heart weight (kg)	0.10	0.10	0.12	0.16
10	Liver weight (kg)	0.22	0.37	0.46	0.58
11	Lungs weight (kg)	0.17	0.27	0.31	0.44
12	Kidney weight(kg)	0.04	0.08	0.08	0.10
13	Separable fat weight(kg)	0.23	0.44	0.61	0.74
14	Dressed Carcass weight(kg)	5.65	8.28	10.90	14.08
17	Dressing percentage	47.14	47.15	48.74	50.02

Table 6: Yield of meat and byproducts of pigs in the state of Assam

Sl. No.	Parameter	Body weight				
		<25 kg	25-50 kg	50-75 kg	75-100 kg	>100 kg
1	Slaughter weight(kg)	21.25	47.50	65.66	86.01	135.82
2	Blood weight(kg)	1.15	1.95	2.23	2.78	3.12
3	Head weight(kg)	1.78	3.88	4.44	6.10	9.01
4	Fore feet weight(kg)	0.16	0.75	0.81	1.09	1.44
5	Stomach weight with content(kg)	0.44	0.89	0.98	1.32	2.13
6	Intestine weight with content(kg)	1.63	3.85	5.28	7.25	10.05
7	Pluck(Heart, Lung & Liver)weight(kg)	0.80	1.33	1.79	2.12	2.78
8	Kidney(kg)	0.09	0.21	0.22	0.24	0.31
9	Separable fat weight(kg)	0.30	1.03	1.73	2.47	3.06
10	Trimmings weight(kg)	0.10	0.14	0.21	0.25	0.22
11	Testicles/udder(kg)	0.00	0.00	0.02	0.00	0.05
12	Dressed Carcass including skin weight(kg)	13.08	29.88	44.51	58.42	96.95
13	Dressing percentage	61.48	73.16	71.70	72.21	73.84

Table 7: Yield of meat and byproducts of chicken in the state of Assam

Sl. No.	Parameter	Broiler chicken				*Desi* chicken		
		< 1 kg	1-1.5 kg	15.-2 kg	>2 kg	< 1 kg	1-1.5 kg	15.-2 kg
1	Slaughter weight(kg)	0.90	1.35	1.71	2.15	0.92	1.30	1.58
2	Blood weight(g)	11.5	18.53	23.01	29.95	14.45	18.09	21.41
3	Head weight(g)	20	31.42	38.77	48.975	24.85	29.89	33.22
4	Skin with feather weight(g)	90	154.73	196.14	245.175	99.68	146.74	177.87
5	Heart weight(g)	10	9.27	11.64	17.05	7.78	10.74	14.53
6	Liver weight(g)	20	26.94	35.55	55.3	20.95	24.25	30.48
7	Gizard weight with content(g)	20	32.39	42.16	66.9	30.18	33.93	39.17
8	Shank weight(g)	80	68.96	82.98	77.175	31.45	52.78	71.96
9	Intestine weight with content(g)	80	79.42	98.84	126.625	51.90	78.47	100.97
10	Separable fat weight(g)	11.5	24.53	33.62	49.725	0.00	4.46	8.17
11	Dressed carcass weight(g)	0.51	0.83	1.07	1.36	0.58	0.83	1.01
12	Dressing percentage	56.7	61.27	62.73	63.54978	62.82	63.67	63.92

Assessment of carcass and meat quality of indigenous pigs (Gunghroo & Niang Megha) and their crosses in comparison to improved pig breeds (Duroc and Hampshire)

R. Thomas and K. Barman

This project has been undertaken with a long term objective to standardize the carcass grading procedure for indigenous pig breeds. Different activities proposed in the project are assessment of a) body measurements of Indigenous pigs and their crosses in comparison to the improved pig breeds, b) carcass quality of Indigenous pigs and their crosses in comparison to the improved pig breeds and c) meat quality of Indigenous pigs and their crosses in comparison to the improved pig breeds. Assessment of the various carcass and meat quality parameters are in progress and data from a total of 58 pigs belongs to different breeds/strains and age groups were collected during the reported period. Documentation of different meat quality parameters (viz. drip loss, pH- pH_1 & pHu, water holding capacity, extract release volume, muscle fibre diameter, muscle fibre length, texture profile analysis, cooking loss, myofibrillar and Salt soluble proteins and total meat pigments) will be continued during 2014-15 period.

HYGIENIC PIG SLAUGHTER OPERATIONS

Fig. 8: Electrical stunning

Fig. 9: Sticking/bleeding

Fig. 10: Dehaired carcass

Fig. 11: Evisceration

Fig. 12: Splitting

Fig. 13: Carcass ready for fabrication

TECHNOLOGY COMMERCIALIZATION

The state of the art R&D pork processing plant has refined and standardized the technologies for processing an array of emulsion based value added pork products. Due to its keen desire to popularize the developed technologies and to establish close linkage with small scale entrepreneurs who are willing to take up these improvised technologies, the Institute has signed a Memorandum of Understanding (MoU) with M/s Arohan Foods, Guwahati to establish a Public-Private-Partnership (PPP).

Currently, 14 different value added pork products (viz. hot dogs, cocktail, ham, nuggets, salami of different flavor and taste) are being marketed in all the states in NE region under the brand name 'Choice Pork Natural' through over 170 retail outlets. The products are also available in the 'Natures Basket' outlets in Mumbai and Kolkata. The brand has already established a strong base in the country's retail market and the customer feedback reports indicate that the products have very good acceptance among the consumers and they are ready to pay more for good quality pork and pork products, if made available. Through this initiative, the Institute is not only trying to demonstrate that there exists a potential market for quality pork and pork products in the region, but also making efforts to show the public that, there exist a better way for processing and marketing of pork and pork products and thereby it is possible to curtail the mushroom growth of unhygienic pork shops in the country.

Fig. 14: Pork products under brand name 'Choice Pork Natural'.

ANIMAL HEALTH

Epidemiological studies on important diseases of pigs

S. Rajkhowa, S.R. Pegu, M.K. Tamuli and D.K. Sarma

(i) Screening of pigs for antibodies against *Mycoplasma hyopneumoniae*

Mycoplasma hyopneumoniae (*M. hyopneumoniae*) is the primary etiological agent of the Swine Enzootic Pneumonia (SEP) that leads to a non-productive cough, mild fever, weight gain loss, high morbidity and low mortality. SEP is considered one of the most common respiratory diseases of pig worldwide and is responsible for high economic loss due to secondary infections. It has also been observed that many cases of lameness in pig is associated with mycoplasmal infection. Its diagnosis can be made based on clinical signs described above and gross lesions detected at slaughterhouses such as hepatized lung areas. However, since several microorganisms may cause similar alterations, it is not possible to state that *M. hyopneumoniae* is the causative agent of such lesions and clinical signs. Although definitive PES diagnostic can be obtained by microorganism isolation, this technique is laborious and requires at least 15 days for colony growth. These features make isolation procedures impractical for daily routine diagnosis. Antibody detection by ELISA can be a diagnostic alternative and hence a study was undertaken to screen the pigs of our institute farm for the presence of antibody against *M. hyopneumoniae* by using a commercially available ELISA. Out of 184 animals examined, 41 animals (22.28%) were found to be positive. Prevalence of antibodies in piglets (up to 2 months), growers (3-6 months) and adults (above 6 months) were 5.43%, 9.23% and 7.60%, respectively.

(ii) Screening of pigs of Northeastern states of India for antibodies against porcine circovirus (PCV) and porcine parvovirus (PPV)

Porcine circovirus Type 2 infection has been reported from nearly every country with a significant commercial production industry. It is strongly associated with the occurrence of Postweaning multisystemic wasting syndrome (PMWS) and also appears to have an association with porcine dermatitis and nephropathy syndrome (PDNS), porcine respiratory disease complex (PRDC), and occasionally reproductive failure. Postweaning multisystemic wasting syndrome usually occurs in nursery or growing pigs and is characterized by gradual wasting, unthriftiness, rough hair coat, polypnea, dyspnea, pallor, diarrhoea, and occasionally icterus. Affected pigs usually die; clinical survivors are severely stunted; non-clinical pigs in the same groups perform quite well.

Similarly porcine parvoviral infection (PPV) is endemic in most swine herds. It is usually subclinical and a very common infection. Prior to porcine reproductive and respiratory syndrome (PRRS), PPV was probably the most commonly diagnosed infectious cause of reproductive failure in swine. Reproductive failure is much more likely to occur in gilts than in sows. It is characterized by the occurrence of large numbers of mummified fetuses, an increase in the number of returns to estrus, small litters, failures to farrow, decreased farrowing rate, and rarely abortion.

Considering the negative impact of both these diseases on pig production a study was undertaken to screen the intensively managed pigs from the states of Assam and Mizoram for the presence of antibodies against PCV and PPV by using commercially available ELISA kits. Out of 186 animals examined, 23 (12.36%) were positive for PCV and 25 (13.44%) were positive for PPV. Prevalence of antibodies against PCV in piglets (up to 2 months), growers (3-6 months) and adults (above 6 months) were 4.30%, 3.76% and 4.30%, respectively whereas the corresponding values for PPV were 4.83%, 5.91% and 2.68%, respectively. It was also observed that antibodies against both these viruses were also present in 11 (5.91%) animals.

iii) Isolation and identification of bacteria associated with respiratory tract diseases of pigs managed under intensive as well as scavenging system of management

Respiratory diseases are considered to be one of the major health problems in pig producing countries throughout the world. A variety of infectious agents have been found to be associated with respiratory tract diseases of pigs. Apart from viral agents many bacteria are responsible for the respiratory diseases of pigs and hence a study was undertaken to find out the bacterial agents associated with the respiratory diseases of pigs managed under intensive as well as scavenging system of management. To isolate the bacteria associated with respiratory diseases of pigs different culture medium (appropriate for a particular bacterial species) and standard bacteriological methods were used. Different bacteria isolated from pigs (no. of bacteria isolated during the reported period are shown within the parenthesis) with clinical respiratory disease were *Pasteurella multocida* (18), *Bordetella bronchiseptica* (3), *Actinobacillus pleuropneumoniae* (2), *S. suis* (6), *Klebsiella species* (6) and *E. coli* (14).

iv) Detection of *Streptococcus suis* associated with fibrinous pericarditis and arthritis in pigs by PCR as well as their antimicrobial resistance pattern

Streptococcus suis (*S. suis*) is an important pathogen of swine responsible for a wide range of diseases such as meningitis, arthritis, septicaemia, endocarditis, encephalitis, abortions, polyserositis and bronchopneumonia, all of which have a negative effect on pig production. Sub-clinical carrier animals are the most important source from which the bacteria are transmitted to susceptible young pigs. Outbreaks have been reported from many pig producing countries of the world. Although the disease has been reported from various parts of the world, only a few studies have been conducted in India. As we commonly observe cases of fibrinous pericarditis (on post mortem) and arthritis in pigs mostly managed under intensive system of management, a study was undertaken to detect *S. suis* associated with such cases and also to determine the antibiotic sensitivity pattern of those isolates. During the reported period we could isolate 9 *S. suis* from cases of fibrinous pericarditis (3 cases) and arthritis (6 cases) and also could confirm by PCR through detection of *gdh* gene. All isolates were found to be susceptible to amikacin and chloramphenicol whereas isolates were resistant to antibiotics such as ceftriaxone and tetracycline.

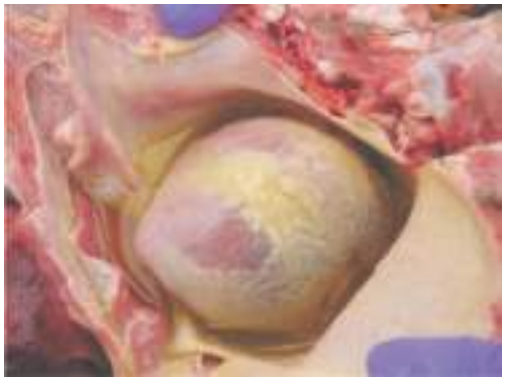


Fig. 1: Fibrinous pericarditis and hydrothorax due to *S. suis* infection in a pig

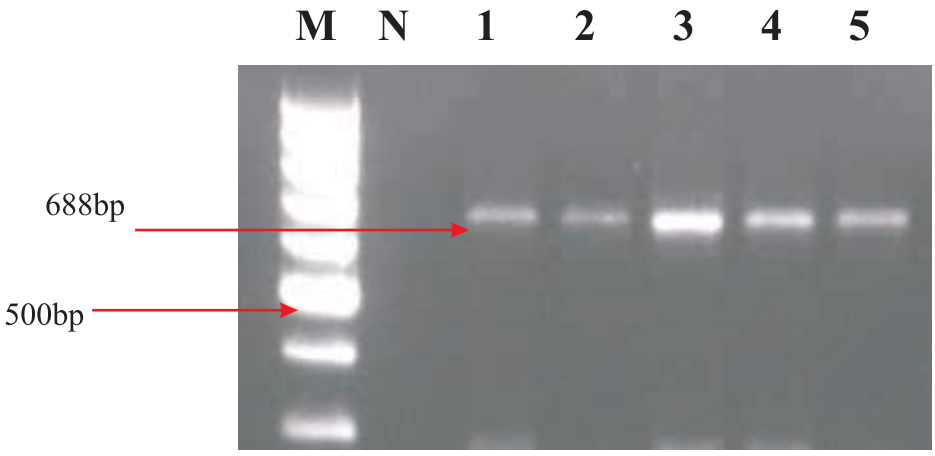


Fig. 2: Detection of Glutamate dehydrogenase (*gdh*) gene of *S. suis* by PCR

M: 100bp DNA ladder, N: Negative control, lane 1-5: positive samples

v) Detection of *stx2e* gene of STEC associated with edema disease of pigs by PCR

Edema disease (ED) is a fatal disease of newly weaned piglets which is caused by Shiga toxin-producing *Escherichia coli* (STEC). It is an enterotoxemic disorder of weaned piglets that represents a significant threat to pig husbandry worldwide. It is considered as one of the important bacterial diseases of pigs which has significant impact on pig husbandry particularly in country like India where pig is generally reared by economically weaker section of the society. The causative *Escherichia coli* (*E. coli*) strains are highly adapted to the porcine host and characterized by the production of Shiga toxin type 2e (Stx2e). It generally affects the rapidly growing piglets and the healthiest piglet of the litter. The clinical signs of the disease include loss of appetite, rise of temperature, respiratory distress, swelling of eyelids, incoordination of movements and on postmortem examination there is presence of fluid in the abdominal cavity, edema in the subcutaneous tissue, submucosa of stomach and intestine. Sometimes piglets in a litter are simply found dead without evidence of any clinical sign. Considering the impact of this disease on pig production a study was undertaken to confirm the disease through use of molecular method like PCR. During the reported period we could confirm the disease in 4 piglets (which have shown the clinical signs of the disease such as swelling of eyelids, incoordination of movements and on postmortem examination there was presence of fluid in the abdominal cavity) through detection of *stx2e* gene by PCR. Out of 4 piglets , in 2 piglets, gene encoding intimin (*eaeA*) was also detected in addition to detection of *stx2e* gene.

