



Govt. of Bihar

Bihar Livestock Master Plan

2018-19 - 2022-23



Animal & Fisheries Resources Department, Government of Bihar

Technical support: **International Livestock Research Institute (ILRI)**

Program support: **Bill & Melinda Gates Foundation**



Govt. of Bihar

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2018-19 - 2022-23



Nitish Kumar
*Chief Minister
Bihar*



Message

I am happy to know that the Department of Animal and Fisheries Resources, Government of Bihar has come up with a Livestock Master Plan (LMP) which includes Livestock Sector Analysis and future projections pertaining to the sector.

The Livestock Sector Plays an important role in building a strong state economy by increasing house hold incomes and employment opportunities along with food and nutritional security. In Bihar, we have started Agriculture Road Map in the year 2008. Presently we are implementing the third Agricultural Road Map (2017-2022) and the Livestock Development is an important component of it. I hope that the Livestock Master Plan will complement and support the implementation of the Agriculture Road Map and help the sector to grow and contribute to poverty reduction and economic gains for farmers.

I expect that the Department of Animal and Fisheries Resources will leave no stone unturned to achieve the targets set up in the third Agricultural Road Map. I appreciate the effort and convey my good wishes for the initiative.

(Nitish Kumar)



Sushil Kumar Modi
*Deputy Chief Minister
Bihar*



Message

It is my pleasure to note that Department of Animal and Fisheries Resources, Government of Bihar is contemplating to bring out the commodity value chain roadmaps of the Livestock Master Plan (LMP) that includes a specific vision and targets, challenges, opportunities and strategies, recommended technology and policy investment interventions with expected outputs, impacts and outcomes on the state development objectives under the Livestock Sector Analysis (LSA) and Livestock Master Plan (LMP) conducted in Bihar with the support of Bill & Melinda Gates Foundation and the International Livestock Research Institute (ILRI).

I congratulate the team headed by Dr. N. Vijaya Lakshmi, Secretary of the Department and the Scientists of ILRI for preparing the Master Plan which would ensure livelihood security and doubling of farmers income in the state of Bihar. I once again convey my best wishes and congratulations to all the members who were part of this endeavour.

(Sushil Kumar Modi)



Pashupati Kumar Paras

*Hon'ble Minister
Department of Animal and Fisheries Resources
Government of Bihar*



Message

I was told that the Bihar Livestock Master Plan is being prepared by the Department of Animal and Fisheries Resources, Government of Bihar in collaboration with Bill and Melinda Gates Foundation and with the technical support from the scientists from the International Livestock Research Institute (ILRI), with a view to prepare an in-depth analysis of the Livestock Sector in Bihar and provide recommendations for strategy and outcomes. I am sure this will enable the Department to implement the Agriculture Road Map in a more meaningful way.

I congratulate the Secretary of the Department, Dr. N. Vijaya Lakshmi and her team along with the ILRI team for undertaking such a study which will enable the sector to grow and reduce poverty in the state through enhanced livelihood opportunities.

(Pashupati Kumar Paras)



Deepak Kumar, IAS
Chief Secretary
Government of Bihar



Message

I am happy to learn that the Department of Animal and Fisheries Resources, Government of Bihar in collaboration with Bill and Melinda Gates Foundation and International Livestock Research Institute (ILRI) is bringing about a sector analysis and a master plan of the Livestock Sector. The Livestock Sector Plays an important role in rural economy along with Agriculture in improving farm incomes and employment opportunities.

The Livestock Master Plan (LMP) would enable all stakeholders to bring in much needed opportunities, investment, vision and ideas to take the Livestock Sector to the next level which would hopefully result in poverty reduction and enhanced incomes for the rural households in Bihar.

I congratulate the team headed by the Secretary for tirelessly working on the project since a year and successfully bringing out the Master Plan in the Livestock Sector.


(Deepak Kumar)



Dr. N. Vijaya Lakshmi, IAS, Ph.D.

*Secretary
Department of Animal and
Fisheries Resources,
Government of Bihar &
Managing Director
Women Development Corporation,
Department of Social Welfare
Government of Bihar*



Message

Livestock is an integral part of Agriculture and plays a very important role in the rural economy. It contributes approximately 26.7% to the agriculture GSDP. Understanding the importance of agriculture and allied sector, the Bihar Government is implementing Agriculture Roadmaps since 2008 and the current one is the 3rd in the series. To increase its support for the implementation of the livestock component of the roadmap, the Department has decided to carry out a thorough and systematic analysis of the Bihar Livestock sector using the herd and economic sector model and to prepare a Livestock Master plan with detailed analysis on each commodity value chain and a five year livestock sector investment plan.

A team of Scientists from the International Livestock Research Institute led by Dr. Barry Shapiro helped us in shaping this Master plan with the funding support from Bill and Melinda Gates Foundation. It took almost a year to collect data, analyse it and also train our officials on the LSIPT model and prepare the master plan. I am grateful to Dr. Purvi Mehta, Asia Head, Agriculture, Gates Foundation, with whom I had initial discussions on this joint collaboration which has shaped the Livestock master plan.

I am very sure the Livestock Master plan will guide the investment plans both from the public and private sectors and will be useful in the development of the livestock sector and increasing the incomes of farmers in Bihar.

Dr. N. Vijaya Lakshmi

Dr Nick Austin Bill & Melinda Gates Foundation



With more than 80% of the population of Bihar dependent on agriculture for their livelihood and incomes; the Bill and Melinda Gates Foundation works in partnership with the Government of Bihar to support the vision of smallholder-led inclusive agricultural transformation. The Foundation's work focuses on testing and generating evidence on innovative solutions that have direct influence on two main drivers of agricultural and income growth: diversification and market access.

Bihar's agricultural growth in last decade outpaced India's national average. The agriculture sector in Bihar can boast of the highest diversification across India, and impressively the livestock sector's contribution to the State's GSDP has been increasing year on year. Over the last few years' the State has identified livestock as a priority sector within agriculture, with untapped potential that can be realized with targeted interventions.

I am pleased to note that during the past year, the Bill and Melinda Gates Foundation, in partnership with the Government of Bihar's Department of Animal Husbandry and Fisheries Resources (DAFR), have engaged the International Livestock Research Institute (ILRI) to support the development of Bihar's Livestock Sector Analysis and Livestock Masterplan (Bihar LMP). The development of the Bihar LMP was guided by a High-level Technical Advisory Committee which included government, industry and civil society representatives to identify critical issues faced by the sector and provide the overall framework for recommendations.

I would like to congratulate the Government of Bihar, Department of Animal Husbandry and Fisheries, the Bihar LMP team and ILRI experts for completion of Bihar's Livestock Masterplan and presenting it to the Government.

This masterplan will support Bihar Government's Third Agricultural Roadmap targets for the livestock sector and further modernize the sector to enable it to make a more substantial contribution to state development goals.

Dr Nick Austin
Director- Agricultural Development
Bill & Melinda Gates Foundation



Dr Purvi Mehta and Dr Sam Thevasagayam Bill & Melinda Gates Foundation

Agriculture sector holds front and central position in Bihar's economy. Within Agriculture, the livestock sector in Bihar employs more than 78% women and role of the sector in inclusive agricultural transformation will not only help in providing income and productivity gains for livestock keepers but its contribution to women's economic empowerment and improving nutritional status of households are equally important. The Third Agricultural roadmap for Bihar focuses on crop diversification strategies for improving sector productivity; and specifically lists out the targets for increasing dairy productivity by one and half times, poultry by ten times and meat by two times the current levels.

In 2017, the Bill & Melinda Gates Foundation partnered with the Government of Bihar's Department of Animal Husbandry Dairying and Fisheries to provide technical support to strategize and identify critical interventions that will help accelerating the growth in livestock sector in Bihar. The Foundation engaged technical experts from the International Livestock Research Institute (ILRI) for development of Bihar's Livestock Masterplan with the objective of conducting a detailed investment analysis in a 5-year framework with recommendations on policy and technology interventions.

We are very pleased to note that the Bihar Livestock Masterplan Team comprising of experts from within the Government of Bihar and the ILRI have successfully completed the Bihar LMP. We would like to acknowledge the support the team received from the senior representatives within the Directorate of Animal Husbandry (Department of Animal Husbandry, Dairying and Fisheries; Government of Bihar); Bihar Livestock Development Agency (BLDA); Bihar State Milk Cooperative Federation Ltd(COMFED); Directorate of Dairying; Institute of Animal Health and Production; BAIF; ICAR Research Centre for the Eastern Region; Bihar Veterinary Association (BVA); Bihar Rural Livelihoods program etc.

We hope this report and its recommendations will help support Bihar Government's ambitious goals for the livestock sector and more substantial contribution to state development goals, including: reducing poverty, improving food security, contributing to employment growth (including among women and youth), raising state economic growth and income, and increasing export earnings, while also ensuring environmental sustainability, adapting better to weather variability and shocks, and mitigating climate change.

Dr Purvi Mehta and Dr Samuel Thevasagayam
Bill & Melinda Gates Foundation

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The Bihar livestock sector analysis (LSA) and the master plan (LMP) were undertaken by a joint team of Bihar and ILRI livestock and planning experts. The analytical work was carried out under the guidance of Dr. N. Vijayalakshmi, the Secretary, Department of Animal and Fisheries Resources. This effort was generously funded and supported by the Bill & Melinda Gates Foundation, South Asia Agriculture Program.

A Technical Advisory Committee chaired by the Secretary periodically reviewed and made recommendations related to ensuring progress in achieving the outputs of the LMP project. It was comprised of the heads of key livestock departments and other relevant government agencies of Bihar, as well as representatives from civil society organizations and development agencies. Once completed, the commodity value chain roadmaps of the LMP were reviewed by eminent livestock scientists of ICAR, the Indian Council of Agricultural Research. They were found credible and defensible.

Many capable individuals and supportive institutions and agencies contributed to the genesis and realization of the Bihar LSA and LMP. Without the hard work and good-will of all of them the LSA and LMP would not have been completed.

Dr N Vijayalakshmi, the Secretary, Department of Animal and Fisheries Resources was the champion of this effort and deserves the highest appreciation for her sincere support for the work. Without her support, useful input and constant encouragement, the work would not have been successfully completed. Dr Vijayalakshmi saw the value of carrying out this exercise to help DAFR in its efforts to support the further development of the sector under the Bihar Agricultural Road Map or ARM and helped to ensure it complements and supports the ARM.

Moreover, Dr Srivalli Krishnan, Senior Program Officer for Agriculture, of the Bill & Melinda Gates Foundation (BMGF) saw the value of DAFR having a livestock development roadmap or LMP to assist it in implementing the ARM. She also deserves the highest appreciation for her sincere support for the work. Dr Srivalli supported the project wholeheartedly, with much appreciated perseverance and facilitation.

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Dr. Sanjay Kr. Sinha, DAFR

Dr. Surendra Narayan Mishra, Team coordinator, DAFR

Dr. Asmita Kumari, DAFR

Dr. Shambhu Kumar, DAFR

Dr. Abdhesh Kr. Jha, DAFR

Dr. Getachew Gebru, Animal Scientist

Mr Kidus Negussie, Animal Scientist

Dr Sirak Bahta, Agricultural Economist, ILRI

Mr Vijay Baskha Reddy, Dairy Processing Engineer and Marketing Specialist

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Dr Nicoline de Haan, Core Theme leader– Gender, ILRI

Dr Isabelle Baltenweck, Deputy Program Leader, Policy, Institutions and Livelihoods

The work of the LMP/LSA team was aided by many livestock experts who sacrificially contributed to the numerous expert consultations held to get technical advice and validate the livestock sector analysis results. The institutions they represented are listed on the page of Contributors.

The LMP team was gratefully guided by a Technical Advisory Committee (TAC), led and chaired by Dr. N. Vijayalakshmi and co-chaired by Dr. Purvi Mehta, Agriculture Director, South Asia, Bill & Melinda Gates Foundation. The TAC provided technical oversight and good counsel. The institutions represented on the TAC included:

1. Secretary, DAFR, Govt. of Bihar, Chair person
2. BMGF Asia Agriculture Director, Co-Chair person
3. Under-Secretary, DAFR, Govt. of Bihar
4. Director, AHD, Govt. of Bihar
5. Director, Fisheries Department, Govt. of Bihar
6. Director, Dairy Department, Govt. of Bihar

7. Assistant Internal Financial Advisor, DAFR, Govt. of Bihar
8. General Manager, NABARD, Patna, Bihar
9. Managing Director, COMFED, Patna, Bihar
10. Representative of farmers from the Kaushalya Foundation, Bihar
11. Director, ICAR-RCER, Patna
12. Senior Program Officer, BMGF – ex officio
13. ILRI Project Leader – ex officio

The team would also like to express its appreciation to members of ILRI Management, Dr Habibar Rahman, Regional Representative, South Asia, Dr Steven Staal, Program Leader, Policies, Innovations and Livelihoods, and Dr Iain Wright, Deputy Director General, Research and Development – Integrated Sciences. The team gained greatly from the constant support and input of these colleagues. We would like to make mention of the kind and competent support beyond the call of duty provided to the team by Ms. Roma Oli and Ms. Tiruwork Melaku.

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Finally, on behalf of the DAFR and ILRI team, I sincerely thank all these dear friends and colleagues for their invaluable contributions to the success of this critically important work! The team hopes the resulting LMP will prove useful to Bihar DAFR in its efforts to support the implementation of the Agricultural Road Map and will result in improved livelihoods for the livestock farmers of Bihar.

Barry I. Shapiro, PhD
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International Livestock Research Institute (ILRI)

Abbreviations/Acronyms

AH	Animal Husbandry
AI	artificial insemination
ARM	Agriculture Roadmap
ASF	animal-source foods
AU-IBAR	African Union Inter-African Bureau for Animal Resources (AU-IBAR)
BAU	business as usual
BCR	benefit-cost ratio
BMCU	bulk milk chilling units
BQ	black quarter
BYP	backyard poultry
COMFED	Bihar State Milk Co-Operative Federation Ltd.
CBC	crossbred backyard chicken
CBS	commercial specialised chicken
DOC	day-old chicks
DAFR	Department of Animal and Fisheries Resources
DCS	dairy co-operative societies
EANPV	equivalent annual net present value
e.g.	for example
etc.	additional items
FAO	Food and Agriculture Organization of the United Nations
FMD	foot-and-mouth disease
GDP	gross domestic product
gm	gram
GoB	government of Bihar
GSDP	gross state domestic product
ha	hectare
HESM	herd and economic sector model
HH	household
HS	haemorrhagic septicaemia
IBC	indigenous backyard chicken
ICAR	Indian Council of Agricultural Research

i.e.	that is
ILRI	International Livestock Research Institute
INR	Indian Rupee
IRR	internal rate of return
kg	kilogram
L	litre
LMP	Livestock Master Plan
LSA	Livestock Sector Analysis
LSIPT	Livestock Sector Investment and Policy Toolkit
MAFW	Ministry of Agriculture and Farmers Welfare
MCC	milk collection centre
MPCS	milk producer co-operative societies
MT	metric tonne or 1,000 Kg
MSP	minimum support price
N/A	not available
NGO	nongovernmental organization
NPV	net present value
NSS	National Sample Survey
PPP	public-private partnership
PPR	peste des petits ruminants
R&D	research and development
SC	Scheduled Castes
SNF	Solid Not Fat
SHG	self-help group
ST	Scheduled Tribes
UHT	ultra-high temperature pasteurization
UK	United Kingdom
USD	United States dollar
WI	with investment intervention

1 Introduction

Motivation for a Livestock Master Plan

Bihar is the third most populous state in India and the most densely populated, while per capita income is the fifth lowest across all states. In 2012, 36% of the population was below the poverty line (World Bank, 2016). Meanwhile, about 89% of the population lives in rural areas, the highest per cent in India after Himachal Pradesh (ORGI, 2011), and around 60% of the rural workforce is engaged in agriculture (NSSO, 2011). Furthermore, Bihar's economy has been growing rapidly since 2005, driven by the services sector, and poverty has been declining. But, while agriculture contributed only 18% to total state income or gross state domestic product (GSDP) (Data.gov.in, 2016), it adds greatly to income volatility according to the World Bank (World Bank 2016). Meanwhile, the livestock sub-sector contributed about 27% to the agricultural GSDP and 5% to state income or GSDP in 2012 (Data.gov.in, 2016).

The high poverty rate in Bihar compared to other similar Indian states has been attributed to low ruminant livestock ownership rate (MOSPI, 2017). The percentage of households which own ruminant livestock (cattle and buffalo) is lower in Bihar (according to the last national livestock census) than comparable states (Ministry of Agriculture, 2014 and 2010). However, Bihar has a large goat population (ranked third in India) and most goats are held by marginal castes and women, so goats are particularly important in poverty-reduction strategies and activities. At the same time, Bihar has made great progress in dairy and is particularly recognized for its high milk production from cows, buffalo and goats (ninth highest state in India).

The importance of the dairy and goat value chains make livestock one of the principle sectors considered to have the potential to help achieve the development goals of the state. The growth and performance of the dairy subsector in Bihar has been better than in many other Indian states (DAHDF, 2017). The Bihar State Milk Co-Operative Federation Ltd. (COMFED), which is supported by the government, has played a key role in developing the dairy subsector, and in raising dairy cow productivity and milk production, as well as in raising dairy farmer incomes. Thus, increasing livestock productivity and production further is seen by the government of Bihar (GoB) and its Department of Animal and Fisheries Resources (DAFR) as a key means of improving per capita incomes and reducing poverty. Livestock could play an important role in employment and income opportunities for the rural masses. It already provides substantial employment to women, and workers belonging to the marginalized sections of society.

Livestock Masterplan to support the Bihar Agricultural Roadmap

To increase its support for the implementation of the livestock component of the current Bihar Agriculture Roadmap or ARM, the Bihar Department of Animal and Fisheries Resources (DAFR) decided to carry out a thorough and systematic analysis of the Bihar livestock sector (LSA) and to elaborate a livestock master plan (LMP). An LMP is a detailed 5-year livestock sector investment plan meant to help increase and better target public and private investment to achieve the targets for the livestock sector in the roadmap or ARM.

The Government of Bihar through DAFR requested the Bill & Melinda Gates Foundation to support engagement of the International Livestock Research Institute (ILRI) to provide technical assistance to carry out the LSA and LMP. The objective of this LMP initiative was thus to provide an investment plan which could help further modernize the livestock sector, enabling it to make an even more substantial contribution to achieving state development goals during the current Agriculture Roadmap. This effort has been generously funded and supported by the Bill & Melinda Gates Foundation.

The Bihar livestock sector analysis and the master plan (LMP) were undertaken by a joint team of Bihar and ILRI livestock and planning experts. The analytical work was carried out under the guidance of Dr. N. Vijayalakshmi, the Secretary, Department of Animal and Fisheries Resources. A Technical Advisory Group chaired by the Secretary periodically reviewed and made recommendations related to ensuring progress in achieving the outputs of the LMP project. It was comprised of the heads of key livestock departments and other relevant government agencies of Bihar, as well as representatives from civil society organizations and development agencies. Once completed, the commodity value chain roadmaps of the LMP were also reviewed by eminent livestock scientists of ICAR, the Indian Council of Agricultural Research, and were found credible and defensible.

The LMP presented here is a series of five-year investment plans or roadmaps for the development of priority livestock value chains, chosen through the sector analysis and based on their potential for making impact on the development objectives of the Bihar government. Each roadmap includes a specific vision and targets, challenges and opportunities and strategies, and recommended technology and policy investment interventions, with expected outputs, impacts, and outcomes on the state development objectives. The roadmaps are also fully budgeted and include timed and sequenced activity plans (or Gantt charts). The findings of the livestock sector analysis (LSA), the long-term strategy for the livestock sector of Bihar, are presented in a separate publication which can be obtained from DAFR.

The Bihar LMP is thus meant to be complementary to and support the implementation of the livestock segment of the Bihar ARM. The analysis presented in section 8 of this LMP shows how the LMP complements and adds value to the ARM and identifies points of overlap between the ARM and LMP strategies, targets and activities, to enable DAFR to rationalize the ARM and LMP where necessary to improve implementation of the ARM livestock sub-sector plan.

The livestock sector analysis (LSA) which forms the basis for the 5-years LMP or investment plan presented in this report was carried out with a livestock herd and economic sector model or HESM. The HESM was built using the livestock sector investment and policy toolkit (LSIPT). LSIPT developed by the French Agricultural Research Centre for International Development (CIRAD), the World Bank, and the Food and Agriculture Organization of the United Nations working under the auspices of the African Union Inter-African Bureau for Animal Resources (AU-IBAR). The development of the LMP was informed by the findings of the LSA and was elaborated with additional methods developed by the International Livestock Research Institute or ILRI.

The LSA used the HESM to carry out a quantitative assessment of the present performance of the sector and then assess the future potential of the sector based on the contribution of proposed investment interventions to achieving improvements in production, income and other development objectives at the household, value chain, livestock subsector, agricultural sector, and state economy levels. The LSA also assessed the contribution of the proposed investment interventions on achieving greater equality and social inclusion opportunities for all gender and marginalized groups working in the livestock sector.

Achieving gender equality and greater social inclusion of disadvantaged groups are important societal goals in

Bihar. However, the HESM built using LSIPT does not differentiate labor components and explicitly consider intervention impacts on gender, youth and disadvantaged groups in Bihar. The LMP team was able to use qualitative survey tools to filter and interpret the outputs of the analytical results of the HESM analysis of proposed technology-policy interventions in the LSA and LMP value chains. Based on the results, the combined investments and policies with the most positive potential impacts on achieving gender equality and social inclusion of disadvantaged groups were identified in the LSA and recommended in the LMP.