Fig. 3: Swelling of eyelids caused by STEC in a pig

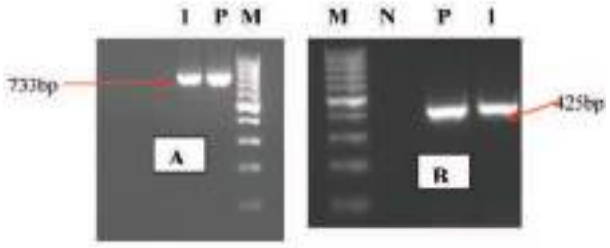


Fig. 4: PCR detection of *stx2e* (A) and *eaeA* (B) genes of STEC associated with edema disease; Lane P: Positive control, lane 1: Test sample, M: 100bp DNA ladder & N: Negative control

vi) Studies on virulence characteristics of STEC isolates from pigs

Escherichia coli O157:H7 and other Shiga toxin (Stx)-producing *Escherichia coli* (STEC) strains are associated with food and waterborne illness around the world. *E. coli* O157 has been implicated as the causative agent in several human outbreaks and is the most common cause of hemorrhagic colitis (HC) and hemolytic uremic syndrome (HUS). Non-O157 STEC strains have more recently been recognized as important pathogens with an increasing impact on human health and are now also considered to be a major cause of disease. As *E. coli* infection is very common in piglets a study was undertaken to determine the prevalence of different virulence genes in STEC isolates recovered from pigs. For this purpose a total of 782 *E. coli* isolates recovered from piglets from major pig producing Northeastern states of India during three years period (June 2010 to May 2013) were screened by the polymerase chain reaction (PCR) assay for the presence of virulence genes characteristic for STEC, that is, Shiga-toxin producing gene(s) (*stx1*, *stx2*), intimin (*eae*), enterohemolysin (*hlyA*) and STEC autoagglutinating adhesin (Saa). Overall STEC were detected in 113 (14.4%) piglets and the prevalence of *E. coli* O157 and non-O157 STEC were 4 (0.5%) and 109 (13.9%), respectively. None of the O157 STEC isolates carried gene encoding for H7 antigen (*fliCh7*). The various combinations of virulence genes present in the strains studied were *stx1* in 4.6%, *stx1* in combination with *stx2* gene in 5.1%, *stx1* in combination with *stx2* and *ehxA* in 0.6%, *stx1* in combination with *stx2* and *eae* in 0.2% and *stx2* alone in 3.7%. All STEC isolates were found negative for STEC autoagglutinating adhesin (Saa).

vii) Management of an outbreak of mange infestation in a newly purchased Large White Yorkshire pig herd

Sarcoptic mange is a common disease and represents the most important ectoparasitic disease of swine. Sarcoptic mange occurs in many other species but the mite *Sarcoptes scabiei* var *suis* is specific only for swine. Spread is by direct body contact and mites from the dam often invade neonatal piglets within a few hours of birth. The disease is characterized by frequent rubbing and scratching, decreased growth rate, inefficient use of feed and low sow productivity. During the reported period a herd of Large White Yorkshire

pig (all growers) which was newly purchased from the state of West Bengal exhibited clinical signs (such as frequent rubbing and scratching and scab formation on different parts of the body but most particularly on inner side of ears) of mange infestation after a few days of introduction in our farm. Skin scrapings from representative animals (6 numbers) of this herd were examined by KOH digestion method and mites were detected in all 6 animals. Infected pigs were treated with a single dose of Ivermectin at 200 ug/kg body weight, subcutaneously. No mites were recovered from treated pigs after a period of 10 days of treatment. This infestation has great significance because it affects the growth rate and feed conversion significantly, specially in grower and weaned pigs. The pig producers are generally unaware about the severity of the problem of mite infestation, so precaution should be taken to prevent their valuable pigs from *S. scabiei var. suis* infestation.

Fig. 5: Mange infested pigs (A & B) and pigs (C) after 10 days of treatment with Ivermectin

Development of a novel molecular diagnostic method for the rapid, specific and simultaneous detection of all prevalent pathotypes of Escherichia coli from diarrhoeic piglets (Funded by Department of Biotechnology)

S. Rajkhowa, N.R. Sahoo and I. Shakuntala

(i) Development of a novel multiplex PCR assay for rapid, specific and simultaneous detection of three important pathotypes of *E. coli* from diarrhoeic piglets

Enteric colibacillosis is very common and the most important cause of enteric disease in pigs. It is responsible for >30% of all gastrointestinal problems in neonatal piglets. It has also been observed that *Escherichia coli* is one of the most important causes of diarrhoea in pigs. Recently an increase in incidence of outbreaks of severe *E. coli*-associated diarrhoea has been observed worldwide. In order to assess the pathogenic potential of *E. coli* strains isolated from piglets a determination of their virulence profiles is required. Identification of virulence factors is important to know the epidemiology because the prevalence of *E. coli* strains that express specific virulence factors varies with geographic location and information on prevalence is essential for the control of *E. coli* infection in pigs. Although *E. coli* infection is frequently observed in piglets in India, little is known concerning their virulence profiles. On the other hand it has also been observed that no reliable diagnostic method is available which is rapid, specific and can detect simultaneously the important prevalent pathotypes of *E. coli* from diarrhoeic piglets. Therefore, we have characterized the *E. coli* isolates associated with

diarrhoea in piglets as well as developed a novel multiplex PCR for the rapid, specific and simultaneous detection of three important prevalent pathotypes of *E. coli* (in a single reaction) from diarrhoeic piglets (Fig. 6) and has been used extensively for detection of different pathotypes of *E. coli* from diarrhoeic piglets.

In order to develop the novel multiplex PCR, the primers were designed using Primer 3 software. The sequences of these primers [encoding virulence genes representing prevalent pathotypes such as enterotoxigenic *E. coli* (*est1/elt1*), Attaching and effacing *E. coli* (*eaeA*$^{+}$ *bfpA*$^{-}$, *stx*$^{-}$) and STEC (*stx*$^{+}$) associated with diarrhoeic piglets] are shown in Table 1, along with their corresponding GenBank accession numbers and predicted product sizes. The PCR reaction mixtures contained 8 primers at a concentration of 20 pmol each, 3µl of template, 10× PCR buffer, 2 mM of $MgCl_2$, 200 µM of each of the four deoxynucleotide (dNTPs) and 1 U Taq DNA polymerase in a final volume of 25µl. Polymerase chain reaction assays were done using a GeneAmp PCR system 9700 thermal cycler (Applied Biosystems, USA) with the following amplification conditions: an initial denaturation at 95ºC for 5 min, followed by 30 cycles of denaturation for 30 sec at 95ºC, annealing at 56ºC for 45 sec, extension for 45 sec at 72ºC with the final extension for 5 min at 72ºC. Amplified PCR products were analyzed by gel electrophoresis in 2% agarose containing ethidium bromide (0.5 µg/ml). The products were visualized with UV illumination and imaged with gel documentation system (Alpha Infotech Corporation, Multi Image System, San Leandro, CA, USA).

Table1: Oligonucleotide sequences used for multiplex PCR

Target genes	Oligonucleotide sequences	Amplicon size (bp)	GenBank Accession number
est1	F: CATGACGGGAGGTAACATGA R: GCACAGGCAGGATTACAACA	222	M25607
elt1	F: CCCTCACCCATATGAACAGG R: TGCTCAGATTCTGGGTCTCC	308	S60731
stx1	F: GCGTGGAGGATGTCAAGAAT R: CCTTCGCCACCACATTAACT	127	M17358
eaeA	F: CAACATGACCGATGACAAGG R: ACGGATATCGAAGCCATTTG	535	Z11541

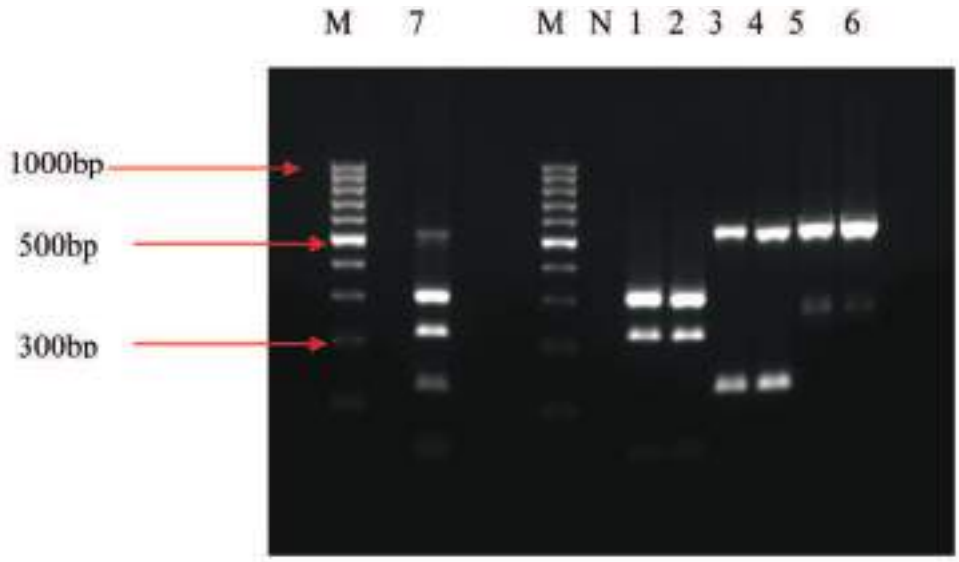


Fig. 6: Agarose gel showing multiplex PCR assays for detection of different pathotypes of *Escherichia coli* from diarrhoeic piglets. Lane M: molecular marker (100bp DNA ladder), N: Negative control, lane 1: Positive control for genes *est1 and elt1, lane 2: Test sample positive for est1 (222bp) and elt1 (308bp) genes, lane 3: Positive control for genes eaeA and stx1, lane 4: Test sample positive for genes eaeA (535bp) and stx1(127bp), lane 5: Positive control for eaeA gene, lane 6: Test sample positive for eaeA (535bp) gene, lane* 7: Mixture of all positive control strains showing band representing different pathotypes of E. *coli* from diarrhoeic piglets

Molecular characterization, antimicrobial resistance and virulence typing of Pasteurella multocida isolates from clinically healthy pigs and pigs with atrophic rhinitis and pneumonic pasteurellosis (Funded by Department of Biotechnology, Govt. of India)

S. Rajkhowa, R.K. Sharma and H. Rahman

(i) Development of a novel simplex PCR for rapid detection of toxigenic strains of *Pasteurella multocida* from pigs

Atrophic rhinitis (AR) is a serious, highly contagious disease of swine characterized by conchal atrophy, facial distortion, sneezing, nasal hemorrhage and impaired growth. The progressive form (PAR) of the disease is caused by toxigenic *P. multocida* alone or in combination with *B. bronchiseptica*. A definite diagnosis of PAR cannot be based solely on clinical and pathomorphologic observations, but requires detection of toxigenic *P. multocida* from nasal and/or tonsillar swabs. Nontoxigenic *P. multocida* can also concurrently infect the nasal cavities and tonsillar surfaces of pigs. The etiologic importance of the toxin necessitates classification of the isolates as toxigenic or nontoxigenic for the diagnosis of PAR. As the disease (PAR) has tremendous impact on swine production an attempt has been made to develop a novel PCR for rapid detection of toxigenic strains of *P. multocida* from pigs.

In order to develop the PCR assay for detection of gene (*toxA*) encoding dermonecrotic toxin of *P. multocida*, the primers were designed (by primer designing software) by using gene sequences available in GenBank. The sequences

of the newly designed primers for detection of *toxA* gene of *P. multocida* were GGTAAAGAGTTTGCCGTGGA (forward) and CGAGGCTTTGTGAAAAGAGG (reverse) and the amplification condition was initial denaturation at 95°C for 5 min followed by 30cycles of denaturation at 95°C for 30 s; annealing at 56°C for 45 s, extension at 72°C for 45 s, and a final extension of 72°C for 5 min. The specificity of each of these primers was initially confirmed by using BLASTN and the GenBank sequence database. The composition of PCR reaction mixture used for amplification of *toxA* gene was as follows: Primers at a concentration of 20 pmol each (forward and reverse), 3µl of template, 10× PCR buffer, 2 mM of $MgCl_2$, 200 µM of each of the four deoxynucleotide (dNTPs) and 1 U Taq DNA polymerase in a final volume of 25µl were used. Polymerase chain reaction assay was done using a GeneAmp PCR system 9700 thermal cycler (Applied Biosystems, USA) with the amplification conditions as mentioned above. Amplified PCR products were analyzed by gel electrophoresis in 2% agarose containing ethidium bromide (0.5 µg/ml). The products were visualized with UV illumination and imaged with gel documentation system (Alpha Infotech Corporation, Multi Image System, San Leandro, CA, USA). The developed assay was validated by using samples from clinical cases and the results obtained were also compared with the results of reference strain. The detection of toxigenic strain of *P. multocida* from pigs by using developed novel assay is shown in Fig 7. The PCR assay developed for the differentiation of toxigenic *P. multocida* strains from non-toxigenic strains can be used for the routine screening of pig herd for toxigenic *P. multocida* , the etiologic agent of PAR.

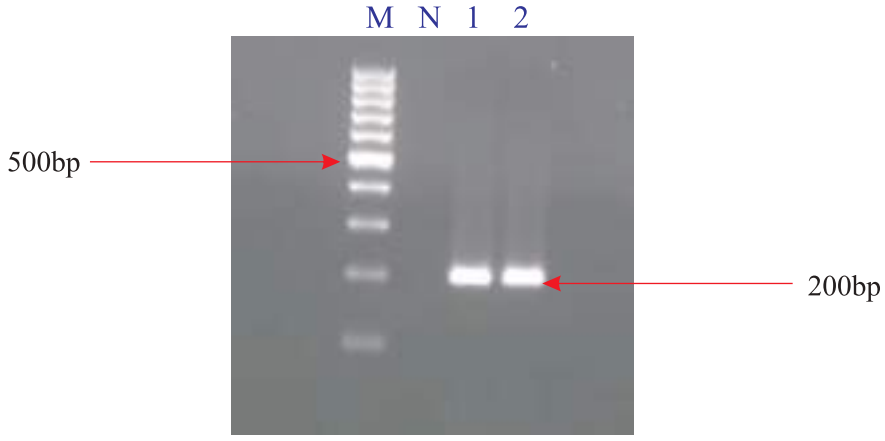


Fig. 7: PCR detection of *toxA* gene of *P. multocida* from pig, M: Molecular marker (100bp DNA ladder), N; Negative control, Lane 1: Positive control, Lane 2: Positive sample

ii) Development of ten novel simplex PCRs for detection of important virulence associated genes (VAGs) of *Pasteurella multocida* from pigs

As determination of virulence associated genes of *P. multocida* helps in knowing the pathogenic potential of the organism, a study was undertaken to develop novel simplex PCRs for detection of ten (10) important VAGs of *P. multocida* from pigs. The ten virulence genes selected were *ptfA* and *pfhA* (diverse adhesions), *tonB* and *hgbA* (iron acquisition proteins), *nanB*

and *nanH* (sialidases) and *OmpA*, *OmpH*, *Oma87* and *plpB* (outer membrane proteins). The primers for these genes were designed (by primer designing software) by using gene sequences available in GenBank. The sequences of the newly designed primers for detection of various VAGs of *P. multocida* from pigs are shown in Table 2. along with their corresponding GenBank accession numbers and predicted product sizes. The amplification conditions for detection of various VAGs associated with *P. multocida* from pigs are also shown in Table 2. Primers at a concentration of 20 pmol each (forward and reverse), 3µl of template, 10× PCR buffer, 2 mM of $MgCl_2$, 200 µM of each of the four deoxynucleotide (dNTPs) and 1 U Taq DNA polymerase in a final volume of 25µl were used. Polymerase chain reaction assays were done using a GeneAmp PCR system 9700 thermal cycler (Applied Biosystems, USA) with the amplification conditions as shown in Table 2. Detection of different VAGs of *P. multocida* from pigs by the developed PCRs are shown in Fig.8.

Table 2: Oligonucleotide sequences used for PCRs

Gene function and gene	Primer sequence	Reaction parameters	Amplicon size (bp)	GenBank Accession No.
ompH	F:TTCACGCGTTTCATTCAAAG R: GACATACGCACCACCAAATG	95ºC for 30 Sec, 56ºC for 45 Sec, 72ºC for 45Sec, 30 cycles	367	U50907
oma87	F: GTGAGCCTCGGTGGTAATGT R: GGCTTGAAAGTACCCAACCA	95ºC for 30 Sec, 57ºC for 45 Sec, 72ºC for 45Sec, 32 cycles	436	U60439
ompA	F: GTATTCGCGGGTGGTTTAGA R: TGTGCAACACCTTTCGCTAC	95ºC for 30 Sec, 55ºC for 45 Sec, 72ºC for 45Sec, 30 cycles	428	NC_017027.1
plpB	CCAAAATTGCGAAGGAAAAA CGCGAAATCGACATCATCTA	95ºC for 30 Sec, 56ºC for 45 Sec, 72ºC for 45Sec, 30 cycles	443	EU408787.1
ptfA	F: AAAAAGCGGCAATCTCTGAA R: ATCCTGCTGGGAAAATGTCA	95ºC for 30 Sec, 57ºC for 45 Sec, 72ºC for 45Sec, 30 cycles	303	AY644678.1
pfhA	F: CCAGAAGATGCACAAAGCAA R: GTGTGACACTGCCACCAATC	95ºC for 30 Sec, 55ºC for 45 Sec, 72ºC for 45Sec, 30 cycles	574	AY035342
tonB	F: TCATTGCTTTTTCACGCAAG R: TAAAGCCGAGCGATAAGCAT	95ºC for 30 Sec, 57ºC for 45 Sec, 72ºC for 45Sec, 30 cycles	477	AE006158.1
hgbA	F: GCACGATAATTGGGGATTTG R: CACTTCTCCAACGAACAGCA	95ºC for 30 Sec, 55ºC for 45 Sec, 72ºC for 45Sec, 30 cycles	461	NC_016808.1
nanB	F: CGGAATTAGGTGATGGCAGT R: AAACGCCATTTGACTTGTCC	95ºC for 30 Sec, 56ºC for 45 Sec, 72ºC for 45Sec, 30 cycles	580	AF274868
nanH	F: GGCAGGAACACAAAACTGGT R: GTGAAGGAGCCGCTGTAGTC	95ºC for 30 Sec, 57ºC for 45 Sec, 72ºC for 45Sec, 30 cycles	518	AF274869

All reactions had an initial denaturation at 95°C for 5 min and a final extension at 72°C for 5 min.