The findings and recommendations of the LSA and LMP are evidence-based and backed by analysis of reliable data. Available quantitative data from field surveys and published literature, as well as expert opinions, were validated through consistency tests. The development of the LSA and LMP were thus supported by the continual involvement of state livestock experts and consultation with a wide range of key sector stakeholders. The LSA and LMP entailed regular and open consultations with relevant technical experts, Government of Bihar partners and other stakeholders to help ensure ownership by all relevant livestock sector stakeholders.

The LMP roadmaps presented here are meant to be implemented by DAFR, other government ministries and agencies, as well as by development partners or investors (donors, development banks, international and local non-governmental organizations (NGOs), civil society organizations (CSOs) etc. and private sector actors, with technical support from state, national and international research and development organizations,

The LSA and LMP development process

To accomplish its mission, the ILRI LMP team engaged with senior and technical staff of the Bihar DAFR and formed a joint Bihar and ILRI LMP team. This joint team then engaged with other livestock experts to understand the existing development priorities of the Bihar government, to agree upon the relevant framework of key species, production systems and a typology of agro-ecological zones to be analysed, as well as the commodity value chains to be included in the LMP diagnostic process, to agree upon the relevant investment options to be tested and compared, to collect relevant and reliable livestock data and parameters to build the HESM, and finally to carry out the sector analysis using the HESM to understand the current situation and future potential of the sector.

The full explanation of the Livestock Sector Investment and Policy Toolkit or LSIPT methodology and the process followed for developing the herd and economic sector model or HESM used to carry out the Bihar sector analysis or LSA is given in Annex 1 of the LSA.

2 Executive summary

An LMP to support the Bihar ARM

Bihar is now implementing its third agriculture roadmap (ARM) or 5-year agriculture sector investment plan. The ARMs are meant to help modernize and transform the agriculture sector of the state, including livestock. An ARM is made up of sub-sector roadmaps with strategies, production targets, programs and activities, and investment costs to achieve the production targets for each sub-sector. The past ARMs have been very successful in helping the livestock sub-sector achieve significant modernization, especially in the dairy value chain, and more recently in the poultry industry.

To increase its support for the implementation of the livestock component of the current Bihar Agriculture Roadmap or ARM, the Bihar Department of Animal and Fisheries Resources (DAFR) decided to carry out a thorough and systematic analysis of the Bihar livestock sector (LSA) and to elaborate a livestock master plan (LMP). An LMP is a detailed 5-year livestock sector investment plan meant to help increase and better target public and private investment to achieve the targets for the livestock sector in the roadmap or ARM.

The government of Bihar through DAFR asked the International Livestock Research Institute (ILRI) to provide technical assistance to carry out a livestock sector analysis or LSA and then develop the LMP. The objective of this LMP initiative was to provide an investment plan which would complement the ARM to help further modernize the livestock sector, enabling it to make an even more substantial contribution to achieving state development goals during the current Agriculture Roadmap. This effort has been generously funded and supported by the Bill & Melinda Gates Foundation, South Asia Agriculture Program.

The added value of the LMP

Using the most recent available data for 15 years, from 2016-17 to 2021-22, a team of DAFR livestock experts and ILRI staff employed the livestock sector investment and policy toolkit (LSIPT) to develop a herd and sector model (HESM) for the Bihar livestock sector and carried out a baseline assessment of the current status of livestock development in Bihar. This HESM was used to assess the potential long-term or 15 years impacts of combined technology and policy interventions on Bihar-designated development objectives. The results of this livestock sector analysis (LSA), then formed the basis for the development of the LMP for the 5-year period of 2018-19 to 2022-23. The LMP is a series of five-year development investment plans or 'roadmaps', to be used to complement and help implement the ARM.

The main objective of the Bihar LMP is to provide evidence-based justification for public and private investments in a set of recommended priority commodity value chains (VCs) of the Bihar livestock sector. The VCs and investment interventions are chosen based on quantitative analysis of the returns on investment (ROIs) from investments in new and/or additional combined technology and policy interventions. The LMP is also meant to inform the development planning of DAFR, together with other Bihar government agencies working on livestock sector development in the state, as well as the investment planning of development partners or donors, nongovernmental organizations (NGOs), civil society organizations, private sector actors and development banks.

In carrying out the LMP, in order to choose the investment and policy interventions to be implemented in the 5-year LMP or sector investment plan for Bihar, the alternative investments in new technologies and innovations combined with changes in policy were tested to show their impact or contribution to the following specific development objectives (through measurable indicators) chosen by Bihar livestock experts and confirmed by DAFR:

- Poverty reduction (improvement in household incomes)
- Economic growth (contribution of livestock sector to Agricultural State Gross Domestic Product (Ag GSDP) and State Gross Domestic Product (GSDP))
- Improvements in food and nutritional security of rural people (more animal source foods (ASFs), including specifically more protein and carbohydrate)
- Potential for surplus trade with the rest of India and surrounding countries (value of potential output marketed to other states and surrounding countries)
- Contribution to industrialization and employment generation (pre and post-production investment and employment impacts)
- Contribution to improving social inclusiveness and equity (production and post-production income, employment and investment increases for women, youth and scheduled minority groups)

Investments in each commodity value chain in the LMP were analyzed based on the projected impacts of livestock improvement strategies and interventions chosen based on past research and recommended by senior livestock sector experts of Bihar. The LMP adds value to the ARM by including analysis of:

- 5-years investment returns (ROI) for the livestock interventions chosen in the LSA
- the challenges and opportunities facing each commodity value chain
- projected investment impacts on 5-year production and income
- projected investment impacts on meeting produced quantities for the commodities and ASFs demanded in future
- most importantly, the impacts of the investments on indicators for achieving the state development objectives outlined above.

Key results of the LMP analysis

The livestock sector in Bihar has several number of technical challenges which need to be addressed for the sector to play its potential role in the further economic development of Bihar. Some prominent challenges are scarcity of feed and poor feed quality and regulation, poor animal genetic potential to produce animal source foods ASFs, inadequate animal health services, lack of organized and continuous livestock production improvement training, loss of livestock due to flooding, and low budget for investment to improve the sector.

Major interventions to address existing challenges

To tap the opportunities and address these challenges, additional investments in livestock improvement interventions are needed in the areas of feed, health, genetics, extension, and marketing and processing.

The priority interventions to address the challenges the sector faces in modernizing are:

- Improve the quantity and quality of livestock feed resources through training farmers to use all available land to produce forage crops, improve crop residues for feed, and upgrade feed quality testing and regulatory institutes to implement feed quality testing in the market
- Improve genetics through selection of local breeds and crossing locals with improved exotic breeds or improved locals in the case of buffaloes
- Increase the quality and quantity of animal health services and livestock producers' access to these services through private and/or private-public partnerships to decrease mortality and morbidity
- Design and implement policies and institutional interventions which enable private investments and public-private enterprises where needed, especially in animal production, input production, processing and delivery, and output marketing and processing
- Design and implement policies, institutional interventions, and programs which will help ensure that social inclusiveness and equity is improved through the LMP interventions to achieve greater income, employment and investment opportunities increase for women and scheduled minority groups
- Farmer training to improve technical and business skills, including through coops, and including what will promote greater gender and social inclusion

Priority livestock value chains of the LMP

The LMP sets out livestock sector investment interventions—better genetics, feed and health inputs and services, and complementary policy support—which could help meet the ARM targets by improving productivity, production, incomes, and employment in the key livestock value chains of dairy with cattle and buffalo, poultry, goats for milk and meat, buffalo for meat, and pigs for pork.

The commodity value chains recommended for investment in the LMP, in order of priority are:

1. Cow and buffalo dairy
2. Poultry or chicken meat and eggs
 - a. Improved backyard chicken (to help women and marginal communities)
 - b. Commercial chicken—broilers and layers
3. Goat meat, milk and skins (increasing the number of goats in the traditional systems of women and marginal communities)
4. Meat from buffaloes (including a focus on marginalized castes)
5. Pigs and pork
 - a. Intensifying the traditional piggery system (and a focus on the traditional systems of marginalized castes)
 - b. Improving and increasing commercial piggeries and fattening operations

Key recommendations for each LMP value chain

Dairy value chain

Dairying with cattle and buffaloes will continue to be the key commodity value chain which can help the most to achieve the development goals of the state, especially: poverty reduction, improved food and nutritional security, economic growth, increased contributions to industrialization and employment, and improved social equity. In Bihar, 57 lakh households own dairy cattle and directly depend on the dairy sector for their livelihoods. Many more HHs have milk-producing buffaloes too or make their living along the dairy value chain. The LSA and LMP analyses show there is still much potential for further expansion of dairying in Bihar.

The major technical interventions required to further modernize the dairy commodity value chain are improving feed availability and quality, selection and crossbreeding of cows with exotics and buffaloes with improved indigenous buffaloes, and inclusion of women and marginalized communities in all interventions, as well as in increased processing of milk and marketing of milk products.

The main technology and policy interventions requiring more investment during the 5-years of the LMP (and ARM) are:

- Training farmers how to improve feed production and feeding practices (introduction of stall feeding, planting fodder trees, use of locally available feed resources) to improve dairy productivity, and ensuring these practices are made available to women
- Mobilizing and strengthening AI and synchronization facilities, services and activities to further strengthen cow and buffalo dairy
- Establishment and enforcement of quality standards and quality-based price incentives for milk produced and sold
- Provision of training and refreshment training to AI technicians—public and private, as well as farmers
- More investments to increase buffalo milk since it is needed to help close the overall milk gap and buffaloes are mainly kept for their milk, not meat.
- Separate buffalo milk and milk products collection, marketing and processing to help ensure a premium price to buffalo milk producers, due to its high fat content.
- Open processing further to private investment in areas where COMFED is not already dominant
- Facilitate access to feed market in surrounding states, to take advantage of better genetics

The returns on the proposed dairy investments in the WI or “with additional investment” scenario, found in the LMP investment analysis, are very encouraging. The annual incremental increase in income per animal from adoption of WI over BAU or “business as usual investment” scenario would go from 10% for indigenous cows to 35% for crossbred cows, showing the benefits of AI to produce crossbred cows with higher genetic potential, if these crossbreds are fed and managed better.

Total milk production and contribution of milk to total GSDP would increase substantially with the WI dairy improvement interventions. Milk production by 2022-23 under the WI scenario is projected to increase by about 50% in the 5 years from the base year (2017-18) production of about 896 crore L. The GSDP contribution of milk under the WI scenario would increase by 52% over the 5 years of the LMP.

To accomplish the needed dairy gains, Bihar needs to provide milk producers with the support they need to continue the improvement of dairy genetics by crossing local cows with exotics and also by using more improved buffaloes produced by crossing with improved locals and feeding both better. In Bihar, adoption of the WI strategy would help the sector to close the projected 41% milk supply gap over the coming 15 years.

Finally, to help ensure farmers invest in WI, including better genetics, we recommend encouraging more public and private investment in value-adding processing to create assured markets for the additional milk which could result from the added investments in WI. This demand-pull strategy of encouraging investment in value-added processing has been found to be highly effective in creating the conditions for dairy transformation (e.g. Andhra Pradesh in India; Kenya, Uganda, Rwanda, and Ethiopia in East Africa). These needed investments in processing in Bihar could come from public or private investors, or from PPPs. In addition to the investments already made and those being planned and implemented through COMFED, additional private investments where COMFED is not already established would seem appropriate to consider in areas where they would not compete with those of COMFED.

Chicken meat and egg value chains

Chicken is the emerging subsector in Bihar with the most potential for further growth. In the LMP analysis, the WI scenario shows substantial potential increases in chickens and eggs in 5-years, 183% more chicken meat and 1,232% more eggs production compared to the base year (2017-18). The potential contribution of the chicken industry to improve food and nutritional security, household income and state economic growth is thus enormous, including an 189% increase in GSDP contribution in 5 years.

Moreover, with the additional proposed chicken improvement interventions, the income per animal from the layers and broilers is expected to increase by 15% and 101%, respectively. There is also already an existing and projected growth of 27% annually in egg production at the current level of investment (the BAU scenario) which will continue to meet the egg demand requirements of the state. Thus, the additional investment needs to focus mainly on broilers for meat rather than layers for eggs.

The increase in income per animal in the broiler system, meanwhile, due to WI is very attractive (INR 99 per bird under WI, but only INR 49 under BAU or 101%). Thus, the investment focus on broilers needs to be on the interventions and increased number and size of farms (more birds per farm) called for under WI which will be critical for meeting the future growing meat demand requirements. Meanwhile, to realize the developmental potential of chicken will also require dramatically increasing production of the cereals that go into chicken feed, particularly maize and soybean, and/or to purchase these cereals from other states.

Finally, additional investment in backyard dual-purpose scavenging birds could raise the incomes of very poor farmers, including women. However, for improving backyard chicken meat and egg production with semi-scavenging crossbreds, public initiatives have not been found to sufficiently help achieve the needed scaling of day-old chick production and sale, or farmer training. Thus, in addition to greatly increased NGO efforts, PPPs and private investments seem advantageous in being able to achieve significant scale, including targeting women. For achieving quick and lasting results, private investment and/or a PPP such as the highly practical and profitable relay model found in Ethiopia and elsewhere is recommended¹.

¹ In a relay system, DOCs are distributed to relay agents or out-growers who provide the hatched eggs with feed and vaccinations. When the pullets (young hens) have had all the vaccinations they require (at 4-6 weeks), the relay agents then sell the young pullets to farmers for egg and meat production (when the hens are culled). Ethiochicken in Ethiopia has a very successful relay system.

Goats and goat meat value chains

Goats show much potential for further public investment, mainly to help achieve equitable development objectives, especially for women and others from marginal ethnic groups. The major focus of the goat interventions is to increase the productivity of goats, rather than impacting production through population increase. This is due to the serious current and projected feed shortage in the state. The interventions needed include increased cross breeding with exotics, improving processing, and increasing access to urban markets and other states, overcoming the local feed constraints by better feed production and/or linking goat producers to feed suppliers from other states, and training to improve feeding practices. A gradual shift from the present extensive to a semi-intensive production system could result in better prices provided these households are linked with markets through self-help groups, goat cooperatives and producers' companies.

The main investment and policy interventions needing to be addressed include:

- Decreasing mortality in goats to result in significant improvement in goat productivity and production, as well as incomes of farmers and GSDP contributions
- Creating a state breeding policy for goat improvement
- Making changes in management and feeding practices (introduction of stall feeding, planting fodder trees, use of locally available feed resources) to improve goat productivity, and ensuring these practices are made available to women
- Ensuring credit and insurance for goat farming since goats are mainly held by very poor women from marginalized communities under risky climate and market conditions

The change in goat meat production in 2022-23 compared to the base year (2017–18) will be about 72% under WI. As well, in the WI scenario, the GSDP contribution from goats would increase to 66% by 2022–23. However, the additional interventions and investment in WI would result in only 14-19% increases in income per animal. Given the low additional income increases per animal under WI, and their small herd sizes, it becomes clear that more attractive income gains are possible under the BAU scenario than WI for those goat keepers considering moving from BAU to WI (with the available technology interventions).

Thus, we can conclude that given the technology options presently available, goat rearing is mainly a life-changing option for marginalized farmers and especially women, who are going into goat production for the first time or can expand their herd sizes. The benefits it provides include empowerment due to the income and asset generation made possible, and the help in achieving better household food security.

Until better genetic potential of goats is realized, present priority interventions should include feed and health options that are affordable and accessible to women and other members of marginalized communities, including by promoting social networks like self-help groups and strengthening cooperatives to facilitate technical and marketing training and updates on new technologies. Promotion of semi-intensive goat production, and investment in scaling up of the Pashu Sakhi delivery mode of animal health services are also key entry points now; and these can help decrease mortality and increase flock size; while facilitating better communication in extension efforts.

If further productivity-increasing interventions could be introduced in future, and the feed constraint overcome, increased marketing and sales to other Indian states and/or exports to nearby countries could help to increase goat prices and incomes further for women and scheduled castes.

Buffalo meat value chains

Milk is the primary product from buffaloes in Bihar, but buffalo meat is becoming increasingly important as a secondary product and source of cash income for farm households. Buffaloes presently contribute about 39% of the milk and 23% of the meat production of the state. While the numbers of indigenous or local cattle have been declining, buffalo numbers are increasing (at 2.3% per year) so there is potential to increase farmer incomes further, not only from buffalo milk production, but also from sale of culled buffaloes for their meat.

As in the case of dairy cows and goats, the current and expected future feed shortage facing buffalo keepers does not encourage increasing production through an increase in livestock population and relying on grazing for feed. The WI feed investment for dairy will also help with feeding buffaloes better, so the major focus of the buffalo meat improvement interventions is to increase productivity of buffaloes.

Assuming the growing feed shortage can be overcome, the benefits of better feeding would increase most if AI services are expanded and more productive buffalo breeds were introduced, through the following investment interventions:

- Greatly increasing semen production and AI delivery through more PPP and private service providers where appropriate and enabled, with incentives, if needed.
- Improving the quality and availability of animal health services and improving producers' access to these services through encouragement of more private service providers and/or PPPs.
- Enabling investments in buffalo slaughter for export which benefit buffalo owners
- Incentivizing private investments which institute social inclusion strategies to make sure productivity-increasing interventions reach and benefit women and marginalized communities
- Providing livestock-related business and marketing skills training to coops, including in tribal development efforts and efforts targeting women

Even if these investment interventions are adopted under the WI scenario for buffaloes, by 2022-23 the change in meat production from the base year (2017-18) is projected to be only 21%. Moreover, the GSDP contribution from buffalo meat by 2022-23 is expected to increase by only 17% over the base year (2017-18). However, in the 15-year LSA period to 2032-33, under the WI investment scenario meat production in Bihar is projected to increase by 45%,

Meanwhile, the demand for meat is low in Bihar and the demand projection of local demand shows it will not increase much, even over the long run 15-years period of the LSA. Thus, whether WI or BAU is chosen as the preferred investment scenario under the 5-years LMP period, these results indicate that there will be surplus supply and markets external to Bihar would need eventually to be accessed, so the additional surplus could go to other states or get exported. Moreover, tapping these markets external to Bihar, under BAU or WI, would require additional investments in buffalo abattoirs and meat processing, raising the cost per kg, but resulting in higher incremental incomes per animal, as shown in the LMP analysis.

This points out it would be both necessary and worthwhile to invest and implement the WI scenario rather than staying with the BAU scenario so the buffalo meat markets outside Bihar can be exploited most profitably. Moreover, even though more and even surplus buffalo meat could be produced in Bihar, due to weak local demand any investment in increasing meat production would be opportunistic and need to be aimed at marketing to other states or exporting. Investments would need to be increased to create new meat processing plants to enable this.

The analysis points to the need for private investments in buffalo abattoirs to facilitate external marketing, including exports to increase the value of their buffalo milk and meat. Such investments in value addition meat processing have been shown elsewhere to induce increased investment by farmers in technologies to increase productivity and production since they create more assured markets. Assured markets would then help production increases to result in income increases being realized by buffalo owners. Male calve fattening could also be expected to be introduced over time and adopted by farmers as productivity increases and mortality could be reduced.

Pig value chain

Pigs are mainly produced by the marginalized communities in Bihar and typically the pigs are managed by women, since 50% of the men in these communities are migratory laborers. Pig productivity and production improvement interventions need to mainly target intensifying production with better management in traditional backyard systems, as well as improving pig breeds. The demand for pork also presently exists mainly in rural areas among the marginalized populations, but the LSA results showed this demand will increase over the coming 15 years, including through expansion to urban markets.

Improving traditional pork production with the WI investment interventions do not show substantial increments in income per animal or in total production over 5 years, only an increase of 6%. The total contribution of pork to Bihar GSDP, meanwhile, will decrease by 1% over the 5-year LMP period. While the increase in pork meat production would also not contribute significantly to fulfilling the state meat requirement, it could, however, continue to contribute to meeting the nutritional requirements of marginalized communities. This indicates that the BAU investment scenario is still to be preferred over WI in the 5-years period of the LMP.

Further investment in improving marketing in the pig sub-sector, however, still has potential to provide development benefits, mainly through marketing live pigs and pork locally, and if live pigs can be marketed to other Indian states and nearby export markets, and perhaps eventually through marketing of pork meat. This sector development could be particularly instrumental for tribal community members, who need to be supported in making the transition to more intensive systems and working on marketing together in coops.

Pig production could thus be promoted over the 5 years of the LMP through additional investments focused on providing marketing training to coops so they can bulk market to local urban centers, other states, and export markets for live pigs in nearby countries. The major recommendation for improving the traditional smallholder extensive or mainly scavenging pig operations is to support their transformation into more intensive piggeries through improved management. The key investment recommendations for improving smallholder production are:

- improving the productivity of sows through crossing with exotic breeds
- increased training how to manage the health of pigs better
- intensifying production in stalls, including through better feeding

Creating more cooperatives focused on pigs, meanwhile, would help small scale producers be able to produce higher quality and bulk market their pigs and profit from better extension. The smallholder producer cooperatives will also need to be provided with business and marketing skills and help in establishing market linkages, so they can band together to market live pigs to urban areas.

In addition, the analysis of investment returns indicates smallholder producers need to eventually become commercial producers since the profits increase greatly due to the economies of scale. To support this process

of transformation, more commercial scale investors will also be needed to provide demonstrations for smallholders, and to help develop the linkages to pig markets further afield.

Key policies and institutional support recommendations across the VCs

Policies and institutional interventions need to be designed and implemented throughout all the VC roadmaps to enable the private and private-public investments in animal husbandry, input production and supply, delivery of services, and output marketing and processing. The major recommendations identified through the LMP analysis include:

- Creating an even more conducive environment for private investment and public-private partnerships in chicken production, including for inputs (especially feed), and in services delivery and processing of milk
- Improving feed quality standards and regulation enforcement, and upgrading feed quality testing and regulatory control
- Upgrading the quality and availability of animal health services and improved access to these services through more encouragement of private service providers and/or PPPs
- Greatly increasing semen production and AI delivery through more private service providers and PPPs where appropriate, and enabled with incentives, when necessary
- Mainstreaming of gender and social inclusion programs and incentives at all levels

Main entry points for improving gender mainstreaming and social inclusion

- Ensuring access and control of resources for livestock production by women and marginalized communities
- Increasing access of women and marginalized communities to credit to buy health services, animal feed and good genetic stock
- Targeted information, including business skills, to support innovation in production, processing and marketing
- Inclusive land tenure policies to expand production, enable investment in processing, and help accessing markets for attractive returns

Main recommendations for LMP VC interventions to mainstream and improve gender and social inclusion

- In dairy, women could benefit more from increased milk production through women's co-operatives, to help ensure they maintain control of this income
- Goats are already the domain of women, so investments in this VC will benefit women, although access to feed and forages will need to be resolved, as well as reducing household demands on women's labor
- Pig and pork production are in the hands of tribal communities, so increasing access through cooperative marketing to reach demand centers would benefit these communities
- In poultry, since women are involved in backyard production, where there is a push to become semi-intensive, it is important to include women in this transition, both for added income and greater family nutritional security

Also needed to improve gender and social inclusion and benefits:

- Research to develop more evidence-based gender and social inclusion policies
- Gender mainstreaming within government departments (budget, staff and expertise)
- Sharing knowledge gained from positive experiences

Joint government and private sector actions required to ensure LMP success require:

- Budget allocation for mobilizing and strengthening AI and synchronization facilities, services and activities to strengthen cow and buffalo dairy
- Creation of AI infrastructure, including regional semen production facilities and cold storage for distribution of AI straws
- Establishment and enforcement of quality standards and quality-based price incentives for milk produced and sold
- Provision of training and retraining for AI technicians— public, private, including farmers
- Improvement of animal health services and access to service provision and drugs for livestock farmers
- Provision of effective technical and business training to all VC actors, especially women and members of scheduled castes
- Expansion of private sector investment in input supply, and processing and marketing

Funding the LMP

Although livestock contributes about 26.7% to agricultural GSDP in Bihar, the current budget allocated for the sector is only 3.7% of the state agricultural budget (Data.gov.in, 2016).

Meanwhile the budget for the livestock sub-sector plan in the 5-years Bihar ARM is about INR 2,600 crores, while in the LMP it is about 6,300 crores, or about 240% higher.

The major explanation for the difference in the total investment costs in the ARM and LMP plans is the difference in the cost of the chicken development scheme and related interventions (see Table 2 and Figure 1). The investment in new poultry farms (broilers and layers) and intensified backyard operations is also the major cost in the overall LMP budget (Table 1).

Of the proposed investments of INR 6,271 Crores in the budget for the LMP —only 16% is expected to come from the public sector (Gov't, NGOs, COMFED, etc.), but 84% from the private sector (see Table 1). The investment in new poultry operations also explains the high private sector investment cost found in the overall LMP budget (Table 1).

Table 1: Public and private shares of the total five-year B-LMP investment cost in INR crores

	Public	Private	Total in INR crores
Total costs	988	5,283	6,271
Percent of the total	16%	84%	100%

Source: Bihar LMP analysis

Investment costs by value chain

Dairy value chain budget

The total dairy value chain improvement investment costs for the LMP 5-year period (2018-19 to 2022-23) is INR 1,285.2 crores; out of which 33% is expected to come from the private sector, while the rest (67%) is expected to be funded by the public sector (Gov't, NGOs, COMFED, etc.). The investment cost for milk marketing and processing takes the highest share of the total investment (about INR 643 crores, 50%) and includes COMFED which is part of the public sector. 53% will be private sector investments in marketing and processing.

Chicken value chain budget

The total investment for the poultry VC roadmap required over the 5 years LMP is INR 4,855 crores. The private sector invests 98% of the total required and the public sector only 2%. The investment in new poultry farms, broilers, layers and intensified backyard operations is the major cost in the chicken VC budget. Except for contributing to improving health and extension services, the other investment requirements are private sector, indicating the predominant responsibility which can be allocated to the private sector investors, including smallscale farmers, to transform the chicken industry in Bihar.

Goat value chain budget

For improvement of the goat VC during the LMP, the total investment required is INR 17.2 crores. The private sector is expected to invest almost 53% of the total required. The estimated investment from the private sector is INR 9.2 crores, and this is associated with the establishment of local slaughter houses and export abattoirs. The public- sector share is 47% or INR 8 crores, for breeding farms, including the transfer of more productive goats to women and scheduled castes (men and women).

Buffalo value chain budget

For improvement of the buffalo meat VC during the LMP, the total investment required is INR 28 crores. The private sector invests almost 72% of the total required and the public sector 28%. The focus of the investments is breeding and processing of meat and hides, and the estimated investment cost coming from the public sector, mainly the Bihar state government, amounts to INR 8 crores to increase the number of breeding farms to help improve the genetics of local breeds. The investment amount expected from the private sector is 20 crores and focuses on slaughter houses and tanneries.

Pig value chain budget

The total investment requirement for the 5 years LMP roadmap for the pig VC amounts to INR 85.2 crore. The major portion of this investment is expected to be for establishment of new pig farms (92%), both large scale commercial and small-scale operations. Thus, it is not surprising that 81% of the total investment is expected to come from the private sector, including existing farmers, and only 19% from the public sector, mainly to support genetic improvement.

Share of the total five-year B-LMP investment cost by budget source

The VC improvement investment costs categorized into seven major intervention areas – feed, genetics and breeding, animal health, research, extension, establishment of new chicken and pig farms, and marketing and processing.

The investment cost for establishment of new farms (mostly for poultry, but also pig farms) takes the highest share of the total investment (about INR 4,639 crores, or 74%) and 99% is proposed to be funded by the private sector. The second highest investment is INR 709 crores for marketing and value addition, or 11% of the total and which is 53 % to be covered by the private sector.

The main public- sector investments account for most of the other intervention costs, and it is important to emphasize that most of the investments in feed, extension, research and health commonly serve all the value chains.

Table 2: Investment costs by intervention areas

No	Investment Intervention	Investment cost (INR crores)			Percent share (%)
		Public	Private	Total	
1	Animal feeding	10	86	96	1.5%
2	Animal breeding and genetics	214	201	415	7%
3	Animal health	185	-	185	3%
4	Research	200	-	200	3%
5	Extension	28	-	28	0.5%
6	Establishment of new chicken and pig farms	15	4,624	4,639	74%
7	Marketing and value addition	336	373	709	11%
Totals		988	5,283	6,271	100%

Source: Bihar LMP analysis

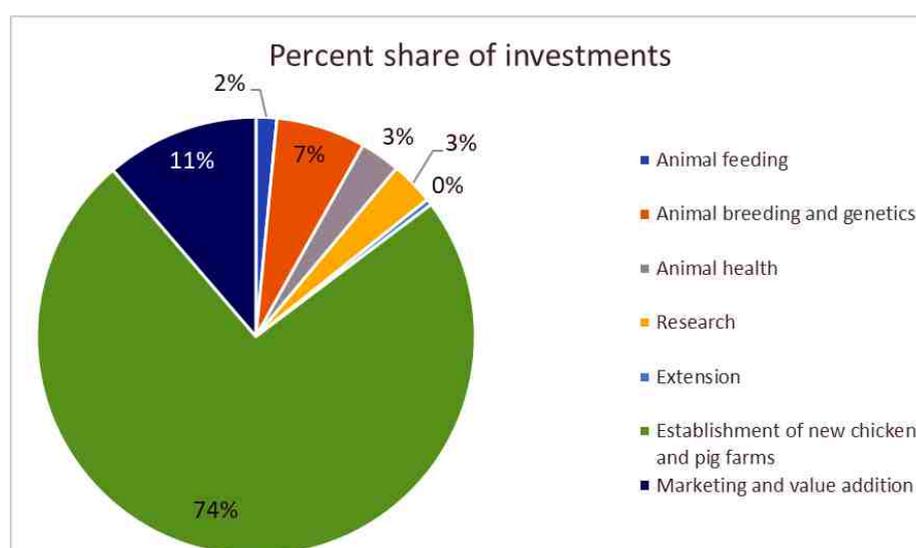


Figure : Share of the total five-year B-LMP investment cost by major intervention areas
Source: Bihar LMP analysis

Convergence of the LMP and Bihar Agricultural Road Map (ARM)

The Bihar LMP is complementary to and supports the implementation of the livestock sub-sector of the Bihar ARM. In developing the LMP value chain roadmaps, the livestock segment of the Bihar ARM was analyzed to ensure the complementarities of each and the added value of the proposed LMP intervention investments, where needed. The LMP roadmaps were also analyzed to identify any potential overlaps between ARM and LMP strategies, activities, and activity budgets to avoid duplication and help DAFR to rationalize the ARM and LMP activities where needed to improve the implementation potential of the ARM livestock sub-sector plan.

The high degree of complementarity between most activities in the LMP and ARM and the added value of other LMP activities suggest that doing most investments proposed in the ARM and LMP could strengthen the ARM, after rationalization of the overlaps in the investments in both plans to avoid duplication. This will be a key job for ministry investment decision makers, with input from DAFR, to get the most out of the ARM and LMP.

In most cases where overlap exists between the LMP and ARM, including in the establishment of more broiler and layer farms, and where complementarity exists, such as in the case of buffalos and pigs for meat, the two plans could easily be rationalized to provide one coherent plan which would include the best elements of both, and this would enhance the impacts of the planned ARM investments in the Bihar livestock sector, as shown by the analysis of investment returns in the LMP.

Finally, if the proposed ARM and LMP investment activities were successfully implemented, the anticipated transformation of the sector has the potential to impact positively on rural livestock keepers by increasing their incomes and on urban consumers through lower animal product prices. The success of the ARM and LMP are also critical to the achievement of food and nutrition security at the household and state levels.

Moreover, if the gender and social inclusion recommendations for ensuring the investment opportunities outlined in the LMP are carried out it would help ensure positive impacts on gender equality, social inclusion and the incomes and welfare of disadvantaged groups. Thus, all strata of Bihar would benefit from the ARM and LMP. (Full details on the convergence of the LMP and ARM are provided in Section 8: Added Value of the LMP and complementarity with the ARM.)

3 Dairy value chain (cow and buffalo) roadmap (2018-19 to 2022-23)

3.1 Key Livestock Sector Analysis (LSA) results and conclusions- the basis for the LMP recommendations

The dairy herd and industry in Bihar have been growing steadily in recent years. Bihar is recognized for its relatively high total milk production from cows, buffalo and goats (ninth highest milk production state in India). The Bihar Milk Co-Operative Federation Ltd. (COMFED), which is supported by the government, has played a key role in developing the dairy subsector, and in raising dairy cow productivity and milk production, as well as in raising dairy farmer incomes through its coops.

To meet the growing milk demand in the state, the productivity of the dairy herd will need to continue to improve. Stakeholders consulted during the LMP indicate that development of the dairy industry will require stronger support services, such as breeding and animal health services and improved access of milk producers to feed inputs. Achieving these improvements will also necessitate investment by private sector dairy processors, particularly in areas where COMFED has not reached and the strengthening of public institutions that provide necessary support.

Milk from cows and buffalo are not presently separated in the collection and processing phases of the dairy value chain. Acknowledging the unique characteristics of cow and buffalo production systems and management, including ownership patterns, and in order to identify unique technical and policy interventions which could impact positively on one or the other, the investment analysis for cow and buffalo dairy was carried out separately in the LSA. This differentiated analysis also allowed the LMP team to analyze whether specialized buffalo milk and milk products collection, marketing and processing which would create a price premium for buffalo milk and higher incomes for buffalo milk producers, which could potentially benefit scheduled castes and women. Meanwhile, the contribution of goats to state milk production is very small, but it is critical to women and scheduled castes, who keep most of the goats in the state. Therefore, while the focus is on milk from cows and buffaloes, goat milk production is also analyzed in the LSA and LMP.

Cow dairy value chain analysis – summary of LSA results

One of the policy decisions facing the government of Bihar is whether to continue to encourage dairy farmers give priority to increasing the number of crossbred cows (local cows crossed with exotic dairy cow breeds) resulting in farmers diminishing their numbers of local or indigenous cows, or to institute a policy of incentivizing dairy farmers to use local animals and improved local breeds (both cattle and buffaloes) for milk production instead of crossbred cows, including improved local buffaloes. This would require the government of Bihar to invest in improving the genetics and number of local cows and buffaloes and result in the number of crossbred cows declining over time. This policy and investment strategy would result in production of A2 milk (see the footnote below), which attracts a higher price than milk from crossbreds.

The cow dairy improvement intervention analysis in the LSA was thus done for three scenarios.

- Business as Usual (BAU) scenario – BAU represents the base case scenario of analyzing the impacts of continuing the current type and level of investment and recurrent spending on milk production, farmer incomes, and the dairy contribution to GSDP during the 15 years LSA analysis period.
- With Intervention-1 (WI-1) scenario – Additional investment to improve the productivity of buffaloes and indigenous and crossbred cattle, in addition to raising milk production by increasing the population of crossbred cattle. This scenario is aimed at meeting the projected milk consumption requirements of the state over the 15-year LSA period.
- With Intervention-2 (WI-2) scenario – Additional investment to improve the productivity of buffalo and indigenous and crossbred cattle in addition to population increase among the improved indigenous cattle – This scenario is aimed at exploiting disease, feed shortage and heat resistance traits of indigenous cattle breeds and satisfying the growing demand for A2 milk².

The percent changes in milk supply from the base year (2017-18) to 2032-33 or over 15 years under the BAU, WI-1 and WI-2 scenarios are projected to be 37%, 181% and 91%, respectively. Meanwhile, the increase in milk demand by the year 2032-33 under the BAU, WI-1 and WI-2 scenarios is projected to be 59%, 101%, 78%, respectively. The milk and dairy production-consumption balance (production over consumption in percentages) is projected to be 59% and 101% in 15 years under the BAU and WI-1 scenarios, indicating that the WI-1 investment will be required to ensure no production-consumption gap. although an increase in milk production can be expected under all the three scenarios, only under WI-1 can projected milk consumption requirements in 2032-33 be met.

Furthermore, the WI-1 scenarios for the cow dairy improvement interventions for indigenous and crossbred cattle result in IRRs of 13% and 50% and BCRs of 1.1 and 1.9, respectively³. Moreover, under WI-1, the additional investment interventions also result in 40% to 150% increases in income per animal.

Thus, we can conclude that the intervention scenario to be recommended is WI-1 and not WI-2 or BAU since WI-1 contributes far more than WI-2 and BAU to improving milk production and incomes, as well as to meeting future demand requirements, and to achieving other state development objectives through the proposed investments in the dairy value chain.

Buffalo value chain analysis – summary of LSA results

Buffalo is one of the fastest-growing livestock value chains (VCs) in the state. It contributes to about 39% of the milk and 23% of the meat production of the state (as a secondary product). The development of the buffalo industry is constrained by insufficient supply of high-quality dairy buffalo genetic stock, inadequate feed supply and inadequate extension services to improve management and feeding, and especially inadequate AI for buffalo breeding and health services. Other pressing constraints highlighted by stakeholders include inadequate financial and credit facilities, inadequate milk collection and distribution centres and inadequate abattoir and meat processing plants. Poor sanitary and phytosanitary conditions are also considered to be major constraints to realizing proposed meat export potential.

² A2 milk is the milk that contains only the A2 type of beta-casein protein whereas A1 milk contains only A1 beta casein or A1 type variant. A1 protein variant is commonly found in milk from crossbred and European breeds of cattle. A2 milk is found in the indigenous cows and buffaloes of India (and Asia as a whole) (Prasanta B. et.al. 2016).

³ The investment analysis for WI-2 was not done since the investment costs would be almost the same as in WI-1 and thus the ROIs (IRR and BCR) would certainly be lower than for the WI-1 crossbred cow scenario.

In the business as usual (BAU) scenario for buffalo, by 2032-33, the change in production from the base year (2017-18) is projected to be only 45% each for meat and milk, while the 15-year change in meat and milk production in the WI scenario in 2032-33 will be about 62 and 78%, respectively. Also, the WI scenario results on average in additional income per animal of about INR 2,094 across the livestock production zones in Bihar. The buffalo meat and milk improvement interventions under WI also result in an attractive IRR value of 15%. The GSDP contribution by 2022-23, meanwhile, is expected to increase by 45% for meat and 67% for milk over the base year under the BAU and WI scenarios. Milk provides the highest GSDP share from the buffalo production system, compared to meat. The GSDP contribution of milk is projected to increase by 76% in 15 years (by 2032-33) under the WI scenario compared to the base year, increasing from INR 6,540 to 11,520 crore. In the BAU scenario, by 2032-33 the GSDP contribution of milk increases by only 45% from the base year.

In conclusion, the dairy VC analysis in the LSA shows that cow and buffalo dairy in Bihar needs to continue genetic improvement through crossbreeding of cows with exotics and buffaloes with improved dairy buffaloes. As well, additional private investment in value-adding processing is needed to help ensure more milk, both from cows and buffaloes is collected, to overcome the projected 41% milk and dairy supply shortage in 15 years. Improvement of local cows for A2 milk will not close the milk supply gap.

3.2 Five-year LMP Vision for the dairy VC

A 50% increase in milk production and 62% increase in GSDP contribution from dairying is achieved through improvements in the genetics, feed, and health of both cattle and buffalo, via better inputs, including feed, wider coverage of AI and health services, and extension education focusing on animal husbandry, as well as by supporting improvements in marketing and processing of milk and milk products along the dairy value chain.

3.3 Investment scenarios analyzed

In the 5-years context of the LMP, the dairy value chain investments for both cows and buffaloes are analyzed in two scenarios; BAU (Business as Usual) and WI (With Intervention, which represents the WI-1 scenario considered in the LSA).

- Business as Usual (BAU) scenario- Represents the base case or existing scenario with the analysis showing the impacts of continuing the current type and level of investment and recurrent spending on milk production, income per animal, and contribution to GSDP throughout the LMP analysis period of 5 years.
- With Intervention (WI) Scenario – Increasing the investments in buffaloes and indigenous and crossbred cattle to improve their productivity, in addition to raising milk production through increasing the population of crossbred cattle⁴. This scenario is aimed at meeting the milk consumption requirement of the state in 15 years.

3.4 Description of the Dairy Production Systems

The dairy value chain analysis includes cattle (both indigenous and crossbred), as well as buffaloes and goats, although the milk from goats does not transcend home consumption. The dairy system in Bihar is also characterized mainly by small household (HH) herds of animals. The average HH herd size of indigenous and crossbred cattle in all the livestock production zones is about 2 animals. However, in the southern livestock production zone, a larger HH herd size for indigenous cattle is observed. In this zone, the average HH herd size of indigenous cattle is about 4 animals. Buffalo production is also dominated by small herd sizes. The average

⁴ Crossbreeding of cattle was analyzed following the Bihar Breeding Policy recommendation.

HH herd size of buffaloes in all production zones is about 2 animals. Farms with large herd size and commercial dairy systems are insignificant in Bihar and are only involved in dairy cow production. The large/commercial cattle dairy production system in Bihar accounts for only about 0.1% of the total cattle population and 0.2% of total cow milk production (Table 12).

A description of the base-year dairy production systems describes the productivity parameters of the farm system herds in the three designated livestock production zones (Northern, Central and Southern) (Table 3). The production zones were created to highlight their differences in suitability for different livestock production systems and animal types. The northern zone is flood prone and summer season feed shortage is common due to flooding. The Central zone is relatively comfortable in temperature and rainfall for livestock and improved/exotic breeds while the southern zone is drought prone. In all zones dairy animals are fed in stalls; with crop residues providing the major share of the feed resources. In the southern zone, however, there is some level of grazing on available communal lands. In conclusion, both cattle and buffalo are more productive in the central zone with average daily milk production of about 3.5 and 7 L per day for both indigenous and crossbred cattle (Table 3), respectively, and about 5.5 L for buffalo (Table 4).

Table 3: Cow dairy production system -- average productivity parameters

Parameters	Northern zone		Central zone		Southern zone	
	Indigenous breed family dairy	Crossbred family dairy	Indigenous breed family dairy	Crossbred family dairy	Indigenous breed family dairy	Crossbred family dairy
Herd size	2	2	2	2.5	4.0	2.0
Parturition rate	0.40	0.45	0.45	0.55	0.40	0.45
Mortality rate (female juveniles)	10	7	9	7	6	10
Mortality rate (male juveniles)	25	35	28	35	18	35
Mortality rate (female –sub-adult)	8	6	8	5	5	8
Mortality rate (male sub-adult)	20	35	30	35	25	35
Mortality rate (Female adult)	5	5	5	4	5	8
Mortality rate (Male adult)	15	20	15	20	5	20
Lactation length (days)	225	300	230	300	220	300
Daily milk production (L)	3.0	6.2	3.5	7.0	2.5	5.0

Table 4 : Buffalo production system -- average productivity parameters

Parameters	(Northern zone) Indigenous breed small	(Central zone) Indigenous breed small	(Southern zone) Indigenous breed small
Herd size	2	2	2
Parturition rate	0.40	0.45	0.40
Mortality rate (female juveniles)	10	8	3
Mortality rate (male juveniles)	40	35	35
Mortality rate (female sub-adult)	8	5	5
Mortality rate (male sub-adult)	30	30	30
Mortality rate (female adult)	3	3	3
Mortality rate (male adult)	25	25	25
Off-take rate	35	35	35
Dressing percentage	54	54	54
Lactation length (days)	300	300	290
Daily milk production (L)	5	5.5	4.5

3.5 Overall LMP targets under with intervention scenario

Overall targets at state level

- In the LMP base year (2017-18), there are about 61 lakh crossbred dairy cattle in Bihar and the number is targeted to increase to 76 lakhs by 2022-23. This will be a 24% increase (see Table 5 below)
- The indigenous cattle population in 2017-18 is about 71 lakhs and it is targeted to reach 59 lakhs by 2022-23, a decrease of 17% (Table 5 below)
- The buffalo population in 2017-18 is about 88 lakhs and the number is targeted to reach 99 lakhs by 2022-23. This will be a 13% increase (Table 5 below)
- In 2017-18, milk production is about 896 crore L and it is targeted to grow to 1,344 crore L by 2022-23, a 50% increase over 5 years (Table 12 below)
- The contribution of milk to Gross State Domestic Product (GSDP) is about INR 13,650 crores in 2017-18 and is expected to increase to INR 20,808 crores in 2022-23, a 52% increase (Table 13).