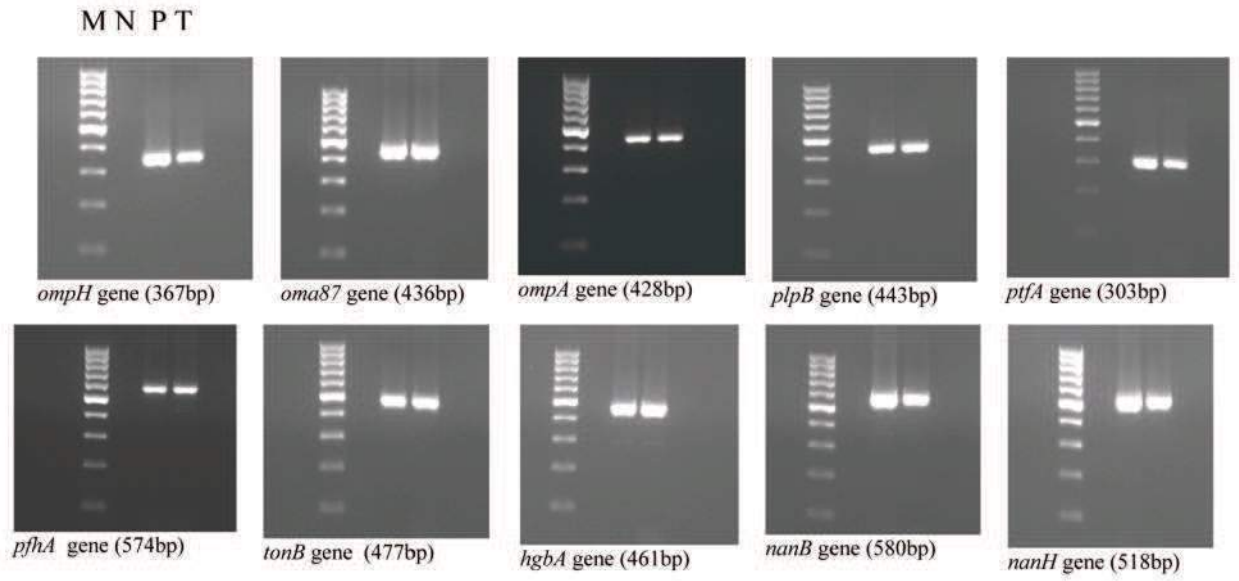


Fig. 8: Detection of different VAGs of *P. multocida* from pigs by the developed PCRs

M: Molecular marker (100bp DNA ladder), N: Negative control, lane P: Positive control, lane T: Test organism

Sero-prevalence study on important viral diseases associated with porcine reproductive disorders

S. R. Pegu, S. Rajkhowa, D. K. Sarma, M. K. Tamuli, S. Naskar and P. P. Gokuldas.

The pig farmers of our country have been facing huge production losses due to various infectious diseases causing reproductive problems like stillbirths, mummified fetus, embryonic death and infertility. The viral infectious causes of swine reproductive problems are Porcine respiratory and reproductive syndrome (PRRS) virus, Circo virus, Parvo virus, Hog cholera virus, Swine influenza virus etc. These pathogens play a major role in various porcine reproductive problems. Infected sows and gilts may show the symptoms of pseudo pregnancy, delayed return to estrus, anestrus and small sized litters and in many cases abortions. Although pig is considered as one of the most versatile and prolific animals, the production losses due to bacterial and viral pathogens causing reproductive problems greatly influence the pig farmer's economy as the infection spread rapidly among the herds and huge cost involvement in the treatment. A large number of embryonic and fetal death occur during the entire pregnancy period of sows and gilts causing heavy drain on the economics of pig production. Considering the huge loss due to reproductive disorders in pigs a sero-prevelance study of viral pathogens associated with reproductive problems in pigs was carried out with commercially available ELISA kits to know the antibody status in the pigs managed under organized and unorganized farms of Assam and its neighboring NE states.

A total of 352 sera samples along with epidemiological data were collected from pigs of different farms and so far 352 sera samples were screened for presence of antibodies against Parvovirus, PRRS, swine influenza and Circo virus. Seroprevalence of PRRS, porcine circovirus, porcine parvovirus and swine influenza were 16 (4.54%), 43(12.21%), 45 (12.51%) and 20 (5.68%), respectively. A format

of questionnaire was prepared and epidemiological data were collected about any reproductive disorders in gilts, sows and breeding males. This epidemiological data will help to develop a database on reproductive diseases of pigs in organized pig farms as well as pigs reared under backyard system of management. Active surveillance in few organized farms including our institute farm is going on.

Fig 9: Macerated fetuses aborted from a gilt on 56 days of gestation

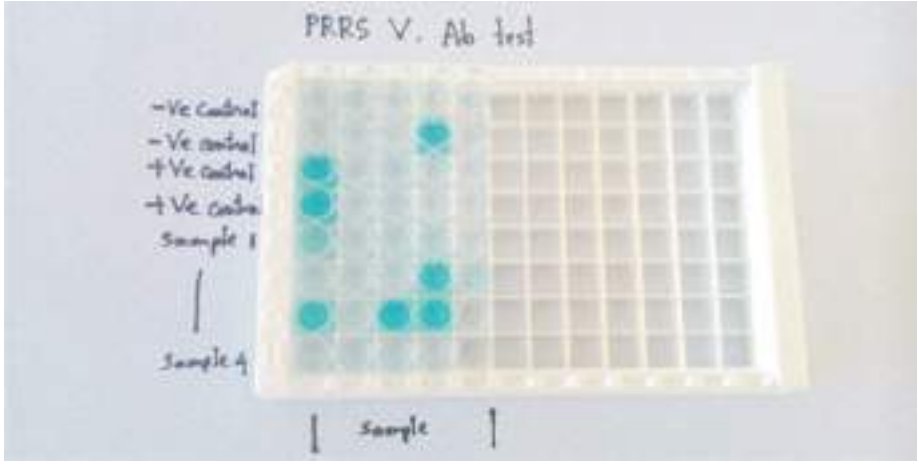


Fig 10: PRRS virus antibody ELISA test

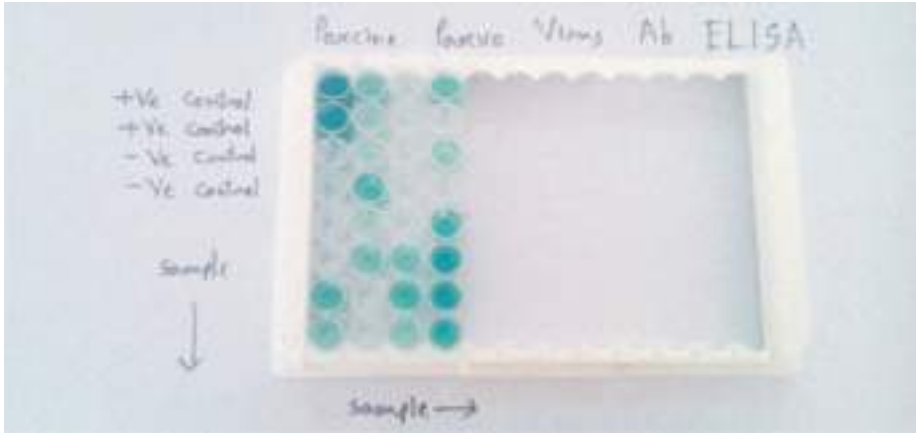


Fig 11: Porcine parvovirus Antibody ELISA test

ALL INDIA COORDINATED RESEARCH PROJECT ON PIG

AICRP on pig started its journey from IVth five year plan (1970-1971) with the main objective of studying the performance of pigs in different parts of the country. Presently the programme is continuing in nine different centers across the country.

National Research Centre on Pig is regularly monitoring the progress of AICRP through conduction of Scientist's meet. The last AICRP Scientists' meet was conducted at Indian Veterinary Research Institute, Bareilly in October, 2013 to appraise the progress made in different centers.

AAU Centre, Guwahati

Since its inception AAU centre, Khanapara has played an important role in development of the piggery sector through demonstration, exhibition, attending training and awareness program, distribution of booklets, selling of quality piglets, elite/gilts sows at nominal price to interested farmers of the state. Pig production in the state is invariably a small scale backyard enterprise and commercial venture of pig farming is still to be set up in the state. However, with the initiative of AICRP on pig, AAU Khanapara a sizable number of unemployed youths, retired persons from affluent families/societies have taken up this venture as a means of livelihood/occupation or as subsidiary income generation. As part of the cross breeding programs the centre worked for the development and maintenance of two genetic groups, 75%H and 87.50%H (Hampshire). The 75%H genetic group attained 15th generation however the 87.50%H attained 2nd generation. In addition to it, another genetic group 50%H was also developed from the centre and maintained at MSP on Pig. The average litter size at birth, litter weight at birth, litter size at weaning and litter weight at weaning were found to be 9.56 $\pm$ 0.33, 9.63 $\pm$ 0.32 kg, 9.11$\pm$ 0.35, 72.96 $\pm$ 2.73kg, respectively of 75 %H genetic group of pig. The corresponding values were recorded as 9.60 $\pm$ 0.22, 9.66 $\pm$ 0.59 kg, 8.50 $\pm$ 0.73 and 69.36 $\pm$ 4.94 kg, respectively in 87.50%H. The average body weight at birth, at 6th weeks (weaning) and at 8 months of ages were found to be 1.0 $\pm$ 0.01kg, 8.21$\pm$ 0.02 kg and 65.37 $\pm$ 0.53 kg, respectively in 75%H and the average body weight at birth and at 6th week (weaning) of age were found 1.01$\pm$ 0.01 kg and 8.15 $\pm$ 0.04 kg, respectively in 87.50%H genetic group of pig.

Fig. 1: 75% Hampshire sow with piglets at AAU centre

BAU Centre, Ranchi

BAU, Ranchi has worked for the improvement of pig breeding and management technologies through transfer of efficient technologies and therefore helped in the upliftment of socio-economic status of pig breeders. Besides 75% Hampshire cross, the centre developed and maintains T&D crossbred pigs under AICRP. Comparative growth

performance of 'T&D' and 75%H pigs were studied in this centre during the year under report. Average body weight at birth was observed to be significantly higher in 75%H (1.31± 0.01kg) pigs in comparison to 'T&D' (1.13± 0.01kg) pigs. Body weight at 8th weeks and 32nd weeks of age did not differ significantly between the groups. However, higher body weight was recorded in 'T&D' (8.68±0.14 and 74.10±0.32kg) than 75% H (8.44±0.14 and 74.50±0.30 kg) at 8th and 32nd weeks of ages respectively. Comparative reproductive performance of 'T&D' and 75%H pigs were studied. No significant differences were observed between these two groups. However, slightly better reproductive performances were noticed in 'T&D' pigs than 75%H. The average litter size at birth, litter weight at birth, litter size at weaning and litter weight at weaning were observed to be 7.15±0.32 and 6.85±0.31, 8.17±0.39kg and 8.87±0.45kg, 6.83±0.36 and 6.17±0.35, 58.43±3.49kg and 48.79±2.06kg for 'T&D' and 75%H pigs, respectively. Polyherbal feed additive has significant effect on performance of pigs under study. Significant difference was observed in body weight and FCR during most of the period under study. However, polyherbal feed preparations for group-I (*Andrographis paniculata,Achyranthus aspera, Terminalia belerica*) and group-II (*Withania somnifera, Ocimum sanctum, Phyllanthus emblica, Asparagus racemosus, Glycerrhiza glabra*) is reported better in most of the economic traits and thus may be supplemented to pigs for

Fig. 2: Management of Pigs at Farmer's field by BAU centre

KVASU Centre, Mannuthy

KVASU, Mannuthy basically focuses on various aspects of pig production and operates as an instructional farm to students, production and distribution of good quality piglets to farmers and to function as a demonstration unit to farmers. Under the AICRP on Pig, two breed (Desi x LWY) and three breed ((Desi x LWY) x Duroc) crosses are produced and supplied to farmers for fattening. The centre has successfully fulfilled the demand of the farmers by supplying 778 fattening piglets (crossbreds). Ten generations of 50% crossbred and three generations of 75% crossbred were produced and their production, reproduction and carcass traits were studied. The average litter size at birth and weaning was 10.60±0.20 and 7.92±0.20, respectively whereas average litter weight at birth and weaning was recorded as 10.27±0.26 and 63.65±0.24 kg, respectively. The breeding stock number was increased; health status of farm stock is improved with utmost care and management. A comprehensive breeding schedule has been introduced for prompt selection / culling of the stock. RNA has been isolated from ovary and uterus of desi pig and sequencing and analysis of FUT1 locus of desi pig is completed. PCR-RFLP analysis for the genetic variants of six genes under study ie., Fucosyltransferase 1 (FUT1), 17-beta-hydroxysteroid dehydrogenase (HSD 17-β), Steroid 21-hydroxylase (CYP21), Estrogen receptor-1 (ESR1), Erythropoetin receptor (EPOR) and Epidermal growth factor

(EGF) is being studied. Retinol Binding Protein 4 (RBP4) gene was investigated to find its association with reproductive traits such as Total Number Born (TNB), Number of piglets weaned (NPW), Litter weight at birth (LWB) and Litter weight at weaning (LWW). Isolation of genomic DNA from blood samples of 180 sows were also performed which comprises three genetic groups Large White Yorkshire (Y), Duroc (D) and Ankamali X large white Yorkshire crossbreed pigs. This centre imparts training programs from time to time and as part of its initiative around *adivasi* youth facilitators farmers and tribal facilitators of People's Rural Education Movement (PREM) were trained in collaboration with Bank. This centre serves as a source of elite germplasm to farmers as well as Government / University farms of Kerala, Tamil Nadu, Karnataka, Andra Pradesh, Goa, Maharastra and Megalaya.

Fig. 3: Crossbred (LWY x Desi) sow with 75% crossbred piglets

Fig. 4: Crossbred (LWY x Desi) sows

SVVU Centre, Tirupati

This centre is maintaining genetic group of crossbreds of 75% (LWY x Desi) by *inter se* mating and performances crossbreds by *inter se* mating are under study. The litter size at birth and weaning was observed as 8.03±0.33 and 7.70±0.37, respectively were as the litter weight at birth and weaning was 9.87±0.37 and 57.90±2.78. During the preweaning period, the mortality percentage was 4.15. The post weaning mortality percentage was recorded as 9.09 which was slightly more, which might be due to weaning of piglets during summer season and no outbreaks of any major infectious diseases during the reported period.

Fig. 5: Germplasm maintained by pig beneficiary of SVVU Centre

TANUVAS Centre, Kattupakkam

The centre at Kattupakkam maintains crossbreds (LWY x Desi) pigs. In 75% crossbred the average litter size at birth was 8.20±0.19, whereas average litter weight at birth was 10.03±0.22 kg. The average litter size at weaning was 6.13±0.52 whereas, the litter weight at weaning was 52.19±2.04 kg. Pre and post weaning mortality rate was 9.80% 2.89%, respectively. Efforts were taken to minimize mortality through prophylactic measures. Summer managemental practices like sprinkling of water and allowing the pigs for wallowing were followed under strict supervision. Growth promoters like mixtures of yeast extract, nicotinic acid, cyanocobalamin and amino acids or combination of calcium, phosphorous and vitamin D_3 and vitamin D_{12} were given to the weak or runt piglets, pregnant pigs and lactating sows to boost up their growth and health. Experiments to study the growth rate of crossbred pigs with nutritional supplements were conducted on a trial basis. Efforts were taken to create a centralized concrete drainage facility at pig breeding unit and establishment of biogas unit. A total of 209 piglets were sold to needy farmers and six new field units were established.