Overall targets at animal and state and zonal herd levels

Dairy cattle

The animal and herd level targets which could be achieved by farmers adopting the proposed dairy improvement technologies are as follows, for indigenous and crossbred cattle:

- Parturition rate of indigenous and crossbred cattle increases from the current 40 and 45% to 45 and 50%, respectively
- The sex ratio at birth of females to males is around 80% for cows that receive sexed semen and sex fixer treatments (Mohteshamuddin 2017)
- Lactation length (in days) of indigenous cattle increases from the current 225, 230 and 220 days in the northern, central and southern zones to 230, 240 and 230 days, respectively
- Daily milk production of indigenous cattle increases from the current 3, 3.5 and 2.5 L/day in the northern, central and southern zones to 5, 5.5 and 4.5 L/day, respectively (MAFW 2017; Vaidya 2017)
- The current daily milk production of crossbred cattle is 6, 7 and 5.5 L/day in the northern, central and southern zones, respectively, and will increase by an additional four L/day in each of the production zones (while MAFW 2017 and Vaidya 2017 reported for every litre of milk 0.4 kilograms (kg) of concentrate is required (keeping genetics in mind))

Buffaloes

- Parturition rate increases from 40% to 45%
- Daily milk production of buffaloes increases from the current 5, 5.5 and 4.5 L/day to 6, 6.5 and 5.5 L/day, in the north, central and southern zones, respectively (MAFW 2017; Vaidya 2017);

Goats

The dominant goat breed of Bihar, the Black Bengal, is highly prolific. It gives on average 1.5 kids per birth, but milk produced does not exceed consumption by goat kids and household consumption. Therefore, for goats, daily milk production and lactation length are not expected to change. However, there are other parameters which have an impact on milk productivity/production (parturition, prolificacy and mortality rates) are listed below with the change targeted in the LSA herd model, under the WI scenario.

- Parturition rate to increase from 1.25 to 1.5 (Miah 2016; Haque et al. 2013)
- Prolificacy rate to increase from 1.5 to 2.0 (Miah 2016; Haque et al. 2013)
- Mortality rate to decrease by 50% (Kumar et al. 2003); Chowdhury et al. 2002 reported mortality reductions of up to 70% through implementation of the above listed interventions

Table 5: Cattle and buffalo population targeted for 5 years under the WI scenario (in lakhs)

	Production zone	Breed	Livestock population (in lakhs)						
			Baseline 2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	% change
Cattle	Northern	Indigenous	39.0	37.6	36.2	34.8	33.5	32.3	-17.3%
		Crossbred	11.6	12.1	12.6	13.2	13.8	14.4	24.0%
	Central	Indigenous	14.1	13.6	13.1	12.6	12.1	11.7	-17.3%
		Crossbred	43.7	45.6	47.6	49.7	51.9	54.2	24.0%
	Southern	Indigenous	18.3	17.6	17.0	16.3	15.7	15.1	-17.3%
		Crossbred	6.0	6.2	6.5	6.8	7.1	7.4	24.0%
	Commercial	Crossbred	0.07	0.08	0.08	0.08	0.09	0.09	17.2%
	Bihar	Indigenous	71.4	68.7	66.2	63.7	61.4	59.1	-17.3%
		Crossbred	61.3	64.0	66.8	69.8	72.8	76.0	24.0%
	Total		132.7	132.8	133.0	133.5	134.2	135.1	1.8%
Buffalo	Northern	Indigenous	40.7	41.7	42.7	43.8	44.9	46.0	13.1%
	Central	Indigenous	35.4	36.3	37.2	38.1	39.0	40.0	13.1%
	Southern	Indigenous	11.8	12.0	12.3	12.7	13.0	13.3	13.1%
	Total		87.8	90.0	92.2	94.5	96.9	99.3	13.1%

Source: Bihar LMP analysis

3.6 Opportunities, challenges, and strategies

Opportunities for dairying

- Demand for milk and milk products in Bihar is increasing significantly
- Widespread use of crossbred cows by farmers who are commercially oriented
- Encouraging chilling, collecting and processing infrastructure of COMFED
- Suitability of the Ganges river banks (Diara area) for rearing more buffaloes and improving milk production
- High fat milk content fetches an attractive price for producers, and supports the livelihoods of marginalized people
- The availability of already established milk processing capacity; availability of food ingredient businesses for baking and confectionary
- Access to markets of Bangladesh, Nepal and North-East India which are milk deficit and are in close proximity to Bihar
- Central zone offers more urbanization and is an education hub, while the south shows opportunity for exploiting the tourism circuit to promote UHT /cheese/yoghurt through specialized wholesalers and retail stores
- New trends in food preferences for the younger generation: cheese, UHT milk, yoghurt, and introduction of new and consumer friendly retail packs and probiotics

- Increased involvement of women in dairy production by training them in all aspects of husbandry and forming self-help groups
- Involving women in dairy processing of value added indigenous dairy products by forming self-help groups and establishing small processing units to cater to the local market after branding these products by quality standard certification.

Table 6: Challenges of dairy production and strategies to address these challenges

Challenges	Strategies to address challenges
Feed	
<ul style="list-style-type: none"> • Scarcity of feed and fodder during two to three months of flood period • Lack of availability of green fodder March to June; lack of quality fodder seeds • High density of cattle population and limited grazing land; lack of availability of quality feed • Fluctuating prices of dry fodder (INR 4–12/kg). • Low milk production (in southern zone) • Scarcity of green fodder (in southern zone) • Insufficient rainfall impacting quantity and quality feed (in southern zone) • Low quality of the concentrate feed (> 100 feed plants, but feed produced does not meet requirement of cows) • High cost of feed and lack of affordability by marginalized castes, including women leads to low productivity 	<ul style="list-style-type: none"> • Conservation of forage to address feed shortage during the 2-3 months of flooding • Establishment of fodder banks; complete feed block development (green fodder, concentrate, dry fodder and mineral mixture); cultivating perennial grasses –Napier cross; import fodder seed from other states e.g. Berseem, sorghum etc.; improve productivity/ha of land; where possible increase land area under fodder, the supply of improved seeds • Availability of green fodder during lean period (April–June) (in central zone); • Conservation of green fodder in form of hay and silage; buffer stock of feed for scarcity period; ensure availability of concentrates in market, year-round; improving the nutritional value (treatment using chemicals) of less utilizable dry fodders e.g. maize Stover, Kadbi etc. • Production of fodder (Napier, sugarcane grass, hybrid Napier, sorghum, Moringa Olerifera); establishing cattle feed plants for provision of concentrates and rations for milking cows required; Improve the poor-quality forages through treatments • Target-based feed interventions (with subsidy for concentrate feed and fodder seeds) for marginalized castes and women to increase productivity • Feed improvement knowledge taught to women and marginalized castes

⁵ South and South West Bihar are more vulnerable to drought and often experiences severe drought (source. Bihar State Disaster Management Authority. 2018)

Challenges	Strategies to address challenges
Animal Health	
<ul style="list-style-type: none"> • High mortality; high parasite infestation; alkali disease due to toxicity of selenium; low mineral contents in feed and fodder • Insufficient animal health services (disease control, treatment); no timely deworming and vaccination • High young stock mortality; villages are scattered, and low veterinary services coverage exists • High incidence of mastitis (clinical and subclinical) heavy protozoan infestation (Trypanosomiasis, Babesios, Theileriosis, Anaplasmosis etc.) • Lack of access to veterinary services by women and marginalized groups due to communication, mobility issues and affordability • Lack of knowledge training to women on disease management 	<ul style="list-style-type: none"> • Improve management at farmers level; sufficient quantity of colostrum feeding at the right time (calves); control of round worm infestation (calves); control of worm infestation (all); vaccination against highly infectious diseases (HS, BQ, FMD etc.) at proper age and time • Equipment for proper drainage of water from paddy fields and less use of paddy straw from water logged fields; supplementation of area specific minerals • Increase availability of vet services through seasonal health camps at village level; strengthen and operationalize the existing sub-divisional level diagnostic facilities; establishment of referral diagnostic labs at district level; make and implement year-round calendar for deworming; strengthen vaccination activities (HS, BQ, FMD and Brucellosis) • Improve calf management • Implement target-based doorstep veterinary services • Develop capacity of women for disease management through self-help group trainings
Animal genetics/breeding	
<ul style="list-style-type: none"> • Lack of quality animals for herd replacement and establishing new farms • Anoestrous and repeat breeding • Women lack access to breeding knowledge and services • Lack of affordability for marginalized groups to access better breeds and high feed costs • Widespread use of crossbred cows by farmers who are commercially oriented continues 	<ul style="list-style-type: none"> • Grading up of local breeds; crossbreeding through AI with good quality semen, increase in the number of semen production centres and AI centres; and reproductive management interventions • Selection among the local breeds; interbreeding and crossbreeding; upgrading indigenous cattle • Regulate improvement of indigenous breeds by crossing with exotic dairy cattle breeds -- not presently regulated or outlawed by the state • Training and capacity building of women for breed improvement through SHGs and target-based breed and feed improvement strategies for marginalized groups

Challenges	Strategies to address challenges
Post-production	
<ul style="list-style-type: none"> • Low urbanization in the north production zone • COMFED monopoly in the central production zone • Low productivity, poor milk collection system in the south production zone 	<ul style="list-style-type: none"> • Improve access to finance; increase availability of uninterrupted power supply; chilling at source to improve the quality of milk; lack of cold chain infrastructure • Collection system: • Enhance milk collection at the village level with SMS based mobile payment system • Create new milk producer societies and district unions, including when relevant women only groups at village level and promoting women leaders in dairy cooperatives. Training and capacity building of women for leadership roles and dairy cooperative management • Separate collection of milk by species to convert to higher value-added products – additional costs only for separate transport to dairy plants • Improve milk transport from collection points through refrigerated/insulated tankers for far areas • Processing: • Establish milk condensing plants for ease of transport; cheese plants for production of mozzarella cheese and feta cheese • Establish processed cheese plants • Establish additional processing facilities to improve procurement and processing • Sales and retailing • Establish customs and formalities agents for milk products in northeast states and seek export permissions from the National Dairy Development Board to access Nepal and Bangladesh markets • Creation of seamless cold chain for product movement • Improvement of quality standards of products • Promotion of local products to help local farmers and add to state GSDP • Introduction of new packaging and products • Promotion and reservation of employment for women and SC/ST in processing plants

3.7 Cow and buffalo dairy improvement interventions

The most prominent production challenges faced by the dairy sub-sector in Bihar include:

- low quality and scarcity of feed, especially green fodder
- low mineral content in feeds and fodder
- high mortality
- high parasite infestation

- high incidence of mastitis and trypanosomiasis
- lack of quality animals for herd replacement and establishing new farms
- anoestrous and repeat breeding

So far there is also limited involvement of the private sector milk in processing and marketing.

The investment context

Cow and buffalo dairy is the most important commodity value chain of the Bihar livestock sector. It contributes about 67% to the livestock GSDP and 21% to the agricultural GSDP (LSIPT results and Bihar Directorate of Economics and Statistics 2016). In Bihar 57 lakh households' own cattle and directly depend on the dairy sector for their livelihoods (Ministry of Agriculture and Farmers Welfare, 2017); and many households make their living along the dairy value chain. Dairy production is found in all areas of the state. As such, the proposed dairy improvement interventions will target the whole state focusing on both indigenous and crossbred cattle and buffaloes. The cow and buffalo dairy improvement interventions include improvements in the genetics and feeding of animals, health and extension service delivery, marketing and processing of milk and milk products, and research. The foresight assessment for these improvement interventions was done under two scenarios; BAU (Business as Usual) and WI (With Intervention).

- Business as Usual (BAU) scenario – BAU represents the base case scenario with the analysis showing the impacts of continuing the current type and level of investment and recurrent spending on the milk VC and contribution to GSDP throughout the LMP analysis period of 5 years.
- With Intervention (WI) Scenario – Additional investment in improving productivity of buffaloes and indigenous and crossbred cattle in addition to raising milk production by increasing the population of crossbred cattle. This scenario is aimed at meeting the milk consumption requirements of the state in 15 years.

WI Scenario - Cow and buffalo dairy improvement targets and interventions

Feed

Scarcity of feed and fodder for dairy is perhaps the most pressing constraint to increasing animal productivity and total production. Feed is particularly scarce during the 2-3 months of the flood period each year. Land for feed production is highly constrained and access to feed markets is also limited. More feed needs to be produced at the smallholder farm level, but also commercially at large scale, and coops need to be assisted to gain skills needed to bulk purchase and distribute to coop members. The constraints facing women dairy producers are particularly constraining. All stakeholders in the dairy VC need to work harder and more closely to improve the whole feed value chain, especially in improvement of feed production, quality and marketing.

The following feed improvement targets and interventions need to be given priority:

- Adoption of targeted fodder production area on 50% of total available area by 2022–23
- Increase rehabilitated permanent pasture land available for grazing by 50% by 2022-23
- Implement year-round forage production through the combination of perennial and annual forages⁶ by overlapping perennial and annual forage crops in the different seasons
- Introduce short-duration forages in gap periods of main season crops and grown on residual moisture

- Introduce intercrops in widely spaced row crops. Cotton, sugarcane and grain crops like maize and sorghum offer scope for adding short-statured forage crops. Inclusion of these forage crops does not affect row-crop production and will benefit the main crop in several ways
- Promote use of dual-purpose crops for both food and feed
- Introduce the integration of perennial forages on bunds and boundaries. Control of stray animals should get enough emphasis to protect planted forages
- Improve community management of communal grazing land
- Replace low-yielding annual grasses with high-yielding perennial grasses that are adapted to the prevailing conditions of each of the production zones
- Promote silage production in flood prone areas to meet feed scarcity in flood season
- Incentivize local entrepreneurs to manufacture feed since the few main ingredients like maize, wheat bran, rice bran, and pulse and their by-products (e.g. Chuni) are available
- Establish on-farm animal productivity enhancement through balanced ration
- Establish fodder seed production farms; support marketing and strengthen forage seed quality regulatory bodies

Genetics

- Increase AI to 50 lakh servings per annum by 2022–23
- Increase the percent of sexed semen/sex fixer used compared to total inseminations to 20% by 2022-23
- Establish a new semen production centre⁷ with a capacity of about 50 lakh straws per year by 2022-23
- Rehabilitate 9 liquid nitrogen cryo-vessel storage plants found in Bihar, out of which 4 are currently functional. In the coming five years, target the existing plants
- Of 3 liquid nitrogen production plants none are functional. In the coming five years, rehabilitate the existing plants
- Currently, two cattle breeding farms exist (managed by DAFR; one of which is not functional). The goal is to strengthen the existing 2 farms and establish 2 new ones by 2022-23
- There are currently 1,476 AI centres (livestock development centres) which are managed by DAFR, and 800 are functional. There are another 3,280 private/NGO AI centres. Make all the existing centres functional and establish 500 new ones by 2022-23⁸.
- Currently, there are three frozen semen banks of which two are not functional. Make the non-functional semen banks operational in the coming five years
- Support use of embryo transfer

⁶ Mixed cropping of gramineous and leguminous forages, when managed properly using modern soil and crop management techniques, can yield 180–300 MT of green fodder (30–55 MT of dry fodder) per hectare (ha)/year (ICAR, 2011).

⁷ This semen production centre is already under construction.

⁸ Assumptions include: one AI centre serves 1,500 breedable cattle.

Table 7: Cattle population (from censuses and projections from the LSA)

	Past censuses(in lakhs)		Projected Figures(in lakhs)	
	2007 Census	2012 Census	Base year (2017–18)	WI Scenario 2022-23
Indigenous breeds	105.8	87.6	71.4	59.1
Crossbreeds	19.8	34.8	61.3	76.0
Total cattle	125.6	122.3	132.7	135.0

Source: Bihar LMP analysis, Ministry of Agriculture, 2010 & Ministry of Agriculture, 2014b

Table 7: Cattle population growth rates -- past years and over LMP period (2017-18 to 2022-23)

Livestock population annual growth rate (% change per year)	Over the 2007-2012 Censuses	Future projection (over 2017-18 to 2022-23) for WI scenario
Indigenous breeds	-3.72%	-3.72%
Crossbreeds	11.95%	4.37%
Total cattle	-0.53%	0.35%

Source: Bihar LMP analysis, Ministry of Agriculture, 2010 & Ministry of Agriculture, 2014b

Health

- The target is to keep a vaccination⁹ rate of 80% by 2022–23, and to improve deworming, sanitation, housing, control of flooding and drought
- Increase the numbers of veterinary dispensaries to 1,400 by 2022–23¹⁰
- Strengthen the existing animal hospitals and clinics with various clinical experts and with diagnostic laboratories
- Incentivize replacement of public veterinary service providers with private veterinary service providers where feasible and establishment of PPPs or public providers where no service providers exist
- Implement mastitis control and prevention technologies

Extension

- Increase the coverage of the full package of dairy improvement training by an additional 15% by 2022-23¹¹. Farmers to receive more intensive and continuous training in dairy cattle and buffalo management (especially feeding, breeding, deworming, tick control, hygiene and milk handling and transport)

⁹ Cattle and buffalo currently receive vaccinations for critical diseases at the following percentages: FMD 80% (started from 2015), brucellosis 90% (from 2017), haemorrhagic septicaemia (HS) and black quarter (BQ) 80% (source: expert consultation meetings, Jan-Mar, 2018).

¹⁰ Calculated based on the livestock number and assumption of one veterinary dispensary serving 5,000 animals

¹¹ According to Glendenning et.al. 2010 (<http://www.ifpri.org/publication/review-agricultural-extension-india>) agri-clinic operators get two months training, out of the trainees 47% didn't succeed in the business in the past and agri-clinic operators served for about 500 households. Also, assuming a training centre will give a two months training for 200 trainees/year and currently there are about 57 lakh households that own cattle.

- Increase the number of training centres to eight (one training centre in each regional directorate) by 2022–23, 20 by 2027–28 and 38 by 2032–33.
- Develop these training centres to be engines to produce livestock extension agents (Pashu Sakhi, agri-clinic and agribusiness operators, para-vets/community animal health workers, input suppliers, other private extension service providers and extension service providers at cooperatives, farmer-based organizations, farmer self-help groups, telecommunication extension service providers/operators etc.)
- Promote decentralised training centres in district level dairy cooperatives with more women staff
- Increase the percentage of milk collection centres (MCCs) and milk producer associations providing dairy input supply, animal health, extension and financial services by 50% by 2022-23.
- Support extension service providers (input, advisory and marketing services) through improved regulation, control, and incentives
- Develop/improve/implement needed parliamentary acts, regulations, guidelines and manuals to help the extension services provide better outreach to farmers
- Control unregistered input, advisory and marketing service providers to assure survival of the legal service providers

Research

- Strengthen the ICAR Research Centre for Eastern Region of the central government by diversifying the research done on the livestock sector
- Establish one new state livestock research centre within 5 years
- Make NRC-IF more vibrant in training goat farmers by developing models for different category of farmers and make it a goat semen centre

Marketing and processing

- Increase the capacity of milk collection centres in Bihar state from the current 13% of the total processed milk produced to 20% by 2022-23
- Increase the functional capacity and utilization of existing milk chilling centres
- Establish new bulk milk chilling units with 5,000 L capacity for areas more than 50 km away from existing milk processing plants
- Strengthen existing dairy cooperative societies and establish 5,000 new milk producer cooperative societies (MPCS)¹² in the five years
- Establish 7 new processing plants in the next 5 years to increase production of pasteurized milk and other milk products (UHT, milk powder, ghee, yoghurt, etc.) (3 UHT, 3 powdered milk and 1 ice cream plants)

¹² Currently, 22,191 registered milk producer cooperative societies (MPCS) are found in Bihar, of which 2,688 are women's milk producer cooperative societies (WMPCS). The total membership of all the MPCS is 11,67,500 farmers. Of the total members, female members are 2,50,500 or 21%. All the MPCS, MCC and milk processing facilities serve for both cattle and buffaloes. (COMFED, 2018)

- Strengthen the capacity of milk quality and safety control laboratories
- Enhance the capacity of MCCs to test milk quality (fat, protein, total solid non-fat and antibiotic residues)
- Provide incentives to the private sector to take part in the marketing and processing of milk
- Increase women's membership in women-only cooperatives in new areas and increase the number of women in leadership positions
- Create an enabling environment to establish functional linkages between private milk traders, MCCs, cooperatives (MPCS), and processing plants
- Train farmers and cottage-scale processors in the use of small-scale technologies to create value addition from raw milk (e.g. curd, ghee, paneer, khoa etc.).

3.8 Investment budget

The investment costs of dairy improvement interventions are categorized into six major intervention areas – feed, genetics and breeding, extension, research, health and milk marketing and processing.

The investment cost for milk marketing and processing takes the highest share of the total investment (about INR 643 crores, or 50%) and 53% will be funded by the private sector () (note: the private sector excludes COMFED).

Genetics and breeding accounts for the second highest share of the total investment cost followed by research, health, extension and feed improvement investment costs.

The total dairy value chain improvement investment costs for the LMP 5-year period (2018-19 to 2022-23) add up to INR 1,285 crores; out of which 33% is expected to come from the private sector, while the rest (67%) is expected to be funded by the public sector (Gov't, NGOs, COMFED, etc.) ().

It is important to emphasize that most of the investments in feed, extension, research and health commonly serve other value chains besides dairy, such as the meat (buffalo, goat, chicken and pig) and egg value chains.

Investment Intervention	Unit and/or capacity	Quantity or number	Unit cost in INR crores	Investment cost in INR crores						Budget source and amount in INR crores			
				2018/19	2019/20	2020/21	2021/22	2022-23	Total	Public	Private		
Establish a new semen production center	Centre (with a capacity of producing 50 lakh straws per annum)	1	65.0		65.0						65.0		
Renovate the 3 liquid nitrogen cryo-vessel storages	Vessel with 10 MT L capacity	3	0.35		0.35	0.35				0.35	1.1		
Upgrade 1 breeding farm and add 2 new cattle breeding farms	Farm with capacity of 500 breeding animals	1+2	4.0 to upgrade and 8.0 for new	4.0		8.0				8.0	20.0	10.0	10.0
Make 500 existing AI centres operational and establish 500 new AI centres ¹³	Centre	1,000	0.15 for both	30.0	30.0	30.0	30.0			30.0	150.0	75.0	75.0
Make the existing 2 semen banks functional and add 2 new semen banks	Semen bank	2+2	0.7 to renovate and 3 for new	0.7	3.7					3.0	7.4	7.4	
Sub Total											243.5	158.5	85.0
Extension services													

¹³An AI center is targeted to serve for 1,500 cows and heifers

Investment Intervention	Unit and/or capacity	Quantity or number	Unit cost in INR crores	Investment cost in INR crores						Budget source and amount in INR crores		
				2018/19	2019/20	2020/21	2021/22	2022-23	Total	Public	Private	
Establish new training centres to increase number to 8	Centre (one training centre in each regional directorate)	8	3.0	3.0	6.0	6.0	6.0	3.0	24.0	24.0		
Research												
Upgrade existing research centre and establish new one to perform all livestock research	Centre (1 existing and 1 new Centre)	1 + 1	200.0 for 2					200.0	200.0	200.0		
Animal Health Investments												
Strengthen the capacity of existing veterinary hospitals/Polyclinics	Hospitals/Polyclinics	39	0.75	6.0	6.0	6.0	6.0	5.3	29.3	29.3		
Establish new 300 veterinary dispensaries	Vet. Dispensaries	300	0.45	27	27	27	27	27	135	135		
Sub Total									164.3	164.3		
Grand Total investment									642.3	551.3		91

Table 9 : Investment interventions in milk and dairy product marketing and value addition processing

Investment Intervention	Unit	Quantity	Unit cost in crores	Investment cost in INR crores						Budget source			
				2018/19	2019/20	2020/21	2021/22	2022-23	Total	Public	Private		
Marketing and processing Investments													
Construction of 5 pasteurized milk and other milk products (Ghee, yoghurt ...) processing plants	Unit with 5,00,000 L/day capacity	5	40.0	40.0	40.0	40.0	40.0	40.0		200.0	80.0	120.0	
Construction of 3 UHT milk processing plants in five years	Unit with 1,20,000 L/day capacity	3	65.0		65.0	65.0	65.0	65.0		195.0	130.0	65.0	
Construction of 3 powder milk processing plants in five years	Unit with 200,000 L/day capacity	3	30.0		30.0	30.0	30.0	30.0		90.0	30.0	60.0	
Construction of 3 ice cream production plants	Unit with 10,000 L/day capacity	3	12.0	12.0	12.0	12.0	12.0	12.0		36.0	12.0	24.0	
Currently 22,191 registered milk producer cooperative societies (MPCS) - milk collection centers exist. Establishing additional 5,000 MPCS to improve their milk collection capacity.	MPCS with a milk collection capacity of 70 L/day	5,000	0.02	20.0	20.0	20.0	20.0	20.0		100.0	40.0	60.0	
Establish new bulk milk chilling units (with 5,000 L capacity - for areas more than 50km away from milk processing plants)	a unit with 5,000 L capacity	200	0.1	2.0	3.0	5.0	5.0	5.0		20.0	10.0	10.0	
Strengthen the capacity of milk quality and safety control laboratories (IAHP)	Laboratory	1	2.0				2.0			2.0	2.0		

Table 10: Total investment and share of dairy improvement investment costs from public and private sources (2017-18 to 2022-23)

Investment categories	Investment Intervention	Investment cost (INR crores)			Investment cost share (%)	
		Public	Private	Total	Public	Private
Feed/ breeding/ extension/ research/ health investment	Animal feeding	4.5	6	10.5	43%	57%
	Animal breeding and genetics	158.45	85	243.5	65%	35%
	Extension	24		24	100%	0%
	Research	200		200	100%	0%
	Animal health	164.25		164.3	100%	0%
Milk marketing and processing	Milk marketing and processing	304	339	643	47%	53%
	GRAND TOTAL INVESTMENT	855.2	430	1285.2	67%	33%

Source: Bihar LMP Analysis

3.9 Impacts of interventions

Returns on investment (ROI) over 15 years

The ROI analysis was only done in the 15-year context of the LSA since livestock investments have a long-term gestation. The WI-1 scenario for cow dairy improvement interventions were found to result in IRRs of 13% and 50% and BCRs of 1.1 and 1.9 for indigenous and crossbred cattle, respectively.

Income increases per animal in 5 years

In Table 11 below the annual income per animal from investing in the WI scenario are compared with the income under BAU for the 5th year of the LMP, 2022-2023, to identify the % changes in dairy animal income (with cattle and buffaloes differentiated) associated with WI over BAU for crossbreds and indigenous animals.

Table 11: Cattle and buffalo income per animal under BAU and WI scenarios after 5 years (in INR)

	Production zone	Species	Annual income per animal (in INR) in 2022-23		
			BAU	WI	% change between BAU and WI
Cattle	Northern	Indigenous	1,424	1,676	18%
		Crossbred	6,121	7,927	30%
	Central	Indigenous	3,279	4,170	27%
		Crossbred	15,288	19,711	29%
	Southern	Indigenous	1,652	1,822	10%
		Crossbred	4,735	6,377	35%
	Commercial	Crossbred	18,246	21,532	18%
Buffalo	Northern	Indigenous	9,436	11,383	21%
	Central	Indigenous	10,686	13,047	22%
	Southern	Indigenous	7,726	9,519	23%

Source: Bihar LMP analysis

In Table 11 below the annual income per animal from investing in the WI scenario are compared with the income under BAU for the 5th year of the LMP, 2022-2023, to identify the % changes in dairy animal income (with cattle and buffaloes differentiated) associated with WI over BAU for crossbreds and indigenous animals.

Table 11 above shows that the percent (%) changes in annual dairy animal income associated with WI over the BAU investment scenario, for both cattle and buffaloes, are positive and significant. The annual income changes for crossbreds are more attractive than for indigenous animals, but those for buffaloes compare well to those for crossbred cows. The increase in annual income per animal is highest for crossbred cattle in all zones, compared to indigenous cattle and buffaloes in all zones. Meanwhile, not surprisingly, in terms of absolute income amounts, the highest incomes per animal under either scenario (WI or BAU) is observed to be in commercial dairying, followed by crossbred cows in the central zone (with its preferable agroecological conditions for dairying) and for income from buffaloes in all production zones.

Milk production

Table 12: Cattle, buffalo and goat milk production projected for 5 years under WI scenario (in lakh L)

	Production zone	Breed	Milk production (in lakh L)						
			Baseline 2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	% change
Cattle	Northern	Indigenous	6,426	6,717	7,022	7,340	7,672	8,020	24.8%
		Crossbred	6,341	7,116	7,986	8,962	10,057	11,286	78.0%
	Central	Indigenous	3,073	3,160	3,250	3,343	3,438	3,536	15.1%
		Crossbred	32,790	36,493	40,614	45,201	50,305	55,986	70.7%
	Southern	Indigenous	2,396	2,523	2,657	2,799	2,948	3,105	29.6%
		Crossbred	2,599	2,948	3,343	3,792	4,300	4,877	87.6%
	Commercial	Crossbred	95	102	110	119	128	138	45.1%
Sub-total			53,721	59,060	64,983	71,554	78,848	86,947	61.9%
Buffalo	Northern	Indigenous	14,747	15,581	16,463	17,394	18,379	19,419	31.7%
	Central	Indigenous	15,585	16,450	17,363	18,327	19,344	20,417	31.0%
	Southern	Indigenous	3,735	3,961	4,200	4,454	4,724	5,009	34.1%
	Sub-total			34,066	35,992	38,026	40,175	42,446	44,845
Goat	Bihar	Indigenous	1,845	1,971	2,106	2,250	2,404	2,568	39.2%
Grand total			89,632	97,024	1,05,115	1,13,980	1,23,698	1,34,360	49.9%

Source: Bihar LMP analysis

- Milk production from cows increases from 53,721 lakh L in 2017-18 to 86,947 lakh L in 2022-23, an increase of 62% over the 5 years of the LMP (see Table 12).
- Milk production from buffaloes increases from 34,066 lakh L in 2017-18 to 44,845 lakh L in 2022-23, and increase of 32% over 5 years

- Milk production from goats increases from only 1,845 lakh L in 2017-18 to 2,568 lakh L in 2022-23, an increase of 39% over 5 years
- Total milk production from cattle, buffalo and goats increases from 89,632 lakh L in 2017-18 to 134.360 crore L in 2022-23, an increase of 50% over the 5 years of the LMP

Gross State Domestic Product (GSDP) of milk

In the WI scenario, the GSDP contribution of the dairy system increases from INR 13,650 crore in the base year (2017-18) to 20,808 crores in 2022-23, a 52% increase (see Table 13).

Table 13: Cattle, buffalo and goat milk GSDP contribution projected for five years under WI scenario (in crore INR)

Production zone			GSDP (in crore INR)						% change
			Baseline 2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	
Cattle	Northern	Indigenous	496	522	550	579	609	641	29.2%
		Crossbred	486	548	617	696	784	884	81.9%
	Central	Indigenous	401	413	426	439	453	467	16.5%
		Crossbred	5,287	5,852	6,476	7,168	7,933	8,779	66.0%
	Southern	Indigenous	238	248	259	269	281	293	23.0%
		Crossbred	192	218	247	280	318	361	87.9%
	Commercial	Crossbred	11	12	13	14	15	16	47.1%
Sub-total			7,111	7,813	8,588	9,445	10,392	11,440	60.9%
Buffalo	Northern	Indigenous	2,948	3,157	3,381	3,621	3,878	4,154	40.9%
	Central	Indigenous	2,915	3,137	3,376	3,634	3,911	4,209	44.4%
	Southern	Indigenous	676	732	792	858	929	1,005	48.7%
	Sub-total		6,538	7,026	7,550	8,113	8,718	9,368	43.3%
Grand total			13,650	14,838	16,137	17,557	19,110	20,808	52.4%

Source: Bihar LMP analysis

3.10 Activities timeline and sequencing: Gantt chart

Table 14: Activities timeline and sequencing: Gantt chart for 5-years LMP period

Investment Intervention	Activities timeline				
	2018-19	2019-20	2020-21	2021-22	2022-23
Investments to improve feeding					
Establish 3 fodder seed production farms (private/public enterprises in 3 years)					
Commercial animal feeds plants – Construction of 2 plants under COMFED					
Strengthen the existing pasture/forage seed quality control laboratories					
Breeding Investments					
Establish a new semen production centre with a capacity of 50 lakh straws production per annum					
Renovate and rehabilitate the 3 liquid nitrogen cryo-vessel storages					
Strengthen the existing breeding farms and establish 2 new cattle breeding farms					
Establish 1,000 new AI centres					
Make the existing 2 non-functional semen banks functional and increase 2 additional semen banks					
Extension services					
Establish new training centres to increase their number to 8 (one training centre in each regional directorates) by 2022-23					
Research					
Strengthen the existing research centre and establish 1 new centre to do research in all livestock sub-sectors					

Investment Intervention	Activities timeline				
	2018-19	2019-20	2020-21	2021-22	2022-23
Animal Health Investments					
Strengthen the capacity of existing veterinary hospitals/polyclinics in the 5 years LMP period					
Establish new 300 veterinary dispensaries in the 5 years LMP period					
Dairy processing and marketing					
Construct 5 pasteurized milk and other milk products (Ghee, yoghurt ...) processing plants					
Construct 3 UHT milk processing plants					
Construct 3 powder milk processing plants					
Construct 3 ice cream production plants					
Establish 5,000 additional MPCS to improve their milk collection capacity.					
Establish new bulk milk chilling units (with 5,000 L capacity - for areas more than 50 km away from milk processing plants)					
Strengthen the capacity of milk quality and safety control laboratories					

3.11 Complimentary success requirements:

- Making land available for fodder production and production and distribution/availability of fodder seed
- Creating policies and activities geared towards enhancing dairy farming
- Extension education provided at block levels
- Ensuring availability of upgraded animals at reasonable prices
- Good governance and monitoring framework for impact of interventions

- Recruitment of enough staff in animal husbandry department for implementation of interventions
- Conducive policies and regulations for private investment in feed, breed and animal health services and milk processing and marketing

3.12 Gender and social inclusion

Dairy is an important source of livelihoods for women and all members of the marginal communities. As women provide the bulk of the labour for dairying (70%) but are not always able to control the income from milk and milk products, the design of interventions for investments should be careful to empower women. Examples include making sure feed technologies are accessible and affordable to women, while promoting marketing chains that allow women to participate in, and benefit from, the interventions. Extension approaches should consider the differentiated needs and capabilities of men and women, and members of the marginal communities, and should include a household approach to extension or other inclusive method. The interventions in the WI are judged to be able to help women and marginalized communities, in this regard.

3.13 Conclusions

Cow and buffalo milk in Bihar are combined at the time of milk collection and processing so dairying in Bihar encompasses and refers to both species. Dairying in Bihar is the most important commodity value chain in the livestock sector of Bihar. It contributes about 67% to current livestock GSDP and 21% to agricultural GSDP. In Bihar 57 lakh households' own cattle and directly depend on the dairy sector for their livelihoods; and many more households make their living along the dairy value chain. The LSA and LMP analyses show there is much potential for further expansion of dairying in Bihar.

Despite many challenges, Bihar has managed to become one of the highest milk producing states in India, ranking 9th in annual total milk production in 2016/17 (MAFW 2017). This outcome is due in large part to the successful efforts of COMFED, the milk coop federation set up with the help of the government of Bihar. These successes create further opportunities for growth of the dairy sector in the state. Furthermore, the National Dairy Plan (NDP) has allocated funding support of 100 Crores to COMFED for further dairy development.

Important opportunities for further growth and development exist due to: projected increasing demand for milk and milk products; widespread and growing use of crossbred cows and growth in the number of commercially oriented farmers (Bihar LSA results, 2018); the existing collection, chilling, and processing infrastructure of COMFED; suitability of the Ganges river banks (Diara area) for rearing more buffaloes and improving milk production; established fat and SNF¹⁴ based pricing; and access to the markets of Bangladesh, Nepal and North-East India which are in milk deficit and are in close proximity to Bihar.

Dairy production in Bihar is found in all areas of the state. As such, the proposed dairy improvement interventions recommend targeting the whole state and both cattle (indigenous and crossbred) and buffaloes. The cow and buffalo dairy improvement interventions include improvements in the genetics and feeding of animals, health and extension service delivery, marketing and processing of milk and milk products and research.

The returns on the proposed investments in the WI scenario, meanwhile, are very encouraging. The annual incremental increase in income per animal from WI goes from 10% for indigenous cows to 35% for crossbred

¹⁴ Milk solids-not-fat, abbreviated SNF, is the substances in milk other than butterfat and water. They include casein, lactose, vitamins and minerals which contribute significantly to the nutritive value of milk.

cows – with differences also existing between production zones, production systems, and species/breeds. The annual incremental income per animal is highest for crossbred cattle in all production zones, followed by indigenous cattle in the central zone and buffaloes in all zones. In terms of absolute values, the highest income per animal in the WI scenario is observed in commercial dairying, followed by crossbred cattle in the central zone and buffaloes in all production zones.

Total milk production and contribution of the milk to total GSDP will also increase with the WI dairy improvement interventions. Milk production by 2022-23 under the WI scenario is projected to increase by about 50% from the base year (2017-18) production of about 896 crores L. The GSDP contribution of milk under the WI scenario will increase by 52% over the 5 years of the LMP.

The total dairy value chain improvement investment costs for the LMP 5-year period (2018/19 – 2022-23) add up to INR 1,285 crores; out of which 33% is expected to come from the private sector, while the rest (67%) is expected to be funded by the public sector (Gov't, NGOs, COMFED, etc.).

Finally, the primary technical and institutional challenges Bihar faces to further modernize its dairy sector are to ensure milk producers have the support they need to continue the improvement of dairy genetics by crossing local cows with exotics and by also using more improved buffaloes and crossing more local buffaloes with improved locals, as well as to help ensure the improved dairy stock are provided with better management by feeding them better and also by providing them with better vet services. These required dairy investments are embodied in the WI or "with additional investment" scenario tested and recommended in the Bihar LMP.

As well, better training in animal husbandry will need to be provided to farmers, as well as marketing and management skills to coop leaders and members. In this regard, especially important will be extension built upon gender and social inclusion strategies which promote marketing chains that allow marginalized communities and women to participate in, and benefit from, the technical interventions. Moreover, as have been already highlighted earlier, extension approaches will also need to consider the differentiated needs and capabilities of men and women, and members of the marginal communities.

Besides public provision of technical support and extension investments which can help increase milk supply, livestock keepers will still need to have assured markets to encourage them to make the required investments embodied in the WI scenario and recommended in the LMP. To ensure farmers make their investments, we recommend encouraging more public and private investment in value-adding processing to create assured markets for the additional milk resulting from the investments they make. Ample success has been achieved elsewhere when assured markets exist to encourage farmers to make the investments required to increase dairy animal productivity and milk production. This demand-pull strategy of encouraging investment in value-added processing has been found to be highly effective in creating the conditions for dairy transformation (e.g. Andhra Pradesh, Karnataka, etc. in India, as well as in many parts of Kenya, and more recently in Africa in the Southwest Region of Uganda, as well as in the milk shed surrounding Addis Ababa and Bahir Dar in Ethiopia).

These needed investments in processing in Bihar could come from public or private investors, or from PPPs. In addition to the investments already made and those being planned and implemented through COMFED, additional private investments in areas where COMFED is not already established would seem appropriate to consider where they would not compete with those of COMFED. In Andhra Pradesh, for instance, welcoming private sector investment along with public investment has brought over 1.5 million famers into dairying and taken the dairy sector to the next level, enabling AP to meet local demand and also to market dairy products all

4 Chicken value chain roadmap (2018-19 to 2022-23)

4.1 Key Livestock Sector Analysis (LSA) results and conclusions– the basis for the Livestock Master Plan (LMP) recommendations

Chicken is the emerging subsector in Bihar with the most potential for further growth. Increased investment in productivity-increasing interventions will be critical for meeting the growing chicken meat demand requirements. Investment needs to focus mainly on broilers, since the projected growth in egg production at the current level of investment (BAU) will continue to meet the demand requirements of the state. Meanwhile, additional investment in backyard dual-purpose scavenging birds for eggs and meat could raise the incomes of very poor farmers, including women.

Chicken productivity improvement interventions in the LSA target improving the genetics and management of the traditional backyard systems, as well as increasing the number of farms producing commercial broilers and layers. The overall chicken population in Bihar (from all 3 systems) between 2017-18 and 2032-33 (15 years) is projected to grow by about 2.5 times under the BAU (Business as Usual) scenario and by more than 10 times in the WI (With Intervention) scenario. Under the WI scenario, the chicken population is projected to grow in 15 years to 33.8 crores from the current 2.9 crores. The proposed interventions are also projected to result in huge increases in production of chicken meat and eggs. It is projected that chicken meat production by 2032 will increase to 15,49,000 metric tonnes (MT), from 2017–18 production levels of 62,000 MT, an increase of 2,400%. Chicken egg production, meanwhile, is projected to leap from the current 41 crores to 980 crores, an increase of 2,283%.

According to the LSA production-consumption balance analysis, there currently is an 83% and 82% shortfall of egg and chicken meat production, respectively, in terms of meeting demand and large amounts of eggs are purchased from other Indian states. The analysis shows that, with the current level of investment (BAU), the total chicken meat production-consumption gap will further widen and is projected to reach a shortfall of 86% by the end of the 15th year, 2032-33. Thus, unless the WI scenario is adopted, the consumption requirements for chicken meat cannot be met in 2032–33. With BAU, the egg production-consumption gap, is projected to decrease by an annual average of 8% and eventually demand will be met in the 13th year

Meanwhile, the Gross State Domestic Product (GSDP) contribution of chickens overall is projected to show a 1,012% increase under the WI scenario, or about an eleven-fold increase to 2032–33 from the base year. The ex-ante impact assessment of the WI improvements on chicken production, moreover, show very attractive investment returns. The IRR results for the chicken investments is greater than 120% for both commercial and backyard chicken systems. Similarly, the BCR results are 28, 1.2 and 1.1 for backyard, broiler and layer systems, respectively.

Overall, improving and increasing the number of backyard crossbred chickens (for both eggs and meat) could significantly help improve the livelihoods of women and marginal communities, as well as the nutrition of rural

families. For achieving quick and lasting results, private investment and/or a PPP such as the highly practical and profitable relay model found in Ethiopia is recommended¹⁵.

These projected improvements in the chicken sub-sector can only happen with a huge increase in chicken feed availability over the 15-year LSA period, either produced or purchased. At the current level of maize, sorghum and millet produced, chicken production in Bihar is currently (in 2017–18) absorbing only about 4% of the total production of these cereals. However, after 15-years (by 2032–33), given the current production trends for maize, sorghum and millet, the share required by the chicken sector will reach about 74% of the total production of these cereals. This implies the need to dramatically increase production of these cereals, particularly maize, and/or the links to markets to purchase feed from other states will have to be strengthened.