Fig. 6: Field Unit of TANUVAS Centre

IVRI Centre, Izatnagar

This centre maintains Landrace crossbred pigs. The present crossbred stock (81.25% L x 18.75% D), so produced was maintained and evaluated for their performance. The average litter size at birth was 9.94±0.006, whereas, average litter weight at birth was 11.14±0.76 kg. The average litter size at weaning was 6.41±0.71 whereas, the litter weight at weaning was 53.94±5.55 kg, respectively. The major causes of mortality were trauma, gastroenteritis, enteritis, pneumonia and still birth. To minimize piglet mortality farrowing management were followed round the clock. The iron and Vitamin B-Complex injection at 4th and 14th as well as at 5th and 15th day of age, respectively, in piglets is given regularly. Besides, the vaccination of FMD, and Swine Fever is regularly done in all the stock of the Farm. Effect of reducing space allowance on performance of crossbred pig was studied and found that there is a scope of reduction of space in case of crossbred pigs.

Fig. 7: Grower animals at IVRI Centre

ICAR RC for Goa Centre, Goa

This centre maintains crossbred (Duroc X Local and Yorkshire X Local) and Goa local pigs. 75 % crossbred pigs were produced by crossing 50%crossbred pigs with pure Large White Yorkshire male. Reproductive observations *viz.* age of puberty and oestrous length are being recorded. During the project period the data were recorded from the crossbred population and evaluated. Average litter size at birth in Goa Local, Yorkshire, 50% and 75% crossbreed was 6.81±0.57, 7±0.25, 7.16±1.64, 8.33±0.55, whereas litter size at weaning was 5.33±0.67, 5.60±0.61, 6.50±1.38, 5.40±1.22, respectively. As management part foggers are installed in pig unit to reduce the heat stress. Boar Semen collection has been standardized and works on Artificial insemination in pigs is in progress. Model of integrated farming is developed at the Institute by incorporating tuber crops, vegetable and fruit crops, medicinal plants and biogas in the backyard of pig unit. Performance study for economics of crossbreed pig production was undertaken at this centre to understand adoptability, feed efficiency, reproductive performance and meat characteristics etc. During the report period farmers were taught about the importance of sanitation, vaccination, sorting, fortification, cooking of the food and utilization of biological waste for reducing feeding cost.

Fig. 8: Field pig unit of Goa Centre

CAU Centre, Aizawl

The centre maintains Zovawk, Zovawk crossed with LWY and LWY under AICRP project. Average litter size (nos.) and litter weight (kg) of Zovawk at birth were 6.28±0.64 and 3.52±0.43, Zovawk × LWY were 8.14±0.79 and 5.19±0.45 and that of LWY were 8.5±1.5 and 12.15±2.47 respectively. Average litter size (nos.) and litter weight (kg) at weaning of Zovawk were 5.57±0.81 and 24.80±5.44, Zovawk ×LWY were 7.14±0.45 and 42.44±2.11, LWY were 7.50±1.32 and 48.10±6.83, respectively. Average individual body weight (kg) at birth and weaning in Zovawk were 0.55±0.03 and 4.24±0.43, Zovawk ×LWY were 0.64±0.03 and 5.99±0.17, LWY were 1.40±0.08 and 6.57±0.30, respectively. The pre and post weaning mortality rate (%) in Zovawk were 8.69 and 17.04, Zovawk ×LWY were 12.27 and there was no mortality in post weaning piglets, LWY were 10.52 and 5.55 respectively. The pre-weaning growth rate (gm/day) in Zovawk, Zovawk ×LWY and LWY were 87.85, 127.3, and 123.09 respectively. The post weaning growth rate (gm/day) was 127.56, 201.13, and 528.64 respectively. During the reporting period a large number of LWY breed of piglets were supplied to farmers and NGO's at subsidized rate. Proper cleaning and sanitation programme is being strictly followed in the farm. Iron injection to the

Fig. 9: Dry/Pregnant Female (LWY) at CAU centre

newborn piglets has been done on day 4th and 14th of birth. Separate arrangement for creep feeding of piglets has also been started from 2nd week to weaning. Newly born/young piglets have been provided with artificial heating arrangement. All animals were vaccinated against Swine Fever. Blood, faeces, nasal samples and skin scrapping of infected pigs use to be sent to Pathology, Microbiology and Parasitology departments to find out the causative agents. Other sanitary and bio-security measures are being followed as per the standard procedure.

Fig. 10: Dry/Pregnant Females (Zovawk) at CAU centre

SASARD Centre, Medziphema

This centre is maintaining Nagaland Indigenous pig and Hampshire boars. The centre continued with the production of piglets mainly of Nagaland indigenous TenyiVo, Upgraded pigs and Hampshire pigs. Average litter size and litter weight (kg) of local Upgraded variety at birth is 7.00±2.70 and 4.16±1.60, respectively. However, average litter size and litter weight (kg) of upgraded variety at weaning is 5.47±2.35 and 25.19±10.24, respectively. Pre and post weaning mortality rate of Nagaland indigenous TenyiVo were nil. However in crossbred mortality was observed. Maximum mortality occurred during rainy season and extreme cold. There was no mortality in the case of adults. The major causes of mortality were found to be anorexia, crushing, enteritis, hypoglycemia/ hypothermia and still birth. Regular and timely vaccination is being carried out strictly for the animals.

Fig. 11: Newly born piglets upgraded Tenyi Vo

Fig. 12: Female Tenyi Vo with two days old Upgraded suckling piglets

MEGA SEED PROJECT ON PIG

Rapid urbanization has resulted in increased demand for quality pork production. However, due to major constraints like non-availability of superior quality seed stock, low cost feed ingredient, imbalanced ration, at reasonable price, unscientific management, lack of financial support as well as marketing channel etc. the growth and development of the piggery sector is affected. Therefore, an attempt was made by launching Mega seed Project on Pig in 4 centers where pig plays a vital role with an idea to produce and supply quality swine germplasm to local farmers. Under this project improved variety of piglets were produced and distributed to the farmers. A total of 1388, 2268 and 2877 nos. of improved variety of piglets were produced and distributed during 2010-11, 2011-12 and 2012-13 respectively.

AAU Centre, Guwahati

In this centre, three genetic groups viz. 50% Hampshire, Ghungroo and T&D are maintained under the Mega Seed Project on Pig. The genetic groups are quite popular among the farmers and there is a demand for quality piglets. The average litter size at birth was found as 8.11±0.15, 8.00±0.50, 8.14±0.23, respectively for the 50%H, Ghungroo and T&D genetic groups. The average Litter size at weaning was found as 7.86±0.17, 7.73±0.52, 7.84±0.26 respectively for the three genetic groups of pig. A total of 978 piglets were produced under Mega Seed Project. Out of which 776 piglets and 97 adult pigs of different categories were sold. The overall pre weaning and post weaning mortality were recorded as 3.33% and 1.12% during the reporting period.

Fig. 13: Breeding Gilts, T&D

Fig. 14: T&D sow with piglets

BAU Centre, Ranchi

Jharkhand is one of the leading states in the country where piggery sector has been accepted by rural people as remunerative enterprises. MSP on pig supplying improved variety of pig T&D to the farmers and gradually farmers are interested to rear this variety because of 5-6 times benefit in comparison to desi pigs under village management conditions resulted into progressive increases in the number of pig breeders.

Approximatly more than 250 pig breeders have been developed which are supplying improved germplasm of pig to the neighboring farmers. The breeding experiments of new breed of black pig named "T & D" was developed by this centre. The total number of piglets produced during the reporting period was 804. Out of which 485 piglets were sold.

ICAR RC for NEH Centre, Nagaland

Among various livestock, pig alone accounts for 48.4% of total livestock population in Nagaland. However, a wide gap between the demand and availability of pork still exists mainly due to rearing of non-descript local pigs which have poor growth and production. Large Black and Ghungroo pigs are maintained in this centre. A total of nine pig breeding unit were established under different ongoing projects at the institute. The performance was evaluated. Till the end of the reporting year, a total of 546 numbers of piglets born out of which 347 numbers of animals were sold by the centre to different beneficiaries such as farmers, KVK's, NICRA Project and NAIP Project Dimapur and Pig breeding Unit Dimapur.

Fig. 15: Ghungroo sow with newly born piglets

Fig. 16: Hampshire grower pig

State Vety. Dept. Centre, Aizawl

The Mega Seed Project on Pig, Mizoram Centre maintains Large White Yorkshire pigs. The centre produced 379 piglets and sold 348 piglets during the reporting period. Vaccination of all pigs with Swine Fever Vaccine obtained from IVRI was performed through Department of A.H& Vety. Govt.of Mizoram. Pig mortality during the reporting period was 11% and the cause was mainly due to piglet scours aggravated by severe cold winter and decreased milk production of some Sows. The average litter size at birth and weaning was 8.5 and 7.5 respectively. The average birth weight and weaning weight was 1.3 and 10 kg. During the reporting period various individual farmers and under-mentioned group of farmers visited the farm for practical training and demonstration purposes.

Fig. 17: LWY pigs at Mega Seed centre of Mizoram

KVK ACTIVITIES

Training

KVK Goalpara organized a total of 59 need-based trainings under various disciplines for which need assessment was done discipline wise and training programmes were conducted accordingly. Among these trainings, 8 nos. were conducted under Animal Science, 21 nos. under Horticulture, 11 nos. under Soil and Water Conservation Engineering (SWCE), 14 nos. under Soil Science and 10 nos. under Home Science section. A total of 1958 trainees attended the trainings out of which 1188 were male and 770 were female trainees. Again the total trainee population comprised of 17 nos. of SC, 1650 nos. of ST, 258 nos. of OBC and 33 nos. from other communities.

OFT on off season cultivation of bottle gourd under open condition

Bottle gourd is an important vegetable crop in Goalpara district of Assam which is generally cultivated in the Kharif season. But it can also be cultivated well in the winter season. Keeping this in view, it was proposed to carry out an OFT on "Off season cultivation of bottle gourd under open condition" in the KVK farm for profit maximization and sustainable crop production for the farmers. In this OFT, local variety was sown in the last week of October with a spacing of 1.5 m × 1.5m in an area was 264sqm under rain fed condition. No disease and pest incidence is observed till date. The programme is in progress.

Fig. 1. On off season cultivation of bottle gourd under open condition

OFT on planting geometry of Tomato

Tomato is one of the most popular vegetables grown throughout the Goalpara district. But it was observed that the farmers do not maintain proper spacing and therefore they do not obtain the maximum production and profit. Keeping this in view, an OFT on planting geometry of tomato with three different spacings i.e 30 cm × 30 cm, 45 cm× 45 cm and 60 cm× 60 cm was conducted. But unfortunately the programme was not successful due to moisture stress condition.

OFT on Use of Winnower for cleaning Paddy

Paddy needs to be cleaned after threshing. Traditional practice of cleaning is labourious and time consuming. An OFT on "Use of Winnower for cleaning Paddy" was undertaken to evaluate performance of hand operated Winnower developed at ICAR Research Complex for NEH Region, Umiam, for cleaning Paddy in Goalpara condition. Field capacity was 150 Kg/hr and cleaning efficiency 99%.

Fig. 2. Use of Winnower for cleaning Paddy

OFT on Use of Animal Drawn Potato Digger

Potato is an important Rabi crop. Traditional practice of Potato harvesting is mostly manual. Powrah is employed for digging in most of the cases. However, the sharp edge of powrah damages some percentage of tuber. Because of this, commercial cultivation becomes difficult. It was also observed that the process of digging is a labour intensive operation. An OFT on "Use of Animal Drawn Potato Digger" was started to overcome these difficulties. Animal Drawn Potato Digger developed at Central Institute of Agriculrural Engineering (CIAE), Bhopal is being tested for potato digging in farmers' field in Goalpara district. Field capacity of the animal drawn potato digger was 0.32 ha/hr against 0.004 ha/hr in manual digging. Field efficiency was 99% and spoilage was nil. Labour requirement was 63.25 man-h/ha while using Potato digger against 243.75 man-h/ha in manual digging leading to 285.37% time saving.

Fig. 3. Use of Animal Drawn Potato Digger

OFT on Use of Improved Sickle for drudgery reduction

Women constitute about 30% of the total agricultural workers and perform all sorts of tasks. Weeding, sowing, dibbling, harvesting, threshing etc. are the important farm activities performed by the women in maximum number. Harvesting of cereal crops is mostly done by women with sickles. It is generally stated that an Improved Sickle reduces drudgery during harvesting. The serrated sickle facilitate cutting and require less effort. Thus to reduce the drudgery and to improve the productivity an OFT on Use of Improved Sickle was started. The Improved Sickle was developed by Central Institute of Agricultural Engineering (CIAE), Bhopal. The programme is in progress.

Fig. 4. Use of Improved Sickle for drudgery reduction

OFT on Integrated horti-fish farming

An OFT on Integrated horti-fish farming consisting of culture of fish and planting of Assam Lemon at pond dyke was started at three locations (two under Kuchdhowa Block and one under

Lakhipur Block) on February – March 2013. Fertilizers application at recommended doses for the first year was completed. Cultural operations such as training, pruning and mulching were completed. The plants were pruned at a height of 50 cm from ground keeping three primaries. The OFT is in its second year of progress.

Fig. 5. OFT on Integrated horti-fish farming

OFT on Polythene Mulching in Pineapple

Use of plastics in agriculture is very limited in this region. Mulching of Pineapple is important for soil moisture conservation, weed control and thereby enhancing production and productivity. 50µ black polythene is a suitable material for mulching Pineapple crop. Therefore use of 50µ black polythene is conducted to evaluate performance of the technology in farmers field in Goalpara condition. The farmers are provided hands on experience on plastic mulching for cultivation of Pineapple. The programme is in progress.

Fig. 6. Polythene Mulching in Pineapple

FLD on Processing of Carambola

Carambola production is very high in Goalpara district but due to lack of processing facilities and knowledge there is huge loss. To reduce the post harvest loss, farmwomen are provided technical know-how and inputs regarding home scale processing of fruits and vegetables. Processed products were prepared by farm women using Class I and Class II preservatives.The products prepared were Carambola Squash, Carambola jam, Carambola Sweet pickle and Carambola chilly pickle. The demonstration resulted in reducing the post harvest loss, nutritional availability of the fruit throughout the year and generated additional income for the family.

Fig. 7. Processing of Carambola

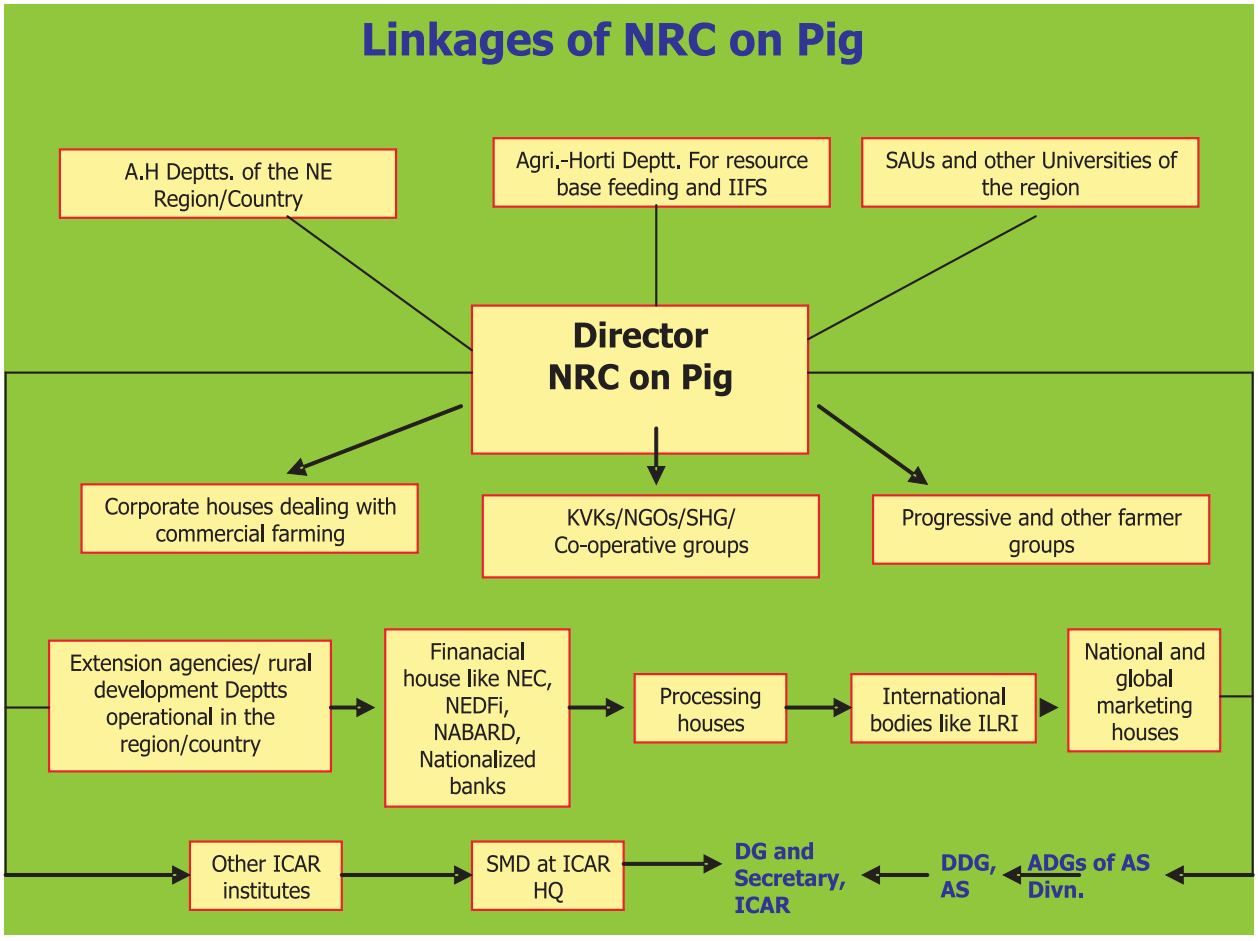
FLD on Pitcher Drip Irrigation in Banana

Traditional practice of Banana cultivating is mostly rainfed. Rainy season in this part of the country is from May till October only. During the remaining months of the year from November till April there is no or negligible rain and the crop has to bear severe water stress. This leads to reduction

in production and productivity of Banana. Therefore, to reduce the water stress and better production a FLD on "Pitcher Drip Irrigation in Banana" was undertaken in farmers' field in Goalpara district. In the pitcher drip irrigation technology, earthen pitchers are used for irrigating the Banana plants with little modification for facilitating drip of water. Drip irrigation has shown 50% gain in weight of bunch and subsequent gain of 40% additional income. A field day was conducted at the end of the programme.