The LSA projects a supply shortage in chicken meat from broilers in 15 years, if the current level of investment (BAU) is continued. Thus, there is need for additional investment (WI) in broilers and this scenario will be analyzed below for the first 5-year LMP period.

Similarly, the LSA projects that the egg supply shortage will be closed by 2030-31, with the current level of investment or BAU, so WI was not recommended in the LSA, especially given the developing feed gap over the 15-year period of the LSA. However, since largescale purchase of eggs from other states is taking place, and feed produced in Bihar is currently available, additional investment in layers is recommended in the first 5-years LMP period to start closing the supply shortage starting now. If this scenario is implemented, the current purchase of eggs from other Indian states can be reduced and the state will be able to produce even more eggs in the following 10-year period of the LSA, lowering the cost of eggs and perhaps enabling sales of eggs to surrounding states. Thus, in the LMP analysis below the investment in the production of eggs will be based on the WI scenario, rather than the BAU scenario reflected in the LSA.

4.2 Five year LMP vision for the chicken value chain

The chicken industry in Bihar will transition to a more knowledge intensive, market-oriented sub-sector adding transformative growth in the amount and value of chicken meat and egg products. Increases in chicken productivity and numbers will result in increases of about 183% and 1,232% in meat and egg production, respectively, as well as a 600% increase in GSDP or state income contribution. The family backyard scavenging system will be transformed by using improved and more productive crossbreeds to help ensure household food and nutritional security, close the state chicken meat production-consumption gap and result in higher income for households and the state, while conserving the environment. The specialized commercial broiler and layer operations will increase in numbers of broilers and layers per production unit, numbers of units, and numbers of farms.

4.3 Investment scenarios analyzed

In the investment analysis done to create medium-term or 5-year LMP roadmaps, two levels of investment scenarios and their implications for chicken and egg production and the contributions of the chicken sub-sector to GSDP are examined to provide two choices for the investment decision makers in Bihar state: the government, private investors and development partners (donors). These scenarios are referred to here as BAU (Business as Usual) and WI (with additional Investment). BAU presents the base case scenario analysis or the implications of continuing the current level of investment and technology interventions on chicken meat and

¹⁵ The relay system starts with breeders or hatchers who produce and/or hatch day-old chicks or DOCs. The DOCs are distributed to relay agents or out-growers who provide the hatched eggs with feed and vaccinations. When the pullets (young hens) have had all the vaccinations they require (at 4-6 weeks), the relay agents then sell the young pullets to farmers for egg production and also meat from the hens after they are culled (when egg production declines enough not to cover feeding and management costs). Ethiochicken in Ethiopia is an example of a very successful relay system.

eggs production, GSDP, annual incremental household income and the return on investments (ROI) throughout the LMP analysis period of 5 years. WI is the recommended level and type of additional investment which could achieve the agreed upon state development objectives.

Despite the encouraging ongoing investment in the layer system, the state of Bihar is currently producing only about 41 crore eggs, which is 17% of total demand. Bihar meets the rest of its demand, about 195 crore eggs, through imports from other Indian states. With the current level of investment (BAU), it is neither possible to close the production gap in the initial LMP phase, 2017-18 to 2022-23, nor is it feasible to achieve the 2022 Bihar agricultural road map target of 546 crore eggs produced. Therefore, to reduce imports in eggs and achieve a greater degree of self-sufficiency in eggs in the coming 5 years, there is a need for additional investment in the layer system. With additional investment (WI) in the layer system, the layer population is expected to increase from the current 1.3 lakhs to 26 lakhs birds, by 2022-23, which is an increase of 1,924%.

Additional investment in the broiler system to increase chicken meat production in the coming 5-years is also crucial, although closing entirely the chicken meat supply shortage in the coming five years may not be possible. However, gradual increase of the recommended investment (WI) in the broiler system will immensely contribute to closing the chicken meat production gap by 2031/32. Under the W1 scenario, in the coming five years the broiler population is expected to grow by 27%, from currently 6.9 to 23 lakhs birds by the year 2022-23.

The proposed growth in the chicken sector is in line with the current and future level of feed availability in the state. At present (2017-18), the chicken sector is taking about 4% of the current total cereal (maize, sorghum and millet) production in Bihar. To achieve the LMP proposed growth of the chicken sector, the share of the chicken sector in the total production of cereals (maize, sorghum and millet) by the year 2022-23, in the coming five years, will increase to 16%. Although the feed availability will continue to gradually decrease after 2022-23, it can still sustain the proposed growth in layer production for eggs and broiler chicken production to close the chicken meat and eggs production gaps.

Transforming the backyard or family chicken system

Transformation of the backyard chicken system involves improvement in the indigenous backyard chicken (IBC) production system and value chain through improved productivity and scaling up of the crossbred backyard chicken (CBC) system while integrating it through market linkages with the upper end of the value chain. The proposed transformation involves improving indigenous chicken productivity through health, feed and management interventions and introducing and distributing higher yielding hybrid breeds to producers.

- The initial average number of hens per family in the IBC system is 1.5 hens and expected to grow to 3 hens with additional interventions (Table 15).
- The initial number of chicks per family in the CBC chicken is 25 (12 females and 13 males) chicks and assumed to remain the same with additional interventions (Table 15).

More details of the interventions in the backyard systems will be described below.

Scaling up the commercial specialized chicken (CSC) system (layers and broilers)

The scaling up of the commercial specialized chicken systems (CSC) involve increasing the scale of operations and/or average number of commercial layers and broilers kept per farm unit and increasing the number of production units per farm or number of specialized farms. Complementary investments include building capacity and putting in place strict biosafety systems and integrating commercial production and marketing from downstream to the upper end of the value chain, including processing.

- The initial number of chicks per farm in the layer system is 5000 chicks and expected to grow to 10,000

chicks with additional interventions (Table 15).

- The initial number of chicks per farm in the broiler system is 1500 chicks and assumed to grow to 5000 chicks with additional interventions (Table 15).

Table 15: Flock size by chicken systems

4.4 Overall LMP targets under with intervention scenario

The overall target is to raise the annual chicken meat production from about 62,000 to 1.75 lakhs MT and eggs from 41 crores to 540 crores between the years 2017-18 and 2022-23 through the indigenous backyard chicken system (IBC), the crossbred backyard chicken (CBC) system, and expansion of the commercial specialized chicken (CSC) – for both layer and broiler systems.

Table 15: Flock Size by chicken systems

Chicken systems	Numbers without change	Numbers with change
IBC average number of hens	1.5	3.0
CBC initial number of chicks	12	12
Layer system initial number of chicks	5,000	10,000
Broiler system initial number of chicks	1,500	5,000

4.5 Improving indigenous backyard chicken (IBC) and expansion of crossbred backyard chicken (CBC) systems (2018-19 to 2022-23)

4.5.1 Targets for Indigenous backyard chicken and crossbred backyard chicken

Table 16: Number of hens and chicken eggs and meat production in IBC and CBC projected for 2017-18 to 2022-23

Chicken systems	Unit	Baseline 2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	% change
IBC hens	lakhs	26	26.8	28	30	31	33	28%
CBC hens	lakhs	4.6	4.7	4.9	5.1	5.3	5.6	22%
Total hens	lakhs	30	32	33	35	36	38	27%
IBC eggs	lakhs	1160	1320	1510	1720	1970	2250	94%
CBC eggs	lakhs	380	390	410	420	440	460	22%
Total Eggs	lakhs	1540	1720	1920	2150	2410	2700	76%
IBC meat	MT	19,371	20,224	21,115	22,046	23,017	24,031	24%
CBC meat	MT	580	637	701	770	847	931	61%
Total meat	MT	19,951	20,862	21,816	22,816	23,864	24,962	25%

Source: Bihar LMP analysis

- The number of hens in IBC grows from 25.5 lakhs in the base year to 32.6 lakhs by 2022-23, a 28% increase.
- Number of chickens in the CBC grows from 4.6 lakhs to 5.6 lakhs, a 22% increase.
- Chicken meat production from IBC increases from 0.19 lakhs MT in the year 2017-18 to 0.24 lakhs MT in the year 2022-23, a 24% increase
- Chicken meat production from the CBC increases from 580 MT to 931 MT between the years 2017-18 to 2022-23, a 61% increase.
- Total meat from the family system increases from 0.2 lakhs MT to 0.25 lakhs MT, a 25% increase.
- Egg production from IBC increases from 1,160 lakhs in the year 2017-18 to 2,250 lakhs in the year 2022-23, a 94% increase.
- Egg production from CBC increases from 380 lakhs in the year 2017-18 to 460 lakhs in the year 2022-23, a 22% increase.
- Total egg production from the family system increases from 1,540 lakhs in the year 2017-18 to 2,700 lakhs in the year 2022-23, a 76% increase.

Targets/assumptions for adopting backyard family chicken improvement interventions for IBC

- Average number of hens per flock will increase from 1.5 to 3 hens
- Average number of clutches per year increases from the current 3 to 5
- Eggs laid per year to increase from 70 to 90
- Weight of indigenous hens in CBC is 1.0 kg
- Chicken mortality before marketing will drop from 20% to 10%

Targets/assumptions for crossbred backyard family chicken improvement interventions for CBC

- Eggs laid per hen per year in CBC is 127
- Weight of crossbred hens in CBC is 1.5 kg

Unique characteristics of backyard chicken production in Bihar state by zone

- In north zone, availability of maize; disease resistant local birds; people are already producing (northeast); large number of landless farmers with the potential to rear chickens; readiness of women to diversify income
- In central zone availability of feed plants; suitable climatic condition as compared to north and south; readily available market (demand is growing); large area for open feeding/scavenging
- In the south, the tribal communities are well suited for backyard chicken compared to the north and central zones since colored birds are preferred for ceremonial and cultural activities of tribal families.
- In the north zone, not much commercial farming yet; access to markets good; labour availability high,

availability of maize for feed; disease resistant local birds; already producers (North-East); large number of landless farmers with potential to rear chickens; readiness of women to diversify for additional income

- In the central zone, there are more urbanized, some commercial operations in both multiplication and out-growing; feed plants available. In the south zone, conditions are suitable for commercial farming; feed plants are available; it is a tourist destination; the tribal community people in south are producing more backyard chicken compared to north and central.

Table 17: Key challenges and strategies related to indigenous backyard chicken (IBC) and crossbred backyard chicken (CBC) production system

Challenges	Strategies to address challenges
Feed	
<ul style="list-style-type: none"> • No serious challenge on feed for backyard • Unavailability of minimum balanced feed 	<ul style="list-style-type: none"> • Increase the availability of maize from north zone; land availability for maize and soybean production Increase availability of different vegetable oil cakes; explore the use nonconventional feeds such as Azola, as a protein supplement in semi – scavenging feeding
Animal health	
<ul style="list-style-type: none"> • High mortality rate (20%) (predators) • Lack of Awareness on proper management • Unavailability of veterinary expert Mortality rate (20%) Poor health care and management 	<ul style="list-style-type: none"> • Timely vaccination; immediate response to diseases; proper housing system; strengthening of chicken Diagnostic lab at district level; training facility at district level; weekly visit by chicken expert at block level • Awareness raising on animal health and management • Community level health programs
Genetics/Breeding	
<ul style="list-style-type: none"> • Egg laying capacity is low (60-80 eggs/year) 	<ul style="list-style-type: none"> • Genetic improvement of the backyard chicken

Backyard family chicken improvement interventions and targets (IBC) & CBC

Intervention areas (production zones)

All livestock production zones (northern, central and southern zones) are targeted for improvements in traditional family chicken.

4.5.2 Priority interventions for improving IBC and CBC

Feed and feeding

- Supplement scavenging chickens with locally available feeds up to 25% of their requirements

- Feed supplementation for incubating hens with at least 55 gm/day.

Genetics and reproductive management

- Improve indigenous chicken productivity through improved breed selection.
- Reduce reproductive wastage through early weaning of chicks and introduction of facilities to protect chicks (Hossen, 2010)
- In CBC, crossbred, semi-scavenging hens are introduced

Health

- Chickens in IBC and CBC vaccinated against priority diseases (Newcastle Disease (ND) and fowl pox) (GALVmed 2016);
- The percent of village chickens vaccinated for ND and fowl pox diseases will reach 50% by 2022–23 (GALVmed, 2016);
- Public and private veterinary services rationalized, with privatization where feasible
- Disease diagnostics and surveillance capacity of the Institute of Animal Health and Production improved

Research and extension

- Research and extension improvement interventions listed in the cow dairy improvement options section also benefit the chicken improvement work.

4.5.3 Impacts of interventions (IBC and CBC)

Rate of return on investment (ROI)

Production impacts

As a result of the interventions, the number of indigenous hens in the traditional family system grows from 26 lakhs in the base year to 33 lakhs in 2022-23, a 28% increase, and the number of the improved crossbred backyard chicken grows from 4.6 to 5.6 lakhs, a 22% increase (Table 16).

Total chicken meat from the family system increases from 0.2 lakhs MT in year 2017-18 to 0.25 lakhs MT in 2022-23, a 25% increase. Similarly, over the same period egg production increases by 76%, i.e., from 15.4 crore to 27 crore (Table 16)

GSDP impacts

As shown in Table 18 below, because of the additional investments, GSDP contribution from the family backyard chicken systems (IBC and CBC) would increase from INR 253 to INR 403 crore for chicken meat (28% increase) and from INR 74 to INR 145 crore for eggs (96% increase), respectively, in the coming 5-years.

Table 18: Changes in GSDP contribution of improved family chicken (IBC and CBC)

Products	Chicken GSDP 2017-18 (INR crore)	Chicken GSDP 2022-23 (INR crore)	Change in %
IBC meat	2,454	3,911	59%
CBC meat	74	118	60%
Total family chicken meat	2,528	4,028	59%
IBC eggs	696	1,297	86%
CBC eggs	41	150	264%
Total Family chicken eggs	738	1,447	96%
Total Family chicken meat and eggs	3,265	5,475	68%

Source: Bihar LMP analysis

The overall GSDP contribution from the improved family chicken systems increases from INR 327 crore in 2017-18 to 548 crores in 2022-23, a 68% increase over 5 years (Table 18).

Projected Income per animal

Table 19 below shows the projected income per animal in five years for IBC and CBC. The income from the indigenous backyard system (IBC) reflects income per hen that includes eight chicks. Therefore, the income per backyard chicken is approximately INR 154 and INR 194 without and with additional chicken improvement interventions, respectively. The income per bird in the village crossbred chicken system (CBC) increases by 92%, from INR 275 to INR 526, with the crossbreeding chicken improvement interventions. The huge increase in the short period of time is attributed to the fact that the investment interventions are already ongoing in the crossbred backyard system (under current programs such as the Bihar rural livelihoods project—'JEEViKA' project for India).

Table 19: Projected income per backyard chicken in 5 years – INR (IBC and CBC)

Production type	BAU	WI	% Change
IBC	1,235	1,537	24%
CBC	275	526	92%

Source: Bihar LMP analysis

4.6 Commercial Specialized Chicken (CSC) production (2018-19 to 2022-23)

4.6.1 CSC Targets

Investment in the commercial specialized chicken (CSC) systems (broilers and layers) involves expansion of the number of layers and broilers in each unit, increase in the number of units, and increase in the number of farm operation in the systems.

Table 20: Increase in number of chicken and chicken meat production in CSC chicken systems

Chicken farm types	Unit	Baseline 2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	% change
Layers	crore	0.13	1.3	2.3	4.2	7.6	2.6	1,924%
Broilers	crore	0.7	0.9	1.1	1.4	1.8	2.3	230%
Total	crore	0.8	2.1	3.4	5.6	9.4	4.9	498%
Layers	MT	695	1,268	2,314	4,223	7,706	14,064	1,924%
Broilers	MT	41,145	52,254	66,362	84,280	1,07,036	1,35,936	230%
Total	MT	41,839	53,522	68,676	88,503	1,14,742	1,50,000	259%

Source: Bihar LMP analysis

The number of chickens in the CSC chicken layers subsystem grows from 0.13 in 2017-18 to 2.6 crore in 2022-23, a 1,924% increase. The CSC chicken broilers subsystem grows from 0.7 crore to 2.3 crore in the year 2022-23, a 230% increase.

Similarly, the total chicken meat production from CSC chicken increases from 41,839 MT in 2017-18 to 1.5 lakhs MT in the year 2022-23, a 259% increase.

Table 21: Egg production from specialized layers in CSC (crores)

Chicken subsystem	Unit	Baseline 2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	% change
CSC layers	crore	26	47	86	156	285	519	1924%

Source: Bihar LMP analysis

Egg production from specialized layers increases from 26 crores in 2017-18 to 519 crores in the year 2022-23, an increase of 1,924% (Table 21). It is expected that such enormous increase in egg production would reduce egg imports dramatically and achieve egg self-sufficiency in the state towards the end of the coming 5-years.

4.6.2 Challenges for commercial chicken production in Bihar state

Table 22: Key challenges and strategies for improving the specialized commercialized chicken system (CSC)

Challenges	Strategies to address the challenges
Feed	
<ul style="list-style-type: none"> • High and fluctuating price of chicken feed • Inadequate feed processing plants and unregistered feed processing plants; • quality control on processed feeds lacking at processing plants; • land access limited for producing feed ingredients like maize and soybeans • No private layer feed manufacturing plant. COMFED is the layer feed provider 	<ul style="list-style-type: none"> • Ensure adequate supply of raw materials for processing chicken feed • Establish feed processing plants • Strengthen the quality control and regulation on feeds • Provision of land, where possible for producing the raw materials required by feed processors
Animal health	
<ul style="list-style-type: none"> • Hygiene and sanitary codes not adhered to • Poor management (light, ventilation etc.); • Chicken diseases e.g. Avian influenza (AI), Chronic Respiratory Disease (CRD), Inflammatory bowel disease (IBD), etc. • Lack of expanded health facility in line with the expanding layer farms 	<ul style="list-style-type: none"> • Establishment of chicken health care centers and provision of chicken experts/field vets in every district of Bihar; • Mass awareness regarding high threat diseases among chicken farmers; • Regular vaccination and proper management; and maintenance of high-grade biosecurity; • Provision of appropriate vaccines as required; • Timely and identification of exposure to diseases
Genetics/breeding	
<ul style="list-style-type: none"> • Limited choice of broiler breeds • Lack of state level research establishment 	<ul style="list-style-type: none"> • Availing tested breeds of broiler chicken; • Set up a research institute for chicken breeding at state level
Post production	
<ul style="list-style-type: none"> • North production zone • Flood prone • Unorganized marketing system • No minimum support price is fixed • Lack of processing facilities • Limited number of training Centre at district level (only three out of 38); • Lack of adequate knowledge of housing to prevent flood damage on chicken • Central production zone 	<ul style="list-style-type: none"> • Organized marketing system; organizing producers into co-operatives; establish market information system; establishment of chicken processing plants, three in each zone Farmers worked in self-help groups (SHG's) and form a cooperative for proper marketing. • Training facility at district level; weekly visit by chicken expert at block level; establish training centre at district level; awareness about appropriate housing during flood period. • Collection system: • Establish a government regulated chicken marketing system for the entire supply chain for eggs as well as chicken.

Challenges	Strategies to address the challenges
Post production	
<ul style="list-style-type: none"> Interference by middle men; lack of processing facilities Limited number of training Centre at district level. (only three out of 38); lack of adequate knowledge of housing <p>South Production zone</p> <ul style="list-style-type: none"> Drought prone Unorganized marketing system No minimum support price is fixed Lack of processing facilities Unavailability of training Centre at district level. (only three out of 38); lack of adequate knowledge of housing <p>Commercial broiler and layers</p> <ul style="list-style-type: none"> Unorganized market and dominance of middle men; demand fluctuation by season (wedding and festival) Very poor on commercial chicken, Unorganized market and dominance of middle men; Demand fluctuation by season (wedding and festival), Few training institutions in Bihar (Patna, Bhagalpur and Muzaffarpur); Lack of skilled labour and management force 	<ul style="list-style-type: none"> Provide necessary support on DOC as well as feed and feed ingredients Coordinate with NECC (National Egg Coordination Committee) <p>Processing</p> <ul style="list-style-type: none"> Establish modern slaughterhouses with processing facilities for value added chicken products Advance hygienic slaughter practices in the retail trade with cold chain facilities Explore option of egg processing to ensure availability for food processing industry development as well as meet the needs in times of shortages (floods/drought etc.) <p>Sales and retailing</p> <ul style="list-style-type: none"> Promotion of processed chicken meat; Promotion for awareness, control and regulations to prohibit unhygienic practices in Chicken shops.
Extension	
<ul style="list-style-type: none"> Lack of skilled manpower Lack of established institution for training 	<ul style="list-style-type: none"> Skilled manpower required—training on management and technical support; Awareness, control and regulations needed to be put in place; Technical knowledge provision to farmers; Establish training institutes at regional directorate level

4.6.3 Scaling up commercial specialized chicken production (CSC)

Intervention areas (production zones)

- Scaling up the CSC systems throughout the state and all the livestock production zones (northern, central and southern zones)

4.6.4 Priority interventions (CSC chicken)

Feed and feeding

- Support production of processed chicken feed
- Establish 4 medium and upgrade 3 existing commercial feed production units (Table 23). Also, commercial chicken farm owners are recommended to have their own feed-processing plant which could cost INR5,00,000–6,00,000 to establish
- Improve quality assurance of processed chicken feeds
- Improve the feed quality testing and regulatory capacity of the Institute of Animal Health and Production

Table 23: Processed/commercial feed needs and recommended number of chicken feed processing plants

Item		Targets in the first five-year periods
		(2017–18 to 2022–23)
Commercial feed requirement (10 ³ MT)		546.4
Chicken commercial feed processing plants (in number)	Upgrade existing plants	3
	Establish new medium	4
	Establish new large	0
Percent of chicken feed expected to be produced by chicken farms themselves (%)		20%

Source: Bihar LMP analysis

- Support production and marketing of maize and soybeans as raw material for chicken feed production.
- Increase the number of chickens in the commercial chicken production system by 498%.
- The number of layers and broilers is targeted to increase, respectively, from 13 and 69 lakhs in the base year to 260 and 230 lakhs, in the final year or by 2022-23.
- Establish large and medium chicken multiplication centers and hatcheries to satisfy the increasing demand for day-old chicks (DOCs)

With an average of 70 lakhs DOC production capacity, 22 additional hatcheries are recommended in the coming 5 years (Table 24)

Table 24: Number of hatcheries recommended by 2022–23

Commodity	Number of hatcheries
	by 2022–23
Hatcheries	22

Source: Bihar LMP analysis

Marketing and processing

- Promote consumption of exotic chicken meat and eggs
- Invest in construction of modern chicken slaughterhouses and cutting and processing plants.