Fig. 8. Pitcher Drip Irrigation in Banana

LINKAGE AND COLLABORATION



MEETINGS AND OTHER ACTIVITIES

Institute Management Committee meeting

10th Institute Management Committee meeting of the Institute was held on 20th July, 2013 under the Chairmanship of the Director, NRC on pig. Various agenda items were discussed in detail and the suggestions put forward by the committee members were incorporated in the proceedings of meeting.

10th IMC meeting of the Institute

Research Advisory Committee meeting

7th Research Advisory Committee meeting of the Institute was held on 21st August, 2013 under the chairmanship of Dr. K.M. Bujarbaruah, Hon'ble Vice-Chancellor, Assam Agricultural University. Other RAC members, Dr. S.C. Dubey, Ex-Joint Director, HSADL, Bhopal, Dr. S.K. Singh, Ex-Dean, College of Veterinary Sciences and Animal Husbandry, Ranchi and Dr. V.V. Kulkarni, Director, NRC Meat, Hyderabad and scientists of the Institute also attended the meeting. The briefing by the Director was followed by the presentations of research projects, carried out under different approved research programmes, by the Scientists of NRC on Pig. Each research project presentation was followed by comments from the Chairman and members of the RAC.

7th RAC meeting is in progress

Institute Research Council meeting

Institute IRC meeting was held under the Chairmanship of the Director during 24-25th September, 2013. Scientists of the Institute presented the progress of ongoing and completed research projects and each presentation was followed by deliberation and comments from the experts and the Chairman.

Interface meeting between ICAR and stakeholders

An Interface meeting was organized between ICAR and stakeholders for 'Identification

Interface meeting on 16th January, 2014

of critical issues on pig husbandry in North Eastern and Eastern states of India' on 16th January, 2014. Dr. K.M. Bujarbaruah, Hon'ble Vice-Chancellor, Assam Agricultural University was the Chief Guest and Dr. R. S. Gandhi, Hon'ble ADG (AP&B) was the Guest of Honour. Directors and Joint Directors of Animal Husbandry Departments, progressive pig farmers and entrepreneurs of eastern and north-eastern states participated in the meeting.

Inauguration of the administrative building of Krishi Vigyan Kendra (KVK), Goalpara

Dr. S. Ayyappan, Hon'ble Secretary, DARE and Director General, ICAR, inaugurated the Administrative building of Krishi Vigyan Kendra (KVK), Goalpara, Assam on 26th March, 2014. The Chief Guest of the function, Dr. S. Ayyappan, welcomed the farmers to the function and emphasized on the role of ICAR in general and KVK in particular in holistic support to agriculture and allied sectors through its farmers first approach. During the occasion, Dr. K.M.L. Pathak, Hon'ble DDG (Animal Sciences), Dr. S.V. Ngachan, Director, ICAR Research Complex for NEH region, Dr. S.N. Puri, Hon'ble Vice-Chancellor, Central Agricultural University and Dr. Apurba Chakravarty, Director of Research (Vety), AAU were also present to grace the occasion.

Inauguration of administrative building of KVK, Goalpara by Dr. S. Ayyappan, Hon'ble Secretary, DARE and DG, ICAR

The DG and other dignitaries planted coconut saplings in the KVK campus and also visited the exhibition organized on the sidelines of the event. About 200 farmers, staff of KVK, Scientists of NRC on Pig and other ICAR Institutes, personnel from line agencies, print and electronic media attended the inaugural function.

Workshop and Farmer Scientist Interaction:

The following workshop and Farmer Scientist interaction have been organized by the KVK, Goalpara during the reported year.

Workshop:

1) Pre seasonal Review workshop and Research Extension, Interface for Kharif 2013 under ATMA at Khanapara.

2) Annual Zonal Workshop of KVKs at CVSc, Khanapara during 28th to 30th May 2013.

3) Annual Action Plan workshop at CVSC. Khanapara during 12th to 14th Fabruary, 2014.

Farmer Scientist Interaction:

1) Programme organized by CSS-ATMA, Goalpara on 28th June, 2013

2) Farmer-Scientist Interaction organized in Krishak Samaroh, ATMA, Goalpara on 21st to 22nd July 2013

3) Farmer-Scientist Interaction organized in "Farm Innovators Day" at KVK on 19th August 2013

4) Farmer-Scientist Interaction organized in Foundation Day of NRC on Pig, Rani on 4th September 2013

5) Farmer-Scientist Interaction organized by ATMA, Goalpara on 11th & 12th Feb 2014.

In addition, the KVK also undertaken a collaborative programme on Farmers Training for "promoting Fisheries Technologies for Entrepreneurship Development in NE Region" under TSP, Govt. Of India with CARI, Port Blair.

Convergence

The KVK has developed linkages with the following organizations for implementation of various programmes.

1. State Institute of Rural Development, Assam for collaborative Action Research Programme.
2. Small Farmers' Agribusiness Consortium, New Delhi for consultancy on preparation of detailed project report for development of entrepreneurship.
3. District rural Development Agency, Goalpara for implementation of training and rural development programmes.
4. ATMA, Goalpara for implementation of RKVY, NHM and NFSM.
5. College of Vety. Science, AAU, Khanapara for collaborative research on animal nutrition.
6. Livestock Research Centre, AAU Hekera.
7. Regional Agricultural Research Station, AAU, Gossaigaon for development of location specific weather based agro-advisory capsule.
8. Horticultural Research Station, AAU, Kahikuchi, Guwahati for technology backstopping.
9. NABARD, Goalpara for formation of farmers Club and exposure visit for farmers.
10. Department of Sericulture, Govt. of Assam, Goalpara for extension programme in sericulture.

11. Rabha Hasong Autonomous Council for extension and rural development programmes.
12. Department of fisheries, Govt. of Assam, Goalpara for training and development.
13. Department of Veterinary an Animal Husbandry, Govt. of Assam, Goalpara for joint diagnostic service, training and development.
14. ICAR Research Complex for NEH Region, Barapani for technical collaboration.
15. All Boro Women Welfare Association for women empowerment programme.
16. All Rabha Women council, Goalpara, for women empowerment programme.
17. Indian Institute of Entrepreneurship for implementation of the DST funded Science and Technology Entrepreneurship Development Project.
18. Department of Agriculture, Govt. of Assam for selection of farmers, training and extension programmes.

CELEBRATIONS

Celebration of Institute Foundation Day

Institute celebrated its 12th Foundation Day on 4th September, 2013. Dr. Anubrata Das, former Director of the Institute was the Chief Guest on the occasion. Sri. I. Lokendra Singh, Commandant, 175 Bn CRPF, Rani also graced the occasion besides other dignitaries. Dr. Raju, Director, Family Welfare Centre, Manipur and Sri. L.M. Dey, SOS Village, Guwahati were the other Guests of Honour in the event. Chief Guest and the Guests of Honour also delivered speeches on the occasion followed by interaction of progressive farmers with Scientists and subject matter specialists of KVK on various aspects of livestock and agricultural issues. About 200 farmers including farm women, scientists and subject matter specialists participated in the interactive session. Various sporting events were also conducted in conjunction with the foundation day celebrations.

Glimpse of Institute Foundation Day Celebrations

Celebration of Independence Day

The Institute has celebrated the 67th Independence Day on 15th August, 2013 where all the staff members of the Institute actively participated.

Celebration of Independence Day at the Institute

Farm Innovation Day

Institute celebrated 'Farm Innovation Day' in collaboration with Zonal Project Directorate, Zone III, Barapani at KVK Goalpara on 19th August, 2013. The meeting was chaired by Dr. D.K. Sarma, Director, NRC on Pig. Dr. A.K. Gogoi, Zonal Project Director, Zone III gave a special address on the role of KVK in transforming the agricultural scenario of the state. An exhibition was organized with display of different adoptable technologies for the benefit of farmers. Farmer-scientists interaction meeting was also organized in which more than 100 progressive farmers and farm innovators attended.

Farm Innovation Day celebrated on 19th August, 2013

Celebration of Hindi Week

Hindi Week was celebrated from 23rd to 28th September, 2013. All the staff members of the Institute actively participated in various competitive events like typing, essay writing, debate, drawing, singing etc. and the winners of the events were awarded with cash prizes. Similarly Hindi divas was celebrated in the KVK located at Dudhnoi, Goalpara and all the staff of the KVK and 3 local leaders and 20 students from farm families participated in the programme.

Agricultural Education Day

'Agriculture Education Day' was celebrated on 3rd September, 2013. Prof. B.K. Konwar, Vice-Chancellor, Nagaland University was the Chief Guest on the occasion.

Agriculture Education Day celebrated on 3rd September, 2013

World Environment Day

Institute celebrated 'World Environment Day' on 5th June, 2013. Under the leadership of the Director, Institute staff actively participated in planting saplings in the campus.

Celebration of Vigilance Awareness Week

The Vigilance awareness week was celebrated from 27th October to 2nd November, 2013 with a pledge taking ceremony by all the staffs in presence of the Director and Vigilance officer. During the week, casual counseling had been carried out about the good points of the vigilance which needs to be maintained with honesty and dignity.

Celebration of National Science Day

National Science Day was celebrated at the Institute on 28th February, 2014. Dr. Kulendhu Pathak, Former Vice-Chancellor, Dibrugarh University was the Chief Guest on the occasion.

AWARD AND RECOGNITION

- Dr. D. K. Sarma, Director, NRC on Pig (ICAR), Rani, Guwahati has received an Award of Honour for his contribution to the field of Agriculture and allied activities offered by the Government of Punjab in association with PHD Chamber of Commerce & Industry in "Progressive Punjab Agriculture Summit-2014" held at Fateh Burj, Baba Banda Singh Bahadur War Memorial, Mohali w.e.f. 16th to 19th February, 2014.
- Dr. D. K. Sarma, Director, NRC on Pig (ICAR), Rani, Guwahati has received late Dr. B.L.Purohit Oration citation from KVP Vet Alumni association.
- Dr. Swaraj Rajkhowa, Senior Scientist, has undergone training as well as conducted a research programme on "Analysis of molecular diversity of *Salmonella* serovars from food and animal sources by use of DNA microarrays" in the School of Medicine, University of California, Irvine, USA for a period of 6 months with effect from 17th June'2013 to 16th December'2013.
- Dr. S. Naskar, Scientist has received Best Poster Award (first) for presentation entitled "Evaluation of Pig Rearing Farmers of North East India as Prospective Breeder: A Retrospective Analysis" in XIth National Symposium of Society for Conservation of Domestic Animal Biodiversity (SOCDAB) on "Harmonizing phenomics and genomics for sustainable management of livestock for upliftment of rural masses" (Feb 6-7, 2014)

at National Bureau of Animal Genetic Resources, Karnal, Haryana.

❖ Dr. S. Naskar, Scientist has received Best Publication Award – 2013, by Society for the Advancement of Human and Nature (SADHNA), Solan, Himachal Pradesh, India, for publication "Genetic Adaptability of Livestock to Environmental Stresses. *In:* Environmental Stress and Amelioration in Livestock Production. Sejian V, Naqvi SMK, Ezeji T, Lakritz J, Lal R (eds.), Springer-Verlag Berlin, pp. 317-378.

❖ Dr. R. Thomas, Scientist, has undergone training in the area of 'Smart Packaging' under Dr. Susan E. Selke, Professor & Associate Director, School of Packaging, Michigan State University, East Lansing, USA from 01st April, 2014 to 29th June, 2014 (90 days).

DISTINGUISHED VISITORS

Hon'ble Additional Secretary (DARE) & Secretary (ICAR) Shri. Arvind R Kaushal, along with Dr. S.N. Puri, Hon'ble Vice Chancellor, Central Agricultural University, Imphal visited the Institute on 18th April, 2013.

❖ Dr. Gaya Prasad, Hon'ble ADG (AH), ICAR visited the Institute and interacted with the scientists and technical staffs on the occasion of 'World Veterinary Day' celebrations held on 18th April, 2013.

❖ Dr. Gurbachan Singh, Hon'ble Chairman, ASRB, visited the Institute on 29th June, 2013. He took stock of activities going on at the Institute and appreciated the efforts made by the scientists in the area of pig production, health and product processing.

❖ Dr. S.K. Bandyopadhyay, Hon'ble Member, ASRB visited the Institute on 2nd October, 2013.

❖ Dr. R.M. Acharya, Ex-DDG (AS), ICAR visited and interacted with the scientists on 6th January, 2014.

❖ Dr. Charan Das Mahant, Hon'ble Union Minister of State for Agriculture and Food Processing, visited the Institute on 9th January, 2014. He took stock of activities going on at the Institute and interacted with the Scientists and other staff. The Minister acclaimed the strong progress made by the Institute during past few decades and appreciated the research efforts being made by the scientists benefiting the farmers in the area of pig production, health and product processing.

❖ Dr. Suresh Honnappagol, Hon'ble Animal Husbandry Commissioner, Govt. of India visited and interacted with the scientists on 4th February, 2014.

❖ Tejas Bhatt from Global Food Traceability Centre, Washington visited National Research Centre on Pig, Guwahati to discuss regarding food traceability on 06th February 2014.

KVK

- Dr. S.Ayyappan, Honourable Secretary, DARE Govt. of India and DG, ICAR
- Dr. K. M. L. Pathak, Deputy Director General (Animal Science), ICAR
- Dr. S. N. Puri, VC, Central Agricultural University, Imphal, Manipur
- Dr. S. A. Patil, Retd. VC, UAS Dharwad, Karnataka
- S. V. Ngachan, Director, ICAR Research Complex, Barapani, Meghalaya
- Dr. A. K. Gogoi, Zonal Project Director, Zone-III, ICAR, Barapani, Meghalaya.
- Dr. M. Premjit Singh, DEE, CAU, Imphal, Manipur

HUMAN RESOURCE DEVELOPMENT

Dr. Dilip Kumar Sarma, Director

- ❖ Attended Executive development programmes at NAARM, Hyderababad from 25-29th June 2014.
- ❖ Attended the National Seminar on Extension approaches for inclusive agricultural development of hilly tribal and backward areas at AAU, Khanapara, Guwahati on 20.8.2013.
- ❖ Attended Board of Management meeting at AAU, Jorhat on 27.8.2013 and 22.11.2013
- ❖ Attended the review meeting of the AICRP /AINP at NASC complex from 29-31 August 2013
- ❖ Attended the Annual Review meeting of the AICRP on Pig and Mega seed on pig at IVRI from 30.10.2013-31.10.2013 and presented the Project Coordinator report
- ❖ Attended a seminar organized by the Animal Resource Development Department' Govt. of Tripura ,Agartala from 28-29th December 2013 and presented an invited lecture on "Emerging and endemic diseases of pigs with particular reference to PRRS in India" .
- ❖ Attended the ICAR Directors conference at Baramati-Pune , Maharashtra on 19-20th January 2014.
- ❖ Attended group meeting, Chaired a technical session and presented a lecture on "Pig as a component of farming system for small and marginal farmers in India-potentialities and limitations" of AICRP on Integrated farming systems held at ICAR RC-NEH Umiam from 2-4th Dec.2013
- ❖ Attended the Progressive Punjab Agriculture Summit at Chappar Chiri, Mohali (Chandigarh),Punjab from 16-19th February 2014 and presented a paper entitled " Prospects and Challenges of intensive pig production in India" on 18.2.2014.
- ❖ Attended the Kisan Mela organized by the CPCRI, Guwahati on 21.2.2014.
- ❖ Attended and presented the Expenditure Finance Committee Meeting of NRC on Pig on 05.03.14.

Dr. M. K. Tamuli, Principal Scientist

- ❖ Attended Workshop on Alternate Agriculture at Chandigarh on 19th & 20th

April, 2013 organized jointly by the Department of Agriculture, Department of Animal Husbandry & Dairy and Department of Fishery under chairmanship of Hon'ble Chief Minister of Punjab, Sri Prakash Singh Badalji.

- Attended Institute Management Committee Meeting for National Research Centre on Yak, Dirang on 7th May, 2013 on the occasion of Silver Jubilee Year for developing road map for yak development in India.
- Attended the National Workshop on Outscaling Farm Innovation from 3-5 September' 13 at NASC complex and delivered leecture on "Innovation Adopted for Piggery Development in India."
- Attended 1st Assam International Agri-Horti Show, 2014 held at the College of Veterinary Science Play Ground, Khanapara, Guwahati-22 w.e.f. 9th & 10th January'14 and delivered a speech on 'Scaling up Artificial Insemination in Piggery Sector'.
- Attended NAIP sponsored National Training Workshop on 'Scientific Report Writing and Presentation' held at National Academy of Agril. Research Management, Hyderabad from 30th July to 3rd August, 2013.

Dr. S. Rajkhowa, Senior Scientist

- Attended National Symposium & XII Annual Conference of Indian Association of Veterinary Public Health Specialists held at the Department of Veterinary Public Health, College of Veterinary Science, Khanapara, Guwahati w.e.f. 4-5th February, 2014.
- Attended Annual Convention of Indian Society for Veterinary Medicine (ISVM) & International Symposium held in the Division of Veterinary Medicine, Faculty of Veterinary Sciences & Animal Husbandry, SKUAST, Jammu w.e.f. 14-16th February, 2014.
- Attended a seminar on topic "Strategies of Defensin-Mediated Innate Immunity in the Small Intestine" held on 4th December, 2013 in the University of California, Irvine organized by the Department of Microbiology & Molecular Genetics, School of Medicine, University of California, Irvine, USA.
- Attended a seminar on topic "Host, Germs and Steel: *Salmonella* and metal in the inflamed gut" held on 13th November, 2013 in the University of California, Irvine organized by the Department of Biological Chemiastry, School of Medicine, University of California, Irvine, USA.

Dr. S. Banik, Senior Scientist

- Attended National Symposium & XII Annual Conference of Indian Association of Veterinary Public Health Specialists held at the Department of Veterinary Public Health, College of Veterinary Science, Khanapara, Guwahati w.e.f. 4-5th February, 2014.
- AICRP/Megaseed project on Pig, review meeting at IVRI, Bareilly on 30 and 31st October, 2013.

Dr. K. Barman, Senior Scientist

- Attended 2nd National Conference of Indian Academy of Veterinary Nutrition and Animal Welfare held at SKUAST, Jammu from September 19th to 21st, 2013.
- Attended a training on preparation of chelated trace minerals at National Institute of Animal Nutrition & Physiology, Bangalore from 2nd to 8th Dec 2013.

Dr. Mohan, N.H., Senior Scientist

- Expert committee meeting on climatic change/sectoral innovation in Krishi Bhawan, New Delhi chaired by Secretary DAHD, Govt. of India on 10.04.13 in New Delhi.
- Regional committee meeting (Region III) at Assam Agricultural University, Jorhat from 17-18th April, 2013.
- AICRP/Megaseed project on Pig, review meeting at IVRI, Bareilly on 30 and 31st October, 2013.
- Invited lecture on Impact of weather and climate change in pig production and adaptation and mitigation strategies to improve pig production again climate change/variability scenario on 13.12.13 at CAADECCS, KVASU, Mannuthy, Thrissur, Kerala.
- Expenditure Finance Committee meeting of Seed Platform at meeting in ICAR HQ on 30.1.14.
- Expenditure Finance Committee Meeting of NRC on Pig on 05.03.14.
- Development of piggery in the state of Jharkhand in New Delhi on 10.3.14.

Dr. Girish, P.S. Senior Scientist

❖ Attended National Symposium & XII Annual Conference of Indian Association of Veterinary Public Health Specialists held at the Department of Veterinary Public Health, College of Veterinary Science, Khanapara, Guwahati w.e.f. 4-5th February, 2014.

Dr. Soumen Naskar, Scientist

❖ Attended National Symposium of Society for Conservation of Domestic Animal Biodiversity (SOCDAB) on "Harmonizing phenomics and genomics for sustainable management of livestock for upliftment of rural masses" (Feb 6-7, 2014) at National Bureau of Animal Genetic Resources, Karnal, Haryana.

❖ Attended National Seminar on "Recent Trends of Research in Science and Technology" and 59th Annual Technical Session of Assam Science Society (Mar 29, 2014), org. by Assam Science Society, hosted by Cotton College State University, Guwahati.

❖ Attended Annual Review Workshop of NFBSFARA (ICAR) (Jul 22-23, 2013), New Delhi (as CCPI).

❖ Attended ICAR sponsored Winter School on "Climate change and abiotic stress management in livestock: Basic concepts and amelioration measures" (Nov 05-25, 2013), organized by National Institute of Animal Nutrition and Physiology, Bangalore (as trainee).

Dr. R. Thomas, Scientist

- Undergone training in the area of 'Smart Packaging' under Dr. Susan E. Selke, Professor & Associate Director, School of Packaging, Michigan State University, East Lansing, USA from 01st April, 2014 to 29th June, 2014 (90 days).
- Participated and presented paper in National Symposium on 'One Health: Harnessing Biotechnology for Addressing Veterinary and Biomedical Concerns on Food Safety, Zoonoses and Environmental Sustainability' & XIIth Annual Conference of IAVPHS held at College of Veterinary Sciences, Khanapara from 4th to 5th February, 2014.

Dr. Seema Rani Pegu, Scientist

- Participated and presented a poster in the 4th Annual Review Meeting on DBT Network Project on Classical Swine Fever with special reference to North Eastern Region" held at College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati, Assam from 26-27th April, 2013.
- Participated and presented a poster in the National Symposium on "One Health" Harnessing Biotechnology for addressing Veterinary & Biomedical concerns on Food Safety, Zoonosis and Environmental Sustainability" & XII Annual Conference of Indian Association of Vety Public Health specialists held at College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati, Assam on 4th and 5th February, 2014.
- Two numbers of Animal Health Camps were organized on 22th January and 11th March, 2014 at village Batabari and Rajapanichanda, Rani respectively from NRC on Pig under TSP. A total of 97 farmers at Batabari and 118 farmers were participated in the Health camp and a package of essential medicines along with mineral supplements were provided to the farmers.

Dr. Gokuldas P.P., Scientist

- Participated in the Workshop on 'Technology Transfer Programmes in NEH States' organized by CIFT, Cochin held at NRC on pig (ICAR) on 10th July, 2013.
- Participated in 'Agri-Tech Investors Meet' at the NASC Complex, New Delhi organized through NAIP to showcase and publicize agro-technologies developed in ICAR/NARS system, during 18-19th July, 2013.
- Attended two days Workshop for SAS Nodal officers under NAIP consortium "Strengthening Statistical Computing for NARS" held at ICAR RC NEH, Barapani, from 4th to 5th December, 2013.

Dr. H. Choudury, SMS, Animal Science, KVK

- Attended training on National Group meeting (Kharif 2014) of AICRP on Forage at SK Rajasthan Agricultural University, Bikaner on 7th and 8th March, 2014.z

WORKSHOP/SYMPOSIA/TRAININGS ORGANIZED

- Workshop on 'Technology Transfer Programmes in NEH States' organized by CIFT, Cochin was held in the Institute on 10th July, 2013. Dr. S.V. Ngachan, Director, ICAR-RC for NEH region, was the Chief Guest of the occasion.
- Farmers' training-cum-workshop on piggery management' was organized under the NAIP sub-project 'Value chain on Novelty Pork products under organized pig farming system' in Nahira Village, Bejoynagar on 30th January, 2014. Dr. R. Ezekiel, National Coordinator, NAIP Component-II was the Guest of Honour. During the workshop, Farmer-scientists interaction meeting was also organized in which more than 150 progressive farmers and farm innovators actively participated.

Farmers' training-cum-workshop on piggery management' under NAIP project

- A training on 'Piggery Development with special emphasis to Artificial Insemination' was organized during 1-8th July, 2013. The training was sponsored by Punjab Veterinary Council, Chandigarh for ten selected Veterinary officers from the state.

Training on AI for the Veterinary officers of the state of Punjab

- Two more training programmes on 'Artificial Insemination in pig' sponsored by Punjab Veterinary Council, Chandigarh was organized during 3-10th August and during 21st to 28th October, 2013 for batches of 10 selected Veterinary officers in each. During the last training programme , one associate Professor from CAU, Imphal had also undergone training.

- Animal Health Camps were organized on 22nd January and 11th March, 2014 at Batabari and Rajapanichanda villages, Kamrup, respectively. The health camps

were organized under Tribal sub-plan (TSP) and a total of 97 farmers at Batabari and 118 farmers in Rajapanichanda participated in these health camps.

Animal Health Camp in Batabari village

Animal Health Camp in Rajapanichanda village

- 'One day training programme on Scientific pig management' was organized in Batabari village on 15th March, 2014. The event was organized under NAIP project-'Value chain on Novelty Pork products under organized pig farming system'.

Training programme on 'Scientific pig management' in Batabari village

- Three days training cum outreach programme on "promoting scientific aptitude through exposure training" was conducted under DBT sponsored Institute Biotech Hub (IBH) programme on 5th, 7th and 10th March, 2014. Approximately 100 students of three schools were given an exposure visit to laboratory, farm and slaughter house facility of the Institute for increasing scientific aptitude.

Training under Institute Biotech Hub

RESEARCH PROGRAMMES AND PROJECTS

Institutional Projects

Animal Genetics and Breeding

- Development of suitable crossbred pig

Animal Reproduction

- Standardization and preservation of boar semen for AI Technology
- Hormonal and nutritional interventions for improving reproductive performance in pigs

Animal Physiology

- Study of endocrine profile in indigenous pigs
- Development of lipid-based technique(s) for improved preservation of boar semen

Animal Nutrition

- Growth performance of poultry and pig as influenced by phytase supplementation in Eastern Region
- Dietary manipulation and feeding management for economic swine production

Livestock Production and Management

- Validation of Improved Pig Production Technologies at Farmers' Field Livestock Products Technology
- Assessment of carcass and meat quality of indigenous pigs (Gunghroo & Meghalaya Local) and their crosses in comparison to improved pig breeds (Duroc and Hampshire)

Animal Health

- Epidemiological studies on important diseases of pig
- Sero-prevalence study on important viral diseases associated with porcine reproductive disorders

Externally Funded Projects

- Regulation of Fatty Acid Synthesis by RNA Interference in Pig (Funded by NFBSFARA)
- Deciphering the effect of Environmental Stressors on pig growth and reproduction through bio-molecular means and development of seasonally required support system for piggery sector (DBT)
- Establishment of Biotech hub (DBT)
- Value Chain on Novelty Pork Products under Organized Pig Farming System- (NAIP)
- Molecular characterization, antimicrobial resistance and virulence typing of *Pasteurella multocida* isolates from clinically healthy pigs and pigs with atrophic rhinitis and pneumonic pasteurellosis (DBT)
- Refinement, standardization and popularization of value added pork products suited to NE India (MFPI)
- Augmenting clean pork production and value addition in NE India (DBT)
- Developing guidelines/standards for export of fresh pork from India (APEDA)
- Evaluation of physio-genomic responses to heat stress and development of potential marker(s) for assessment of stress in pigs (DBT)

TECHNOLOGY DEVELOPED

- Developed suitable crossbred pig for propagation in farmers' field.
- Developed technology for successful production of piglets through non-surgical embryo transfer.
- Developed a cost-effective method for estrus induction and synchronization in pre-pubertal gilts.
- Developed and popularized Artificial insemination technology in pigs.
- Developed good management package of practice for different breeds of pigs.
- Developed 14 different value added pork products (viz. hot dogs, cocktail, ham, nuggets, salami of different flavor and taste) and are being marketed in all the states in NE region under the brand name 'Choice Pork Natural' through over 170 retail outlets.
- Prepared brush from pig bristle/hair
- Developed a novel multiplex PCR for simultaneous detection of three most important pathotypes of *E. coli* (ETEC, STEC and AEEC) from diarrhoeic piglets, novel simplex PCR for rapid detection of toxigenic strains of *Pasteurella multocida* (the causative agent of atrophic rhinitis in pigs) and 10 most important virulence associated genes (VAGs) of *P. multocida*

PERSONALIA

NRC ON PIG

SCIENTIFIC STAFF

Dr. Dilip Kumar Sarma, Ph.D., Director & Project Coordinator

Dr. Madan Kumar Tamuli, Ph.D., Principal Scientist (Animal Reproduction)

Dr. R. K. Mahapatra, Ph.D., Senior Scientist (Animal Physiology)

Dr. Swaraj Rajkhowa, Ph.D., Senior Scientist (Veterinary Medicine)

Dr. Santanu Banik, Ph.D., Senior Scientist (Animal Genetics & Breeding)

Dr. Keshab Barman, Ph.D., Senior Scientist (Animal Nutrition)

Dr. Mohan N. H., Ph.D., Senior Scientist (Animal Physiology)

Dr. R. Pourouchottamane, Ph. D., Senior Scientist (LPM)-up to 08/11/2013

Dr. Girish, Patil S., Ph. D. Senior Scientist (Livestock Products Technology)

Dr. Soumen Naskar, Ph.D., Scientist (Animal Genetics & Breeding)

Dr. Rajendran Thomas, Ph.D., Scientist (Livestock Products Technology)

Dr. Seema Rani Pegu, Ph.D., Scientist (Veterinary Pathology)

Dr. Gokuldas PP, MVSc. (Animal Reproduction)

TECHNICAL STAFF

Dr. Purabi Kaushik, Ph.D., Assistant Farm Manager (T-4)

Dr. Anil Kumar Das, Assistant Farm Manager (T-3)

Dr. Gagan Bhuyan, Assistant Farm Manager (T-3)

Shri Siba Chandra Deka, Driver (T-2)

Shri Kailash Choudhury, Technical Assistant, (T-1)

Shri Rana Pratap Kakati, Technical Assistant, (T-1)

ADMINISTRATIVE STAFF

Smt. June Dhkar, AO

Shri. B.P. Dey, AAO- up to 30.06.2013

Shri. P.K. Nayak, AF & AO

Shri. Uttam Prakash, Assistant

Ms. Laxmi Kumari, Assistant

Shri Utpal Ghosh, Upper Division Clerk

Smt. Jonali Nath, Lower Division Clerk

Ms. Hira Moni Thakuria, Jr. Stenographer

SUPPORTING STAFF

Shri Naren Chandra Deka, Skilled Supporting Staff

Shri Ratul Baishya , Skilled Supporting Staff

KVK, DUDHNOI

Dr. U. K. Baruah, Ph. D., Programme Coordinator (Discipline: Aquaculture)

Dr. Hitu Choudhury, SMS, Animal Science (T-6)

Mr. Biswajit Dey, SMS, Horticulture (T-6)

Mr. Utpal Kumar Bhattacharyya, SMS, Plant Protection (T-6), (On Study Leave)

Mr Hari Charan Kalita, SMS, Agronomy (T-6), (On Study Leave)

Mr. Jyotish Barman, SMS, Fisheries (T-6), (On Study Leave)

Dr. Popiha Bordoloi, SMS, Soil Science (T-6)

Er. Benjamin Kaman, Programme Assistant, Soil & Water Conservation Engineering (T-3)

Mrs. Minakshi Barah Kaman, Programme Assistant, Home Science (T-3)

Mrs. Mousumi Bhuyan, Programme Assistant, Horticulture (T-3)

Mr. Ashit Biswas, Office Superintendent cum Accountant.