4.6.5 Impacts of interventions (CSC chicken)

Rate of return on investment (ROI)

- The results of the financial indicators are based on 15-year discounted incremental cash flow analysis and indicates that the investment in the commercial chicken production systems are highly financially viable.
- IRR of investments in the layer CSC over 15 years is 124%.
- IRR of investments in the broiler CSC over 15 years is 178%.

Production impacts

- Chicken meat production from CSC broilers increases from 41,145 MT in 2017-18 to 1.4 lakhs MT in the year 2022-23, a 231% increase. Similarly, chicken meat production from SP layer increases from 695 MT to 14,064 MT, an increase of 1,924%.
- Egg production from specialized layers increases from 25.7 crore in 2017-18 to 519 crores in the year 2022-23, an increase of 1,924%.

Total chicken meat production

Table 25 below shows the total chicken meat and egg production from the family and commercial specialized systems. The total chicken meat increases from 0.62 lakhs MT in 2017-18 to 1.76 lakhs MT in 2022-23, an increase of 183%. Similarly, the total egg production from the family and commercial specialized systems increases from 41 crore eggs in 2017-18 to 546 crore eggs in 2022-23, a growth of 1232% over 5 years.

Table 25: Total chicken meat and eggs production with additional investment

Products	Unit	2017-18	2022-23 with case	% change
Total chicken meat from the Family systems	MT	19,951	24,962	25%
Total chicken meat from CSC system Broilers	MT	41,839	150,000	259%
Total chicken meat production	MT	61,790	174,962	183%
Total eggs Family systems	crore	15	27	76%
Total eggs from CSC Layers	crore	26	5,19	1924%
Total eggs production	crore	41	546	1232%

Source: Bihar LMP analysis

GSDP impacts

- As shown in Table 26, the GSDP contribution of the specialized chicken meat system (CSC) increases from the current INR 85 crore to INR 429 crore (a 408% increase) and eggs from the specialized layers increases INR 12 crore to INR 244 crore (an 1979% increase) over the 5-year investment period.
- The total GSDP contribution of commercial specialized chicken system increases from INR 96 crore to INR 673 crore, a 600% increase.

Table 26: GSDP contribution from commercial specialized chicken system 2017-18 and 2022-23

GSDP contributions	Chicken GSDP 2017-18 (INR crore)	Chicken GSDP 2022-23 (INR crore)	Change in %
SP chicken meat GSDP	855	429	408%
SP chicken eggs GSDP	12	244	1979%
Total contribution	96	673	600%

Source: Bihar LMP analysis

Total GSDP

Overall, as shown in Table 27, with the recommended interventions the GSDP contribution from the total chicken meat and eggs production increases by 189%, from the current INR 423 crore to INR 1221 crore over the 5-year investment period.

Table 27: Total chicken meat and eggs production GSDP contribution with additional investment

Products	GSDP 2017-18 (INR crore)	GSDP 2022-23 (INR crore)	Change in %
Backyard chicken meat and eggs contribution	327	548	68%
Specialized chicken meat and eggs contribution	96	673	600%
Total chicken GSDP contribution	423	1221	189%

Source: Bihar LMP analysis

Projected annual income per animal

Table 28 below presents the projected increase in annual income per animal by 5-years in the CSC chicken system. With the additional proposed chicken improvement interventions, the income per animal from the layers and broilers is expected to increase by 15% and 101%, respectively, in the first five years (2018-19 to 2022-23). The increase in income per animal is due to additional chicken improvement interventions in the layer system is relatively small (INR 130 to INR 150) since the investment interventions has been ongoing.

Whereas in the broiler system there has not been much past or ongoing chicken improvement interventions. Any chicken improvement interventions in the broiler system will thus have more impact, in terms of income per animal, among others.

Table 28: projected income per animal in 5 years - INR (CSC chicken)

	BAU	WI	% Change
Layers	130	150	15%
Broilers	49	99	101%

Source: Bihar LMP analysis

4.7 Investment budget

Table 29 shows five-year chicken meat and egg production improvement investment costs (2017-18 – 2022-23). The investment costs of chicken and egg improvement interventions are categorized into six major intervention areas – chicken feeding, chicken breeding, chicken health, extension, marketing and processing and establishment of broiler and layer farms.

As shown in Table 29, the total investment required over the first five years to implement the proposed interventions adds up to 4,855 crore INR. The private sector invests 98% of the total required and the public sector 2%. Except for the health and extension services, the other investment categories are predominantly private sector investments which indicates the great responsibility of the private sector in transforming the chicken industry in the state of Bihar.

Table 29: Total investment and recurrent costs for chicken meat and egg production VC development

Investment category	Responsible actor		Total investment cost (crore INR)	Proportion of total investment
	Public	Private		
Chicken Feeding	5.3	80	85	2%
Chicken breeding	37	116	153	3%
Chicken Health	21	-	21	0%
Extension	3	-	3	0.1%
Marketing and processing	12	21	33	1%
Broiler and layer farms, abattoirs & coops	-	4560	4560	94%
Total Investments in chicken Value Chain	78	4777	4855	100%

Source: Bihar LMP analysis

Table 29 also shows, the investment cost for establishing broiler and layer farms takes the highest share of the total investment (about INR 4,560 crore INR, or 94%). Chicken breeding takes the second highest share of the total investment cost followed by chicken feeding.

Table 30: The percent contribution of public and private investments by investment areas for improving the chicken meat and egg production VCs

Investment category	Proportion (%) by responsible actor	
	Public	Private
Chicken Feeding	6%	94%
Chicken breeding	24%	76%
Chicken Health	100%	0%
Extension	100%	0%
Marketing and processing	36%	64%
Broiler and layer farms, Abattoirs & Coops	0%	100%
Total Investments in chicken Value Chain	2%	98%

Source: Bihar LMP analysis

Table 31 : Five-year Chicken meat and egg production improvement investment costs (crores INR, 2018-19 – 2022-23)

Investment Intervention	Unit	Number	Unit cost	Investment planned year wise in crore INR					Total	Budget Source	
				2018	2019	2020	2021	2022		Public	Private
Chicken Feeding											
Establishment of medium size feed processing plant with a capacity of 12 tonnes/hr.	Unit of 12 tonnes/hr. capacity	10	3	6	6	6	6	6	30		30
Upgrade the existing chicken feed processing plants	Feed processing plant	5	1	1	1	1	1	5			5
Improve the capacity of existing chicken feed quality control laboratory (upgrading feed quality test laboratory)	Laboratory	1	0.3		0.3				0.3	0.3	
On farm feed processing plants	Small feed processing plant 0.5 tonnes per hour	1000	0.05	10	10	10	10	10	50	5	45
Sub-total									85.3	5.3	80
Chicken breeding											
Establish hatcheries with a capacity of producing 0.7 crore Day Old Chicks per year or 20,000 DOC per day	Hatchery (0.7 crore d.o.c capacity/year)	22	6	26.4	26.4	26.4	26.4	26.4	132	26	106
Upgrade the current multiplication centers	Multiplication centers	3	0.2			0.2		0.2	0.6	0.6	
Establish new chicken multiplication centers	Multiplication centers	20	1			10			20	10	10
Sub-total									153	37	116
Chicken Health											
Upgrade the capacity of IAHP to make it capable of producing vaccines		1	20						20	20	

Investment Intervention	Unit	Number	Unit cost	Investment planned year wise in crore INR					Total	Budget Source	
				2018	2019	2020	2021	2022		Public	Private
Chicken Feeding											
Upgrade the capacity of IHP to improve its disease diagnostic and surveillance capacity		1	1	0.5	0.5			1	1		
Sub-total								21	21		
Extension											
Promotion of exotic chicken and egg consumption (Use of FM radio and local channels – 0. crore per month)	To air TV / Radio Commercial	15	0.2			1	1	1	3		
Establish a comprehensive training centre on commercial chicken production	Centre										
Sub-total								3	3		
Marketing and processing											
Encourage establishment of new chicken slaughtering house (1000 bird slaughter house including chicken value added products)	slaughter house	3	3	3			3	3	9		9
Establish 4 cold storage units for eggs and chicken	cold storage with 20 MT capacity	4	6	6	6	6	6	6	24	12	12
Sub-total									33	12	21
Establishment of new layer farms	Farm of 5,000-10,000 chickens	3700	0.8	592	592	592	592	592	2960		2960
Establishment of new broiler farms	Farm of 1,500-5,000 chickens	4000	0.4	320	320	320	320	320	1600		1600
Sub-total									4560	0	4560
Total Investments in Chicken Value Chain									4855	78	4777

4.8 Activities timeline and sequencing: Gantt chart

Table 32: Intervention activity timeline and sequencing: Gantt chart

Investment Intervention	Activities timeline				
	2018	2019	2020	2021	2022
Chicken Feeding					
Encourage establishment of medium size feed processing plant with a capacity of 12 tonnes/hr.	■		■		■
Upgrade the existing chicken feed processing plants	■	■	■	■	■
Improve the capacities of existing chicken feed quality control laboratory (upgrading feed quality test laboratory) (cost of upgrading is 0.3 crore INR per laboratory)		■			
On the farm built in feed processing plants	■	■	■	■	■
Chicken breeding					
Establish hatchery with a capacity of producing 0.7 crore Day Old Chicks per year or 20000 DOC per day at 2 hatcheries per year	■	■	■	■	■
Upgrade the current multiplication centers	■		■		■
Establish new chicken multiplication centers	■		■		
Chicken Health					
Upgrade the capacity of IAHP to make it capable of producing vaccines				■	■
Upgrade the capacity of IAHP to improve its disease diagnostic and surveillance capacity		■	■		
Extension					
Promotion of exotic chicken and egg consumption (Use of FM radio and local channels – 0.2crore per month)			■	■	■
Establish a training Centre to give comprehensive trainings on commercial chicken production					
Marketing and processing					
Encourage establishment of new chicken slaughtering house (1000 bird slaughter house including chicken value added products costs- 3 crore INR)		■		■	■
Establish 4 cold storage units for eggs and chicken		■	■		
Establishment of new layer farms – 300 per year	■	■	■	■	■
Establishment of new broiler farms – 1000 per year	■	■	■	■	■

4.9 Complementary success requirements

Check for indiscriminate use of antibiotics and growth promoters in chicken feed for healthier products

- Awareness of farmers about strict biosecurity measures
- Establishment of government/cooperative PPP mode chicken farm at block level for education, demonstration and for distribution of chicken amongst BPL farmers
- Advancing the use of Ross and Cobb variety broiler chickens
- Skilled manpower required –training on management and technical support
- Create training institutes at zonal/district level for providing technical knowledge to farmers
- Encourage private participation by allotting land and ensuring access to finance
- Feed and feed additive availability

4.10 Gender and social inclusion implications for chicken value chain development

Backyard chicken are traditionally reared by marginalized communities, among others, including women. They play an important role in household nutrition and provide a source of income with low input levels. Investment in this sub-sector will automatically benefit women and SC/ST communities. However, this sub-sector is currently characterized by informal trading, low productivity and high chicken mortality rates. Collective action through producer organizations like coops is important for control of mortality, input supply and product marketing. Chickens are thus considered worthwhile investments for women and marginalized community empowerment. Investments in institutional arrangements like women's coops and links to private players will facilitate inclusive growth of the egg and chicken meat value chains.

Broiler and layer farming are traditionally controlled by resource rich farmers as there is need for land and capital for investment which is scarce among marginalized groups and women. Innovative institutional arrangements for small scale contract farming with marginalized communities and women, involving fewer birds, especially broilers, and capacity building for business skills would help promote inclusive growth. As chicken will continue to be important for women, it will be worthwhile to invest in developing gender analysis capacity, and to develop investment solutions in chicken production for women in the long run.

4.11 Conclusions

Chicken meat and egg production under the WI scenario show substantial increases, 183% and 1,232% more production, respectively, compared to the base year of the LMP (2017-18). The potential contribution of the chicken industry to improve food and nutritional security, household income and state economic growth is enormous. The backyard crossbred chickens can help significantly improve the livelihoods of women and marginal communities, as well as the nutrition of all rural families. A private and/or PPP investment such as the relay model practiced in Ethiopia, or the private investment relay models in Uganda and Rwanda have been found highly profitable for investors and farmers and to achieve lasting results.

Overall the supply shortage in chicken meat will remain in the coming 5 years and will need to be balanced with additional investment through the 15-year LSA period to 2031/32. With the current level of investment, a shortage with respect to demand in eggs is projected until 2030-31, when the state egg production consumption gap is expected to balance. However, additional investment (WI) in the layer system is

recommended to close the production gap earlier, in the first 5-years or the LMP period, to reduce import of eggs from other Indian states.

The challenges and strategies and the proposed policy and investment interventions, along with indicative required investment funds are presented in this LMP. The financial viabilities of various interventions and the impacts of interventions on chicken productivity and production, and household income, as well as the state economy in terms of gross state domestic product (GSDP), are presented in Table 33.

Table 33: Summary of total chicken meat and egg production and GSDP impacts of the WI interventions

Production 5th year	Investment Scenarios		% change
	2017-18	2022-23	
Meat in MT	61,790	1,74,962	183%
Eggs in crores	41	546	1,232%
GSDP 5th year in INR crore	423	1221	189%

Source: Bihar LMP analysis

It is observed that the policy and investment interventions for both the backyard and specialized chicken production systems could substantially increase chicken meat and egg production and would eventually contribute (in 15 years) to closing the gap in production-consumption of chicken meat and eggs in Bihar.

However, the above benefits can only be realized if:

- The feed shortage is resolved by increasing production or developing access to feed markets
- The support services for animal health and breeding are improved
- More post production and marketing facilities are put in place
- The existing incentives provided to private investors in the layer system is continued
- Private investors in the sector (in broilers, layers, processing plants, feed producers) are provided adequate incentives in terms of tax holidays, subsidized loans and leasing rates and priority access to land.

5 Goat meat value chain roadmap (2018-19 to 2022-23)

5.1 Key Livestock Sector Analysis (LSA) results and conclusions- the basis for the LMP recommendations

Households who cannot keep dairy cows in Bihar due to feed and capital constraints keep goats, Bihar already had a large goat population with 1.2 crores counted in the last livestock census in 2012, and the goat population ranks third highest in India (MoA, 2014b). Most goats are held by scheduled castes and marginalised women and are reared in a traditional and subsistence manner by these disadvantaged members of society (including landless labourers) who are unable to rear large animals (Dey et al. 2007). Meanwhile, women control about 63% of revenues from goats (ILRI FDGs, 2018), and therefore any interventions targeting goats would likely benefit them and their families. Recent goat development projects led by the Aga Khan Foundation have shown the potential of goat rearing to raise the incomes of women and other members of marginalized ethnic groups, as well as improve the nutritional security of their families. Investing in improvement of the goat value chain thus shows much potential to aid the achievement development objectives in Bihar.

Goats are kept for their meat, milk and skins, with meat being the most important product. In base year for the LSA and the LMP (2017-18), Bihar produced about 29.9 lakh MT of goat meat in the state. This meat is produced predominately for household consumption and local sales, with little presently being marketed to neighboring states. Based on the Bihar LSA results, the goat population is currently growing at a substantial annual rate of about 3.6%. Due to this existing rapid growth and the serious current and projected feed shortage in the state, the major focus of the additional investment or WI intervention scenario for goats is to increase goat productivity, rather than impacting production through population increase. With additional investment through the WI scenario, the state-level goat meat and skin production could increase greatly (about twofold and fourfold, respectively).

In the LSA 15-years foresight analysis, the increase in meat and skin production found is due to the increase in average live weight of goats of 14% and the increase in offtake rate of 52%. This result is also due to the decrease in the mortality rate due to better health care leading to increases in parturition and prolificacy rates. Moreover, a change in feed management practices (introduction of stall feeding, planting and feeding from fodder trees, and use of locally available feed resources) could have positive impacts on goat productivity. Moreover, the impact of such better management would be multiplied if the genetic potential of the goats kept could take advantage of the better feeding and health care.

Thus, even with the increase in offtake rate of 52%, the projected income per animal in 15 years increases only on average by less than INR 150 with the present additional investment or WI scenario in the LSA. Even though this a 20-33% in income per animal across both predominant goat farm types (with small and medium size

herds) and production zones, the actual additional income per goat (INR 150) is very small and also makes little difference in total goat herd income given the very small herd sizes (of 2.5-3 or 13 on average) which are found in Bihar¹⁶.

Meanwhile, according to the LSA results for investment returns under WI, the financial indicators based on the 15-years discounted incremental cash flow analysis show that the additional investments in both small and medium size goat farms in all livestock production zones are financially viable. The IRR value is 31% and the BCR is 1.6 under WI in the small size goat operations, both denoting attractive investments, but given the low incremental income increases per animal, it becomes clear the IRR and BCR are attractive mainly due to low additional costs associated with WI and not significant increased income due to major productivity gains. However, at the macro state income level, under the WI scenario the GSDP contribution from goats would increase 197% by 2032–33 from the base year (2017–18), while the GSDP increase would be only 71% in the BAU scenario in 2032–33.

The quantity of goat meat needed to meet demand, meanwhile, is projected to increase to 231 thousand MT by 2032–33 from the baseline level of about 93 MT in 2017–18, an increase of about 148%. However, the quantity of goat meat produced is projected to increase by 67% without additional investments (BAU) and 185% with additional investments in goat improvement interventions (WI). The supply of goat meat is thus projected to continue to display a shortfall with respect to demand under both the BAU and WI scenarios due to the existing feed shortage, among other constraints.

Thus, for marginalized farmers and especially women, going into goat production for the first time, even with the present income gains possible under the BAU scenario from the available interventions and investment level, could be a life-changer in terms of the empowerment taking place due to income and asset generation, and the help in achieving household food security. However, credit and insurance for goat farming will be required where it does not already exist or will need to be scaled up where it already does, since goats are mainly an attractive investment for very poor women and others from marginalized communities, who face serious capital constraints and financial risks as barriers to participating in goat enterprises.

Furthermore, if new productivity-increasing interventions could be identified and introduced, including identifying exotics for crossbreeding to achieve significant genetic gains from well-adapted breeds, and the severe feed constraint overcome, the projections for growing demand within the state ensure that markets for live goats would remain strong and could absorb any increases in production, leading to income increases for women and other members of the marginalized communities.

Lack of access to land resources and thus feed by marginalized communities, including women, also hinders going into goat production or increasing flock size. This is further compounded by the lack of access to knowledge on feed production and effective feeding of goats by the same groups. There is thus a need for training, as well as strategizing target-based feed interventions (e.g., feed cards for concentrate feed) for marginalized women and other members of disadvantaged communities. Short-term training programs on goat entrepreneurship and on science-backed goat rearing practices, are a priority.

5.2 Five-year LMP Vision for the goat VC

The vision is bringing many more women and other members of marginalized communities into goat rearing

¹⁶ INR 200 is not a very large amount of additional income per goat per annum in actual or absolute terms. Notably, similar low income increases from goat production improvements and investments in the goat VC under the WI compared to BAU scenarios have been found across all the countries where LMPs have been done in Asia and Africa.

for the first time during the 5-years LMP to improve their incomes and the food security of their families. Goat meat production is increased by 22,000 MT or 72%, and contributes 66% more to state income (GSDP), while income per animal increases by only 14-19% for adopters of the WI interventions, but over INR 700 on average per goat for new goat keepers (i.e., when assumed to be operating under BAU), helping to raise the incomes of rural people, including women and other members of marginalized communities.

5.3 Investment scenarios analyzed

In the investment analysis done to create medium-term or 5-year LMP roadmaps for Bihar, two levels of investment scenarios and their implications for goat productivity and incomes, and goat meat, milk, and skin production and the contributions of the goat sub-sector to GSDP are examined to provide two choices for the investment decision makers in Bihar state; farmers and new goat keepers, the government, private investors and development partners (donors). These scenarios are referred to here as BAU (Business as Usual) and WI (with additional Investment).

BAU presents the base case scenario analysis or the impacts of continuing the current level of investment and technology interventions on goat meat and milk production, GSDP, annual incremental household income and the return on investments (ROI) throughout the LMP analysis period of 5 years. WI is the level of investment analyzed to see if it could help achieve a higher level of the agreed upon national development objectives: poverty reduction and asset accumulation, food and nutritional security, economic growth or state income, industrialization and employment, marketing and exports, and social inclusiveness and equity.

5.4 Description of the goat systems to be considered for additional investment (WI)

Goats in Bihar are reared in a traditional and subsistence manner by members of the marginalized communities of the society, with little land and financial assets (Dey et al. 2007). This traditional way of keeping goats results in high mortality and low productivity. Feed shortages and inadequate health services result in high mortality and small herd sizes. Thus, the goat meat improvement intervention (WI) focuses on reducing mortality and improving parturition and prolificacy rates through feed improvement (feed availability and quality) and better access to health services (primarily vaccinations).