Ms. Kabyawati Rabha, Junior Stenographer cum Computer Operator

Mr. Mrinal Baruah, Driver (T-2)

Mr. Jayanta Choudhury, Tractor Driver cum Mechanics (T-1)

Mr. Jitumani Kalita, Skilled Supporting Staff

Mr. Dhruba Lachan Rabha, Skilled Supporting Staff

PUBLICATIONS

RESEARCH ARTICLES

- Badyal N, Das A, Naskar S, Roy TC, Nath KC, Das B, Magotra A, Pourouchottamane R, Pankaj PK. (2013). Molecular characterization of halothane (*hal*) gene in indigenous pigs. *Veterinary Practitioner* 14(1):28-29.
- Banik, S., Pankaj, P.K., Pourouchottamane, R., Naskar, S., Barman, K., Tamuli, M.K. and Das, A. (2013). Evaluation of transport stress on grower pig and its management. *Indian Journal of Animal Production and Management*. 29(3-4):79-81.
- Barman,K., Das,A. and Bora,S.(2013). Effect of feeding different level of protein and energy on performance of crossbred (HampshirexGhungroo) starter pigs. *Indian Veterinary Journal*. 90(4):36-37.
- Barman, K., Das, A., Thomas, R. and Banik. S. (2014). Effect of replacement of maize with water hyacinth (*Eichhornia crassipes*) foliage on nutrient utilization in crossbred (Hampshire X Ghungroo) grower pigs. *Indian Journal of animal Science* (*Communicated*).
- Barman,K., Gupta,J.J., Dey,A., Das,A., Tamuli M.K., Thomas,R. and. Sarma,D.K. (2014). Effect of phytase supplementation on performance of crossbred (Hampshire x Ghunghroo) pigs fed on rice polish base diet, *Indian Journal of Animal Nutrition* (Communicated).
- Barman, K., Tamuli,M.K., Banik, S., Mahapatra, R.K., Thomas, R., Bhuyan, G. (2013). Effect of Replacing Maize with Sugar Beet on Performance of Cross Bred (Hampshire x Ghungroo) growing pigs. *Indian Journal of Animal Nutrition* (*Communicated*).
- Barman,K.,Tamuli,M.K., Das,A. and Das, H.K. (2013). Effect of replacement of concentrate with aerial part of colocasia (*Colocasia esculenta*) on growth and nutrient utilization in crossbred (HS X GH) grower pig. *Animal Nutrition and Feed Technology* .13:311-315.
- Borah S, Sarmah BC, Chakravarty P, Naskar S, Dutta DJ, Kalita D. (2014). Effect of zinc supplementation on certain serum biochemicals in grower pig. *Journal of Applied Animal Research 42(2):244-248*.
- Borah S, Sarmah BC, Chakravarty P, Naskar S, Dutta DJ, Kalita D. (2014). Effect of zinc supplementation on growth, reproductive performance, immune and endocrine response in grower pigs. *Indian Journal of Animal Sciences* 84(2): 186–190.
- Deka Devajani, Phukan A., Sarma, D. K. (2013). Epidemiology of parvovirus and coronavirus infections in dogs in Assam. *Indian Vet. J.* 90:49-51.
- Deka, Devajani, Phukan,A. and Sarma,D.K (2014). Diagnosis of canine viral gastroenteritis. *Indian Vet. J.* 91:36- 39.
- Gokuldas, P.P., Tamuli, M.K., Mohan, N.H., Barman, K., Chutia, T. and Mahapatra, R.K. (2013). Farrowing response and piglet viability following Cloprostenol-induced farrowing in Duroc sows with prolonged

gestation. *Journal of Applied Animal Research* (Accepted).

- Kaushik,P., Handique, P.J., Rahman,H., Das,A., Das,A.K. and Bhuyan, G.(2013). Pre-weaning growth performance of Pure and Crossbred Pigs under organized farm condition in Assam. International Journal of Engineering, Science Invention: 2 I : 10-12.
- Khan,K., Rastogi,A., Barman,K., Sharma,R.K. and Bashir,Y. (2014). Effect of feeding mixed silage of oat fodder and jamun leaves on nutrient utilization in goats, *Indian Journal of Animal Sciences.* 84 (1): 85–87.
- Kumar, K., Singh, R., Ranjan, R., Yasotha, T., Singh, R.K., Kumar, M., Bhanja, S.K., Mohan,N.H. and Bag, S. (2013). Effect of "extract egg" in development of parthenonogenetic caprine embryo. *Indian Journal of Animal Sciences.* 83 (4): 377–378.
- Mohan, N.H., Debnath,S., Mahapatra, R.K., Nayak, L.K., Baruah,S., Das,A., Banik, S. and Tamuli, M.K. (2014). Tensile properties of hair fibers obtained from different breeds of pigs. *Biosystems Engineering.* 119:35–43.
- Mohan, N.H., Nayak, L.K., Tamuli, M.K. and Das, A. (2014). Pig hair fiber utilization in India: Present status and future perspectives. *Indian Journal of Animal Sciences* .84 (2): 99–102.
- Nath, B.G., Chakraborty,A., Sarma,D.K., Rahman,T. and Boro,P.K. (2013). Seroprevalence of hepatitis A virus infection in non-human primates in Assam, India. Journal of Threatened taxa 5(12)4722-4724.
- Naskar S, Deb SM, Kumar S, Niranjan SK, Sharma D, Sakaram D, Sharma A. (2014). Molecular characterization of T cell receptor-zeta subunit (TCR-ζ; CD247) gene in buffalo (*Bubalus bubalis*). *Journal of Applied Animal Research 42(1):38-43.*
- Naskar S, Mandal GP, Borah S, Vashi Y, Thomas R, Dhara SK. (2014). Evaluation of fatty acid profile in subcutaneous adipose tissue of indigenous and crossbred pigs. *Indian Journal of Animal Sciences* 84(1): 88–90.
- Rajkhowa, S., Kalita, C. and Sarma, D.K. (2014): Enterotoxigenic and attaching and effacing *Escherichia coli* strains in diarrhoeic piglets and their antibiogram. Accepted for publication in *Philippine Journal of Veterinary Medicine.* 51:30-37.
- Rajkhowa, S., Pegu, S.R., Sarma, D.K., Kalita, C. and Das, J.P. (2014). Detection of *Staphylococcus hyicus* associated with greasy pig disease by polymerase chain reaction and their antibiogram. Accepted for publication in *Indian Veterinary Journal.*
- Rajkhowa, S. and Sarma, D.K. (2014). Prevalence and antimicrobial resistance of porcine O157 and non-O157 Shigatoxin-producing *Escherichia coli* from India. *Tropical Animal Health and Production.* DOI 10.1007/11250-014-0587-4
- Roychoudhury, P., Sarma, D.K., Rajkhowa S., Muhammad Munir and Kuchipudi Suresh V (2014) Predominance of genotype 1.1 and emergence of genotype 2.2 classical swine fever viruses in North Eastern Region of India.*Transboundary and Emerging Diseases* (Accepted)
- Sahoo, N.R., Banik, S., Pankaj, P.K. and Sahoo, M. (2013). Cytogenetic architecture

of Niang Megha pigs. *Indian Veterinary Journal*. 90 (12):59-61.• Pankaj, P.K., Pourouchottamane, R., Mahapatra, R.K., Banik, S., Sahoo, N.R., Das, A. and Tamuli, M.K. (2013). Quantitative and qualitative estimation of milk in Ghungroo sows. *Indian Veterinary Journal*. 90 (4): 140-141.

- Sahoo NR, Das A, Naskar S, Tamuli MK, Mukherjee A, Mukherjee S, Longkumer I. (2013). Chromosomal profile of Ghungroo breed of pig. *Indian Veterinary Journal,* 90(9): 77-79.
- Sakaram D, Deb SM, Naskar S, Niranjan SK, Mitra A, Kumar S, Sharma A. (2013). PCR-RFLP studies in exon 2 and 3 of buffalo MHC class II (BuLA) DYA gene. *Indian Veterinary Journal* 90(4):80-82.
- Sakaram D, Deb SM, Niranjan SK, Naskar S, Mitra A, Kumar S, Sharma A. (2013). PCR-RFLP studies on exon 2 and 3 of MHC class II DRA gene in Murrah buffalo. *Indian Veterinary Journal* 90(6):49-51.
- Sonwal, S., Barua, A.G., Hazarika, R.A., Rajkhowa, S. Barua, C.C. and Bhattacharya, D.K. (2014). Detection of glutamate dehydrogenase gene (*gdh*) of *Streptococcus suis* isolated from pigs. *Indian Journal of Animal Sciences*. 84 (3):287-288.
- Pankaj, P.K., Pourouchottamane, R., Barman,K., Sahoo, N.R., Banik, S. and Venkatasubramanian, V.(2013). Standardization of weaning in Ghungroo pigs. *Indian Veterinary Journal*. 90 (6): 69-71.
- Pankaj, P.K., Pourouchottamane, R., Sahoo, N.R. Banik, S., Jain, R.and Venkatasubramanian, V. (2013). Standardization of weaning in Niang megha pigs. *Indian Veterinary Journal*. 90 (7): 50-51.
- Pankaj, P.K., Pourouchottamane, R., Banik, S., Tamuli, M.K., Naskar, S. and Das, A. (2013). Sexual separation and growth rate in Ghungroo pig. *Indian Journal of Animal Production and Management.* 29(3-4):72-74.
- Pourouchottamane, R., Pankaj, P.K., Banik, S., Naskar, S., Tamuli, M.K. and Das, A. (2013). Response of pigs to thermal stress under intensive system of rearing. *Indian Journal of Animal Production and Management*. 29(3-4):75-78.
- Thomas, R., Jebin,N.Tamuli,M.K. and Sarma,D.K. (2013). Bamboo shoot extract-a potential natural preservative for pork nuggets at refrigeration temperature (4+10C) storage. *Fleisch Wirtchaft International* 2: 70-78.
- Thomas,R., Jebin,N.,Barman,K. and Das,A. (2014). Quality and shelf life evaluation of pork nuggets incorporated with fermented bamboo shoot (*Bambusa polymorph*a) mince. *Meat Science*.96: 1210-1218.

ABSTRACTS

- Banik, S., Naskar, S., Pankaj, P.K., Pourouchottamane, R., Barman, K., Mohan, N.H. and M.K. Tamuli. (2014). Understanding piglet mortality under changing climatic scenario of northeastern India. National Symposium on Heath harnessing biotechnology for addressing veterinary and biomedical concerns on food safety, zoonoses and environment sustainability and XII annual conference of Indian Association of Veterinary and Public Health Specialist (IAVPHS). College of

Veterinary Sciences, Assam Agricultural University, Guwahati. 204.• Barman, K., Das, A., Tamuli, M.K., Bora, S. and Sarma, D.K. (2013). Effect of feeding different levels of protein and energy on performance of cross bred (HampshirexGhungroo) finisher pigs. In: Proceeding of 2nd National Conference of Indian Academy of Veterinary Nutrition and Animal Welfare .FVSc & AH, SKUAST-Jammu, RS Pura, Jammu. 149. w.e.f.

- Barman, K., Tamuli, M.K., Mahapatra, R.K., Thomas, R., Das, A., Bhuyan, G. and Sarma, D.K. (2013). Effect of replacing maize with sugar beet on performance of crossbred (Hampshire x Ghungroo) growing pigs. In: Proceeding of 2nd National Conference of Indian Academy of Veterinary Nutrition and Animal Welfare , FVSc & AH, SKUAST-Jammu, RS Pura, Jammu.160.
- Barman, K., Thomas, R., Tamuli, M.K., Banik, S., Mahapatra, R. K., Gokuldas, P.P., Bora, S. and Das, A. (2013). Effect of maize replacement with steam fleck rice by-products (SFRB) on growth and nutrient utilization in finisher crossbred (Hampshire X Ghungroo) pigs. In Book of Abstracts, 2nd National IAVNAW Conference. Sher-e-Kashmir University of Agricultural Science and Technology of Jammu and Indian Academy of Veterinary Nutrition and Animal Welfare. Jammu, Jammu and Kashmir.150.
- Barman, K., Thomas, R., Tamuli, M.K., Banik, S., Mahapatra, R. K., Gokuldas, P.P., Bora, S. and Sharma, D.K. (2013). Effect of replacing maize with bakery waste on performance of growing crossbred (Hampshire X Ghungroo) pigs. In Book of Abstracts, 2nd National IAVNAW Conference. Sher-e-Kashmir University of Agricultural Science and Technology of Jammu and Indian Academy of Veterinary Nutrition and Animal Welfare. Jammu, Jammu and Kashmir. 159.
- Borah S, Naskar S, Konwar P, Sarmah BC, Goswami J, Dhara SK, Thomas R, Vashi Y, Mahapatra RK, Das AK. 2014. Steroid and metabolic hormonal profile of porcine serum vis-a-vis follicular fluid. *In:* Proceedings of International Conference on Reproductive health: Issues and strategies under changing climate scenario and 24th Annual Meeting of Indian Society for the Study of Reproduction and Fertility (Feb 6-8, 2014), org. at IVRI, Izatnagar, UP. pp. 93.
- Begum, S., Hazarika, G.C. and Rajkhowa, S. (2014). Antibiotic sensitivity pattern of Shiga toxin producing Escherichia coli from pigs and cattle. Presented in National Symposium & XII Annual Conference of Indian Association of Veterinary Public Health Specialists held at the Department of Veterinary Public Health, College of Veterinary Science, Khanapara, Guwahati w.e.f. 4-5th February, 2014.
- Borah S, Naskar S, Sarmah BC, Goswami J, Thomas R, Vashi Y, Dhara SK. (2013). Steroid and metabolic hormonal profile of porcine follicular fluid. *In:* National Symposium on "Physiological and nutri-genomic interventions to augment food security and animal welfare" and XXII Annual Conference of Society of Animal Physiologists of India (SAPI) (Nov 19-21, 2013), org. at College of Veterinary Science and Animal Husbandry, U. P. Pt. Deen Dayal

Upadhyaya Pashu Chikitsa Vigyan Vishwavidyalaya Evam Go-Anusandhan Sansathan, Mathura. pp. 37-38.

- Borah S, Naskar S, Vashi Y, Thomas R, Das AK, Chutia T, Tamuli MK, Dhara SK. 2014. Comparative efficiency of indigenous and crossbred pigs as donor in embryo transfer programme. *In:* Abstracts and Souvenir of National Symposium on "Frontier reproductive biotechnologies for enhancing animal fertility and fecundity: Global perspective" and XXIX Annual Convention of ISSAR (Jan 8-10, 2014), org. by Maharashtra Animal & Fisheries Sciences University, Nagpur. pp. 354.
- Das, A. and Banik, S. (2013). Piggery based entrepreneurship development though participatory approach. In compendium of ICAR sponsored short course on Avenues for farmers' employment and agro-based entrepreneurship development. ICAR Research Complex for NEH Region, Nagaland Centre. Jharnapani, Medziphema, Nagaland. 171-176.
- Das, A., Pourouchottamane, R. and Banik, S. (2013). Pig Production System in North-East Hill Ecosystem – Climate Change Effect, Adaptation and Mitigation Strategies. ICAR Research Complex for NEH Region, Barapani, Meghalaya.
- Gokuldas, P.P., Tamuli M.K, Barman, K., Naskar, S., Thomas, R. and Chutia, T (2014). Evaluation of diagnostic accuracy of real-time ultrasound (RTU) imaging in swine pregnancy diagnosis. In: National Symposium on "Frontier Reproductive Biotechnologies for Enhanced Animal Fertility and Fecundity: Global Perspective " organized by The Indian Society for Study of Animal Reproduction (ISSAR) held at Nagpur Veterinary College, Nagpur .207.
- Gokuldas, P.P., Singh, S.K., Tamuli, M.K, Barman K., Naskar S., Thomas, R. and Agarwal S.K. (2014). Dietary modulation with Omega-3 fatty acids alter systemic IGF-1 levels during early gestation in multiparous sows .In: the National Symposium on "Frontier Reproductive Biotechnologies for Enhanced Animal Fertility and Fecundity: Global Perspective' organized by The Indian Society for Study of Animal Reproduction (ISSAR) held at Nagpur Veterinary College, Nagpur .210.
- Gokuldas, P.P., Tamuli, M.K, Mohan, N.H. Naskar, S.Thomas, R. and Tukheswar,C. (2014). Efficacy of low-dose gonadotrophin regimen for estrus induction and synchronization in pre-pubertal gilts. In the National Symposium on "Frontier Reproductive Biotechnologies for Enhanced Animal Fertility and Fecundity: Global Perspective' organized by ISSAR held at Nagpur Veterinary College, Nagpur .124.
- Gupta S, Mukherjee A, Srivastava L, Agarwal M, Mondal SK, Sarkar M, Bhure SK, Saha SK, Bag S, Maiti SK, Naskar S, Sharma B, Dhara SK. (2013). Bone marrow derived stem cells can be propagated for a prolonged period in culture. *In:* Proceedings of National Symposium on Emerging Trends in Biotechnology Research for Sustainable Animal Health and Productivity and XIX Annual Convention of Indian Society for Veterinary Immunology and Biotechnology (ISVIB) (April 8-10, 2013), IVRI, Izatnagar, UP. pp. 163.

- Kaushik P, Naskar S, Handique PJ, Rahaman H, Das AK, Das A. 2014. Molecular characterization of growth hormone releasing hormone gene in exotic and crossbred pigs. *In:* Souvenir cum Compendium of National Symposium on One health: harnessing biotechnology for addressing veterinary and biomedical concerns on food safety, zoonoses and environmental sustainability & XII Annual Conference of Indian Association of Veterinary Public Health Specialists (Feb 4-5, 2014), org. at College of Veterinary Science, Assam Agricultural University, Guwahati. pp. 322-323.
- Kaushik P, Naskar S, Handique PJ, Rahaman H, Das AK, Das A. 2014. Genetic Polymorphism of Growth Hormone Releasing Hormone Gene in Exotic and Crossbred Pigs. *In:* Compendium of XIth National Symposium on Harmonizing phenomics and genomics for sustainable management of livestock for upliftment of rural masses (Feb 6-7, 2014), org. at National Bureau of Animal Genetic Resources, Karnal, Haryana. pp. 173.
- Konwar P, Naskar S, Pankaj PK, Pourouchottamane R, Banik S, Borah S, Vashi Y, Mahapatra RK, Goswami J, Sarmah BC. 2014. Amelioration of thermal stress through shelter management as evidenced by reduced occurrence of piglet mortality in north east India. *In:* Proceedings of National Seminar on "New dimensional approaches for livestock productivity and profitability enhancement under era of climate change" and XXI Annual Convention of Indian Society of Animal Production and Management (Jan 28-30, 2014), org. at C.V.Sc.&A.H., AAU, Gujarat.
- Konwar, P., Naskar, S., Pankaj, P. K., Pourouchottamane, R., Banik, S., Borah, S., Vashi, Y., Mahapatra, R. K., Goswami, J. and Sarmah, B. C. (2014). Amelioration of thermal stress through shelter management as evidenced by reduced occurrence of piglet mortality in northeast India. National Seminar on New Dimensional Approaches for Livestock Productivity and Profitability Enhancement under Era of Climate Change & XXI Annual Convention of Indian Society of Animal Production & Management. College of Veterinary Science & Animal Husbandry, Anand Agricultural University, Anand, Gujarat.148.
- Naskar, S., Borah, S.,Vashi, Y., Thomas, R., Dhara, S.K. and Banik, S. (2014). Evaluation of pig rearing farmers of north east in India as prospective breeder: a retrospective analysis. In XI National Symposium on Harmonizing phonemics and genomics for sustainable management of livestock for upliftment of rural masses. Society of Domestic Animal Biodiversity. National Bureau of Animal Genetic Resources. Karnal, Haryana. 218.
- Naskar, S., Konwar, P., Pankaj, P.K., Pourouchottamane, R., Banik, S., Borah, S., Vashi, Y., Mahapatra, R.K., Goswami, J. and Sarmah B.C. 2014. Population dynamics of pig production system in northeast India. In XI National Symposium on Harmonizing phonemics and genomics for sustainable management of livestock for upliftment of rural masses. Society of Domestic Animal Biodiversity. National Bureau of Animal Genetic Resources. Karnal, Haryana.106.

- Naskar, S., Vashi, Y., Magotra, A., Banik, S., Sahoo, N.R. and Borah, S. (2014). Conventional Breeding to Marker Assisted Selection (MAS): Animal Science Perspective. In: Book of Abstracts, National Seminar on Recent Trends of Research in Science and Technology and 59th Annual Technical Session of Assam Science Society .Organised by Assam Science Society, hosted by Cotton College State University, Guwahati.162.
- Pankaj, P.K., Pourouchottamane, R., Naskar, S., Banik, S., Sahoo, N. R., Tamuli, M. K. and Das, A. (2014). Good management practices for improving profitability of pig production. National Seminar on New Dimensional Approaches for Livestock Productivity and Profitability Enhancement under Era of Climate Change & XXI Annual Convention of Indian Society of Animal Production & Management. College of Veterinary Science & Animal Husbandry, Anand Agricultural University, Anand ,Gujarat.58.
- Pankaj PK, Pourouchottamane R, Naskar S, Banik S, Sahoo NR, Tamuli MK, Das A. 2014. Good management practices for improving profitability of pig production. *In:* Compendium of National Seminar on "New Dimensional Approaches for Livestock Productivity and Profitability Enhancement under era of Climate Change" and XXI Annual Convention of Indian Society of Animal Production & Management (Jan 28-30, 2014), org. at College of Veterinary Science & Animal Husbandry, Anand Agricultural University, Anand, Gujarat. pp. 58.
- Pegu, S.R., Rahman, T. and Barman, N.N. (2013). Incidence of classical swine fever in pigs and its impact on economic aspects of tribal pig farmers of Assam. In :Souvenir cum compendium of National Seminar on Extension Approaches for Inclusive Agricultural development in Hilly,Tribal and Backward Areas held at College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati, Assam.
- Pegu. S.R., Rahman, T., Barman, N.N. (2013). Molecular and Immune-histochemical detection of classical swine fever virus infecting domestic pigs of Assam and Meghalaya. In: Souvenir cum compendium of Veterinary Pathology Congress and Satellite Seminar held at College of Veterinary Science, OUAT, Bhubaneswar.
- Pegu,S.R., Rahman, T. and Barman, N.N. (2013). Detection of classical swine fever virus in various types of clinical and post mortem samples by Single step Real Time PCR. In: Souvenir cum compendium of Veterinary Pathology Congress and Satellite Seminar held at College of Veterinary Science, OUAT, Bhubaneswar.
- Pegu, S.R., Rahman, T. and Barman, N.N. (2013). Chronic Classical swine fever virus infection in pigs and its immune-pathological effect on lymphoid tissues. In: Souvenir cum compendium of National Symposium on "One Health" Harnessing Biotechnology for addressing Veterinary & Biomedical concerns on Food Safety, Zoonosis and Environmental Sustainability" & XII Annual Conference of Indian Association of Vety. Public Health specialists held at College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati, Assam.

- Pouruchottamane, R., Ramesha, K.P., Pankaj, P.K., Murugan, M., Naskar, S. and Banik, S. (2014). Status and strategies for improved yak husbandry in India in context of changing climatic scenario. In Souvenir cum Lead paper of National Seminar on "New Dimensional Approaches for Livestock Productivity and Profitability Enhancement under Era of Climate Change" & XXI Annual Convention of Indian Society of Animal Production & Management. College of Veterinary Science & Animal Husbandry Anand Agricultural University, Anand, Gujarat. 458-469.
- Rajkhowa, S., Pegu, S.R., Sarma, D.K., Kalita, C. and Das, J. P. (2014). Virulence genes profiling and antimicrobial resistance of O157 and non-O157 Shigatoxin-producing *Escherichia coli* strains from pigs. Presented in National Symposium & XII Annual Conference of Indian Association of Veterinary Public Health Specialists held at the Department of Veterinary Public Health, College of Veterinary Science, Khanapara, Guwahati w.e.f. 4-5th February, 2014.
- Rajkhowa, S., Sharma, R.K., Rahman, H. and Sarma, D. K. (2014). Virulence genes profiling of *Pasteurella multocida* isolates from pigs. Presented in 32nd Annual Convention of Indian Society for Veterinary Medicine (ISVM) & International Symposium held in the Division of Veterinary Medicine, Faculty of Veterinary Sciences & Animal Husbandry, SKUAST, Jammu w.e.f. 14-16th February, 2014.
- Rajkhowa, S., Sahoo, N.R., Shakuntala, I., Pegu, S. R., Kalita, C. and Sarma, D. K. (2014). Molecular characterization and antimicrobial resistance of enterotoxigenic *Escherichia coli* and attaching and effacing *Escherichia coli* from diarrhoeic piglets. Presented in 32nd Annual Convention of Indian Society for Veterinary Medicine (ISVM) & International Symposium held in the Division of Veterinary Medicine, Faculty of Veterinary Sciences & Animal Husbandry, SKUAST, Jammu w.e.f. 14-16th February, 2014.
- Rajkhowa, S., Sahoo, N. R., Shakuntala, I., Sarma, D.K., Pegu, S.R., Kalita, C. and Das, J. P. (2014). Development of a novel multiplex PCR assay for simultaneous detection of three different pathotypes of *Escherichia coli* from diarrhoeic piglets and its application to field isolates. Presented in National Symposium & XII Annual Conference of Indian Association of Veterinary Public Health Specialists held at the Department of Veterinary Public Health, College of Veterinary Science, Khanapara, Guwahati w.e.f. 4-5th February, 2014.
- Roychoudhury,P. and Sarma,D.K. (2013). Antigenic characterization of classical swine fever virus isolates by liquid phase blocking ELISA and neutralization peroxidase linked assay. Asia Pacific Congress of Virology, Amity Institute of Virology and Immunology, Amity University, Noida from 17-20 December 2013.
- Roychoudhury,P. and Sarma, D.K. (2013). Molecular characterization of classical swine fever virus isolates from North Eastern Region, India. Asia Pacific Congress of Virology, Amity Institute of Virology and Immunology, Amity University,Noida from 17-20 December 2013.

- Sonwal, S., Barua, A.G., Hazarika, R.A., Rajkhowa, S. Barua, C.C. and Bhattacharya, D.K. (2014). Isolation and antibiogram of *Streptococcus suis* from pigs. Presented in National Symposium & XII Annual Conference of Indian Association of Veterinary Public Health Specialists held at the Department of Veterinary Public Health, College of Veterinary Science, Khanapara, Guwahati w.e.f. 4-5th February, 2014.
- Sonwal, S., Barua, A.G., Hazarika, R.A., Rajkhowa, S. Barua, C.C. and Bhattacharya, D.K. (2014). Detection of glutamate dehydrogenase gene (gdh) of Streptococcus suis isolated from pigs. Isolation and antibiogram of Streptococcus suis from pigs. Presented in National Symposium & XII Annual Conference of Indian Association of Veterinary Public Health Specialists held at the Department of Veterinary Public Health, College of Veterinary Science, Khanapara, Guwahati w.e.f. 4-5th February, 2014.
- Tamuli, M.K., Gokuldas, P.P., Mohan, N.H., Banik, S., Gulie, N.T., Chutia, T. and Kayastha, R.B. (2014). Comparison of steroid and protein hormone treatment for induction of heat in gilts. In National Symposium on "Frontier reproductive biotechnology for enhancing animal fertility and fecundity: Global perspective" and XXIX Annual convention of the Indian Society for Study of Animal Reproduction. Nagpur Veterinary College, Nagpur, Maharastra Animal and Fishery Science University, Nagpur. 157.
- Tamuli, M.K., Mohan, N.H., Gokuldas, P.P., Chutia, T., Banik, S. and Naskar, S. 2014. Effect of short term extenders on boar semen preservation at 15°C. In National Symposium on Frontier reproductive biotechnology for enhancing animal fertility and fecundity: Global perspective and XXIX Annual convention of the Indian Society for Study of Animal Reproduction. Nagpur Veterinary College, Nagpur, Maharastra Animal and Fishery Science University, Nagpur.290.
- Thomas, R. and Gadekar. Y.P. (2014). Industry Oriented R&D: A must for improving the visibility of Indian meat research. In: National Seminar on 'Sheep and goat biodiversity and breeding policies-issues and perspecitive' and Annual Conference of ISSGPU held at K.N. Patil College of Veterinary Sciences, Sirwal, Maharashtra.
- Thomas,R., Jebin,N., Saha, R., Girish, P.S. and Sarma,D.K. (2014). Use of sticky rice flour, jack fruit seed powder and tapioca flour as alternate fillers in pork nuggets. In: National Symposium on One Health: Harnessing Biotechnology for Addressing Veterinary and Biomedical Concerns on Food Safety, Zoonoses and Environmental Sustainability & XII th Annual Conference of IAVPHS held at College of Veterinary Sciences, Khanapara.
- Thomas, R., Jebin,N., Saha,R. and Sarma,D.K. (2014). Evaluation of antioxidant and antimicrobial effects of kordoi fruit juice and bamboo shoot extract in pork nuggets. In: National Seminar on 'New Dimensional Approaches for Livestock Productivity and Profitability Enhancement under Era of Climate Change' XXI Annual Convention of ISAPM held at College of Veterinary Science and Animal Husbandry, Anand Agricultural University, Gujarat.

TECHNICAL/ POPULAR ARTICLE/BOOK CHAPTERS

- Banik, S., Mohan, N.H., Naskar, S., Pourouchottamane, R., Barman, K. and Tamuli, M.K.(2012-13). Annual Report All India Coordinated Research project and Mega Seed Project on Pig . National Research Center on Pig. 102.
- Banik, S., Pankaj, P.K. and Naskar, S. 2014. (In Press) Climate change impacts on livestock diversity in tropical countries. In: Malik, P.K., McSweeney, Chris, Prasad, C.S. and Bhatta, R. (eds.) Climate Change, Methane Mitigation, and Livestock Production Tropics and Subtropics. CABI.
- Barman, K. and Konwar, D. (2013). Methane production in ruminants and its mitigation strategies. In: Nutrition Health Interactions for optimum livestock production and human welfare. (Eds Sharma, R.K., Rastogi, A., Pathak, AK, Gupta, SK and Pathak, NN) published by Indian Academy od Veterinary Nutrition and Animal Welfare and SKUAST-Jammu.18-37.
- Kaman, B.(2014). Modernizing Agriculture for Socio-Economic upliftment of Misings. Souvenir- Annual session of Mising Sahitya Sabha at Dhemaji.
- Kaushik,P., Das,A., and Das,A.K.(2014). Porcine reproductive and respiratory syndrome virus (PRRSV). The North East veterinarian. XIII: 19-20.
- Mohan,N.H. (2013) Dietary nutrients: More than mere nourishment. Science Reporter. 50:34-35.
- Mohan, N. H. (2013). Impact of Climate Change on Animal Production. Proceedings of National Seminar on Modern Approches to Disease Diagnosis in Veterinary Practice. Government of Kerala. 198-201.
- Mohan. N.H. (2013). Physio-genomic responses of pigs to Heat Stress: Strategies for Mitigation of Climatic stress. In: Fundementals of Livestock Meteorology. (Rao, S.S.L.H.V.P, Varma, G.G, eds), Centre for Animal Adaptation to Environment and Climate Studies, KVASU/DST-SERB, Govt.of India.29-45.
- Naskar, S. and Banik, S. (2013). Pig Genetic Resources and Their Improvement: Indian Scenario. In: Indian Livestock Resources and Improvement. Arun K Tomar et al (Eds.).
- Naskar, S., Banik, S., Pourouchottamane, R. and Pankaj, P.K. (2013). An overview of Indian piggery sector and breeding strategies for climate resilience. Compendium of Model Training Course on Management strategies for sustainable livestock production against impending climate changes, sponsored by Directorate of Extension, Department of Agriculture and Co-operation, Ministry of Agriculture, Govt. of India, published by NDRI Southern Regional Station, Bengaluru.103-107.
- Naskar, S., Niranjan, S.K. and Banik, S. (2013). Utilisation of pig genetic resources of India (chapter 17). In: Sustainable utilization of indigenous animal genetic resources of India. Pundir RK, Niranjan SK, Behl R (eds.), pub. By National Bureau of Animal Genetic Resources, Karnal, Haryana, India. 120-125.
- Thomas, R. (2013). Business is possible

beyond Brahmaputra. Intelligent Entrepreneur.74-77.

- Thomas, R. (2013). Processed pork firm plans big. The Telegraph, 1st July, 2013.
- Thomas,R. and Das,A. (2013). Technologies for value added pork products. In: Annual Report. Ministry of Food Processing Industries. 6-8.
- Thomas,G.Patil,S. and Sarma,D.K. (2014)Hygienic pork production a pictorial guide for pork handlers published by NRC on Pig,Rani,Guwahati.
- Thomas R. and Sarma, D. K. (2014) Success story of commercialization of technologies forprocessing of value added pork products, Published by NRC on Pig,Rani,Guwahati.
- Thomas, R., G.Patil, S. and Sarma, D. K. (2014) Do's & Don'ts in pork industry,Published by NRC on Pig, Rani, Guwahati.