Table 34: The goat systems and herd sizes considered in the LMP

Livestock production system	Sub-system	Average no. of heads in a flock
Northern	• Improved small size family farm with 1 to 5 goats	3
	• Improved medium size family farm with 1 to 5 goats MF (6-20)	13
Central	• Improved small size family farm with 1 to 5 goats	2.5
	• Improved medium size family farm with 1 to 5 goats MF (6-20)	13
Southern	• Improved small size family farm with 1 to 5 goats	2.5
	• Improved medium size family farm with 1 to 5 goats MF (6-20)	13

Two types of flock sizes classifications were considered in the analysis. The small size flock ranges between 1 to 5, while the medium is between 6 and 20. In the state of Bihar, the small size family goat keeping comprises of maximum of three heads, while the medium represents 13. The live weight of these goats varies between 13-17 kg. The goat breeds are primarily the black Bengal, which is a prolific breed. However, due to high kid mortality as well as lack of knowledge on improved management, in addition to poor health keeping, the productivity level remains low.

Table 35: Herd structure and composition

Flock structure	% composition
Female	
Juvenile (0-0.5 year)	19
Sub-adult (0.5-1 year)	12
Adult(1-11 years)	52
Sub-total	83
Male	
Juvenile (0-0.5 year)	13
Sub-adult (0.5-1 year)	2
Adult (1-11 years)	2
Sub-total	17
Total	100

5.5 Overall LMP targets under with intervention scenario

The intervention targets for WI are presented for population. The changes in the herd growth parameters are captured in the section below by comparing the base year estimates with the projection in 2022-23.

Table 36: Number of goats projected for 2017-18 to 2022-23

Production zone	Goat population (lakhs)							
	Baseline 2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	% change	Growth rate (%)
Northern	78.9	81.8	84.8	87.8	91.0	94.3	20	3.64
Central	44.7	46.3	48.0	49.8	51.6	53.5	20	3.64
Southern	21.6	22.4	23.2	24.1	25.0	25.9	20	3.64
Total	145.3	150.5	156.0	161.7	167.6	173.7	20	3.64

Source: Bihar LMP analysis

The population of goats in Bihar reaches 174 lakh heads in 2022-23, a 19.6% increase.

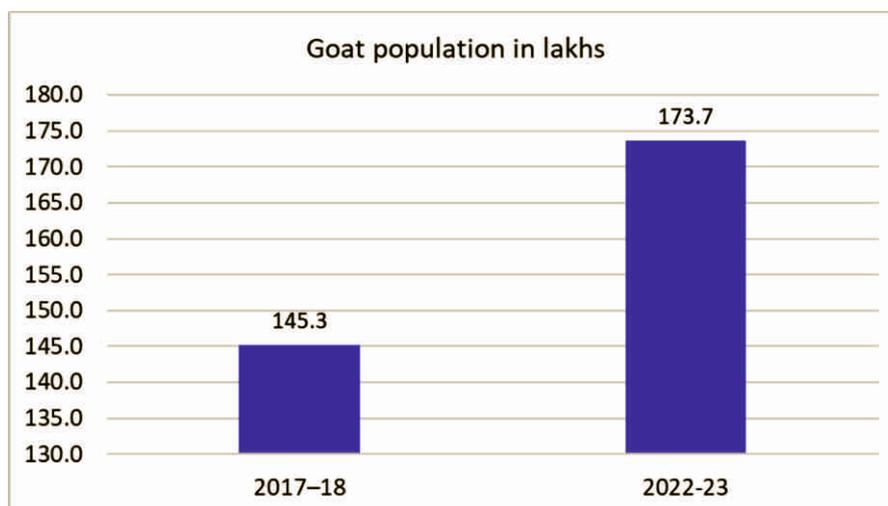


Figure 2: Population across the 5-year period between 2017-18 and 2022-23

Source: Bihar LMP analysis

5.6 Challenges and strategies

Goats in Bihar are reared in a traditional and subsistence manner by most sections of the society (including marginalized farmers, landless laborers, and women) who are unable to rear large animals (Dey et al. 2007). Lack of access to improved technologies (breeding, animal health services, feeding and management) by these poorest producers, often women, results in low productivity and high mortality. Provision of funds and access to credit are entry points in the roadmap. Encouraging goat co-operative/self-help group (SHG) models at the village level is also recommended. To build good practices of management, goat management training is also recommended in the road map, where goat keepers receive more intensive and continuous training in goat management (feeding, breeding, deworming, tick control, hygiene and milk handling and transport).

Although the most commonly used breed, Black Bengal goat, is highly prolific and resistant to diseases, feed shortages and inadequate health services result in high mortality. In the following table, the challenges are listed and categorized as feed, animal health, genetics and breeding, post production (marketing and processing), and gender and social inclusion. The strategies to address the challenges are also outlined in Table 37.

Table 37: Challenges to goat production and strategies to address these challenges

Challenges	Strategies to address challenges
Feed	
Small size flock (owned by marginalized including women) <ul style="list-style-type: none"> • Fully grazing-based goat rearing • No supplementation of concentrates; scarcity of feed resources during flooding • Scarcity of community grazing land • Low biomass 	<ul style="list-style-type: none"> • Grow good green biomass producing trees at small portion of land; • Encourage semi-intensive feeding and where applicable stall feeding • Follow scientific lopping practices; • Increase amount of concentrate in goat feeding; explore developing cheaper

Challenges	Strategies to address challenges
Feed	
<ul style="list-style-type: none"> • Concentrate not affordable <p>Medium size flock:</p> <ul style="list-style-type: none"> • No scientific feeding practices are followed; little concentrate is given to goats • Feed shortage • Scarcity of community grazing land • Low biomass and limitation on access to land • Inability to supplement concentrate due to affordability • Lack of land resources by marginalized communities including women prevents them from increasing the flock size. • Lack of access to feeding knowledge by women and marginalized 	<p>balanced ration for goat stall feeding; use of nonconventional feeds e.g. Azolla</p> <ul style="list-style-type: none"> • Target based feed interventions (feed cards for concentrate feed) for marginalized communities and women. Women and marginalised are included in training
Animal health	
<ul style="list-style-type: none"> • Lack of awareness on economic loss due to PPR, goat pox, enterotoxaemia etc. • Lack of timely and complete vaccination • Diagnostic facility not fully functional • Very limited availability of vet services • High humidity coupled with lack of space (overcrowding) 	<ul style="list-style-type: none"> • Awareness raising on the loss due to diseases • Ensuring • Strengthening the existing diagnostic facilities • Increasing access to veterinary services • Low cost shelter
Genetics/Breeding	
<ul style="list-style-type: none"> • Small size and body weight of the nondescript local breeds • Limited research on local breeds improvement • Black Bengal has good quality meat, but size is small • Lack of quality bucks • Population of unimproved local nondescript goats is higher in this zone 	<ul style="list-style-type: none"> • Black Bengal breed of goat needs to be conserved • Selection of black Bengal type bucks from within the herd from same area; • Inbreeding needs to be checked (discourage service with unwanted available bucks) • Castration of scrub bucks to discourage inbreeding

Challenges	Strategies to address challenges
Post production	
<ul style="list-style-type: none"> • Unorganized goat market • Poor funding and insurance facilities • Lack of package of practices for goat rearing • Limited access to animal health centres and vets • Lack of strategic planning to produce large number of marketable goats in peak season • Lack of infrastructure for processed meat market 	<ul style="list-style-type: none"> • Create live animal market infrastructure at each block level and encourage goat co-operative/self-help group (SHG) models at the village level • Use of by-products of goats (milk and manure) which give better income to the goat producers • Develop community owned processing unit or cluster approach of processing units to support the export houses <p>Sales and retail</p> <ul style="list-style-type: none"> • Organized marketing facilities, digital marketing platform • Cold chain • Halal certification to fulfil religious beliefs • Meat cuts/product packs and promotion • Ready to eat meats and sausages/shawarma concepts • Input and services (breeding, concentrate feed, seeds, insurance and extension services) • Promotion of link between producers, traders, processors

5.7 Goat meat improvement interventions

Intervention areas (production zones): All the livestock production zones (northern, central and southern zones) are target areas for the goat improvement interventions. The interventions and targets outlined are categorized as interventions related to feed, animal health, genetics, extension, research, and post production interventions on processing and marketing.

Feed

- Support backyard, hedge and live fence etc. fodder production
- Develop least cost feed rations for different goat production system like semi-intensive and intensive production
- Support a fodder-based livestock production system, rather than the grain-based system
- Exchange of feed and fodder from large farmers to marginalized farmers through target-based feed cards. This helps for increasing flock size of marginalized farms where labour is abundant
- Educate farmers to feed dam/doe with supplementary concentrate feeds a month before and after parturition to increase their mothering ability and birth weight and survival of kids (Chowdhury et al. 2002);
- The area of land under permanent pasture/grazing during 2013–14 was about 15,000 ha. The plan is to increase productivity by over sowing with improved grasses and leguminous forage seeds and use of fertilizer, where applicable. The target is to increase rehabilitated permanent grazing land to encompass 50% of the total permanent pasture land by 2022–23

- Improve production, marketing and quality control of forage seeds, forages and concentrates through the strengthening of existing regulatory bodies
- Improving access to, and use of common lands

Health

- Veterinary hospitals/poly clinics, veterinary dispensaries and veterinary aid centres presented in the cow dairy improvement intervention options section will cater to all species including goats
- Goats to receive vaccinations through last mile delivery (Pashu Sakhi) for critical diseases¹⁷ such as peste des petits ruminants (PPR), goat pox, enterotoxaemia, HS, FMD and BQ
- Increase adoption¹⁸ by farmers to the recommended rate of external and internal parasite control treatments
- Private veterinary service providers, including Pashu Sakhi, to be supported by the government
- District level diagnostic labs to be established, and links between Pashu Sakhi and government veterinary system to be strengthened

Breeding and Genetics

- Improve local breed goats through breed selection
- Breeding farms to be used to develop and multiply improved local goat breeds; with genetic screening of the goat population for identification of best goats for further improvement
- Perform community-based goat breed improvement programs to increase productivity of indigenous goats; Community based in-situ breed improvement strategies including women and marginalized to be followed (Best Farmer award for breed improvement in each district, and exchange of best buck through animal 'mela' or show, etc.)
- Implement AI for goats in collaboration with ICAR-Central Institute for Research on Goats, Mathura (Uttar Pradesh)
- Strengthen breeding farms and establish private farms to be used to generate improved goats for distribution to beneficiaries. Distribution of goats to continue as per the 2011 breeding policy.

Extension

- Develop specific guidelines or manual for extension services for small animals including goats¹⁹
- Promote more women extension staffs to increase communication with women producers - Pashu sakhi can be promoted as the extension service providers

¹⁷ Currently, about 80% of goats are receiving vaccinations for PPR by public campaign programs and through Pashu Sakhi. it is assumed that the vaccination coverage will remain 80% by 2022-23. Adoption of vaccinations for other diseases is targeted to increase to 50% by 2022-23 and 80% by 2027/28.

¹⁸ Adoption is projected to reach 80% over the next 15 years.

¹⁹ The goat producers do not have access to required extension services due to their low status and affordability. In house/village training with flexible timings and target-based training procedures are direly needed

- Put in place the necessary parliamentary acts, regulations, guidelines and manuals to support rapid growth of extension service providers.
- Scrutinize bureaucratic procedures that hinder service providers; review and revised these to ensure responsible and ethical provision of services.
- Control unregistered input, advisory and marketing service providers
- Provide continuous goat management training²⁰

Research

- Carry out quantitative and qualitative gender and social inclusion analysis in goat production to understand all gender roles, and increase investment impacts on women and marginal communities

Processing and marketing

- Establish one goat abattoir by 2022-23 to be used for exports

Animal and herd-level targets and assumptions for farmers adopting goat meat improvement interventions

- Parturition rate to increase from 1.25 to 1.5 (Miah 2016; Haque et al. 2013)
- Prolificacy rate will increase from 1.5 to 2.0 (Miah 2016; Haque et al. 2013)
- Mortality rate to decrease by 50% (Kumar et al. 2003; Chowdhury et al. 2002 reported mortality reductions of up to 70% through implementation of the above listed interventions)
- Live weight of goats to increase by 2 kg
- Does to be fed 200 g of concentrate daily for one month prior to and after parturition, to increase milk production, and improve survival of kids (Chowdhury et al. 2002)
- Each animal to be provided with 5 gm/day of mineral supplementation and common salt
- Expenditures on external and internal parasite treatment and control, as well as on vaccination to result in veterinary-related cost increases of INR100 per animal/year;²¹ and
- Price of skins increase by 10% due to external parasite treatment/controls.

5.8 Investment budget

The major investment in terms of infrastructure for goat improvement relates to animal breeding and genetics, and marketing and processing. The investment is proposed to come from the public and private sector investments, through a public and private sector partnership. The estimated investment cost coming from Bihar

²⁰ Coverage to reach 15% of farmers by 2022–23. Farmers to receive more intensive and continuous training in goat management (feeding, breeding, deworming, tick control, hygiene and milk handling and transport).

²¹ Vaccination for important diseases (PPR, ET, FMD, goat pox, HS, BQ etc.) - (INR 50); External parasite treatment is INR 10 per year/animal (three/year); internal parasite treatment INR 15 per year/animal (three/year); other disease treatments INR 25 per year/animal

state government amounts to INR 8 crore. The corresponding amount from the private sector is in the quantity of INR 9.2 crores, and this is associated with the establishment of slaughter house and export abattoir.

Table38: Five-year goat meat production improvement investment cost (2018-19 to 2022-23)

Investment intervention				Investment cost (crore INR)						Budget source	
	Unit	Qty	Unit cost	2018	2019	2020	2021	2022	Total	Public	Private
Animal Breeding and Genetics											
<ul style="list-style-type: none"> establish 2 new breeding farms²² by 2022. Each goat and sheep breeding farm with a capacity of 500 animals. 	Breeding farm	2	4		4	4			8	8	
Marketing and processing											
<ul style="list-style-type: none"> Establish 3 local goat slaughter houses - with a capacity of slaughtering 500 goats 	Plant	3	0.4		0.4	0.4		0.4	1.2		1.2
<ul style="list-style-type: none"> Export abattoirs for 500 Animals with rendering and effluent plant²³ 	Plant	2	4				4	4	8		8
Total					4.4	4.4	4.0	4.4	17.2	8.0	9.2

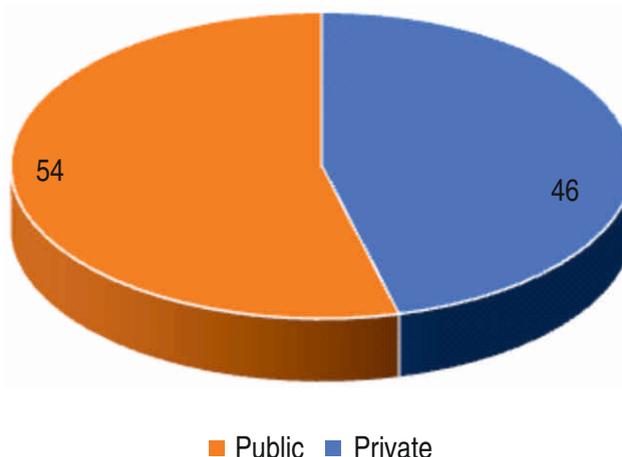


Figure 3: Percent share of investment by source: Goat

Source: Bihar LMP analysis

9.5 Impact of investments on interventions

Production

Production of goat meat increases from close to 30,000 MT in the base year to 52,000 by 2022-23. This shows a 72% change in production (Table 39).

²² Number of goats and sheep breeding farms (1 under AH department and it is not functional) strengthen the existing 1 farm. The cost of establishing one farm is INR 4 crores

²³ INR 3 crores excluding Land and building. Building cost including rendering and effluent plant - INR 1 crore per plant

Table 39: Change in goat meat production with intervention

Production zone	Production: Goat meat (in MT)		% change
	Baseline 2017-18	2022-23	
Northern	16,199	28,351	75
Central	9,633	16,390	70
Southern	4,086	6,774	66
Total	29,918	51,515	72

Source: Bihar LMP analysis

Gross State Domestic Product (GSDP)²⁴

Investments in goat interventions show an increase in the contribution of goat meat to GSDP. The GSDP in the base year is increased by 66% by year 5, thus bringing the GSDP to INR 1,425.1 crores as compared to INR 857.4 crores under WI.

Table 40: Change in contribution to GSDP of goat meat production with intervention (INR crores)

Production zone	Goat Meat contribution to GSDP (INRcrores):		
	Baseline 2017-18	2022-23	% change
Northern	467.1	793.4	70
Central	251.7	420.4	67
Southern	138.5	211.3	53
Total	857.4	1,425.1	66

Source: Bihar LMP analysis

Income per animal

The net income per animal for small size (3) flocks (the most prevalent) ranges between 875-909 INR. The interventions bring about a 14-19% change in annual income per animal comparing the base year with the 5th year (Table 41).

²⁴ It is anticipated there is a 5-8% increase in market price of goat meat. However, these incremental values were not used to estimate the contribution to GSDP. Value per unit used is fixed across time. The LSIPT uses fixed product prices, and intermediate costs, and that way the fixed price enables the analyst to see the real changes due to the intervention. In the LSA we used the base year price fixed for all years to calculate the GSDP as Value added=(Price*production)- (price production*intermediate costs), but production varies overtime. Intermediate costs were also assumed to be fixed, thus do not vary across time

Table 41: Income (INR) per animal (in INR)

	flock size	Average no. of heads	Net income/animal (BAU)	Net income/animal (WI)	Net income (% change)
Northern	small	3	758	904	19
	medium	13	728	842	16
Central	small	2.5	742	875	18
	medium	13	635	733	16
southern	small	2.5	796	909	14

Source: Bihar LMP analysis

5.10 Activities timeline and sequencing: Gantt chart

Table 42: Intervention activities timeline and sequencing: Gantt chart

Investment Intervention	Activities timeline				
	2018	2019	2020	2021	2022
Goat Breeding Investments					
Establish 2 new goat breeding farms ²⁵					
Post production processing and marketing					
Establish goat abattoir - with a capacity of slaughtering 500 goats per day					

5.11 Complementary success requirements

- Support for goat-rearing groups, especially women's coops and strengthening of community institutions through public-private partnership (PPP), as well as input from NGOs
- Promotion of goat meat marketing outside Bihar by government assistance in linking to markets, including participation in trade fairs
- Increasing the coverage of goat animal health management and related husbandry services 24/7 via use of community-based animal health workers
- Government support for infrastructure development, including breeding farms
- Supporting the private sector to play a needed key role in the goat processing value chain
- Creating a conducive environment for private investment for commercial goat rearing, goat breed improvement and animal health services

²⁵ Each goat and sheep breeding farm with a capacity of 500 animals. The cost is INR 4 crores

- Establishment and implementation of a small animal development policy specifically targeted at women and others from marginalized communities for poverty reduction and women empowerment

5.12 Conclusions

The change in goat meat production in 2022-23 compared to the base year (2017–18) under WI will be about 72%. As well, in the WI scenario, the GSDP contribution from goats would increase to 66% by 2022–23. However, the additional interventions and investment in WI would result in only 14-19% increases in income per animal.

Since there is not much scope for increasing the population of goats given the serious and costly current and projected future feed constraint expected to constrain goat keepers over time, we would expect that extra investment in increasing productivity through improvements in feeds and improved health should be prioritized for public support to meet future goat meat demand requirements. Furthermore, we would expect that women and other members of marginalized communities, who play a key role in goat rearing, would be the main beneficiaries of any additional investment on goat improvement. However, given the low additional income increases per animal under WI, and their small herd sizes, it becomes clear that marginalized farmers and especially women, who are going into goat production for the first time can expand their herd sizes. More attractive income gains are possible under the BAU scenario than for those goat keepers considering moving from BAU to WI given the available technology interventions.

Thus, we conclude goat rearing is mainly at present a life-changing option for new goat keepers presently in Bihar, in terms of the empowerment taking place due to the income and asset generation made possible, and the help in achieving better household food security. Until better genetic potential of goats is realized, present priority interventions should include feed and health options that are affordable and accessible to women and other members of marginalized communities, including by promoting social networks like self-help groups and strengthening cooperatives to facilitate technical and marketing training and updates on new technologies. Promotion of semi-intensive goat production, and investment in scaling up of the Pashu Sakhi delivery mode of animal health services are key entry points now; and these can help decrease mortality and increase flock size; while facilitating better communication.

In sum, the BAU investment option for further improving the goat meat value chain can serve as a basis for detailing an effective implementation plan for the five-year period of 2017-18 to 2022-23. Increased investment in new or expanded goat production units and the value chain could especially help improve the livelihoods of women and other members of marginalized communities and the nutrition of their families.

Future interventions need to include increased cross-breeding with exotics, selection of best locals for further improvement, overcoming the local feed constraints by linking goat producers to feed suppliers from other states, and increasing access of live goats to urban markets and other states. A gradual shift from extensive to semi-intensive production system would indicate better price realization provided these households are linked with markets through SHGs, goat cooperatives and producers' companies.

Lastly, the income impact of such better management could have been multiplied if the genetic potential of the goats kept was higher and such higher-yielding goats could be combined with better feeding and health care. Unfortunately, Bihar has not been able to make much progress identifying high-potential exotic goat breeds which are well-adapted for crossing with local breeds, or in selecting for improved locals. There is an urgent need to strengthen breeding farms to develop and multiply improved local goat breeds, with genetic screening of the goat population for identification of best goats for further improvement.

6 Buffalo meat value chain roadmap (2018-19 to 2022-23)

6.1 Key LSA results and conclusions – basis for the LMP recommendations

Milk is the primary product from buffaloes in Bihar, but meat is becoming increasingly important as a secondary product and source of cash income for farm households. Buffaloes contribute about 38% of the milk and 36% of the meat production of the state (Singh et al, 2010). Buffaloes are found across all the three major livestock production zones of Bihar: the northern, southern and central zones. While the numbers of indigenous or local cattle have been declining, buffalo numbers are increasing (2.3% per year) and there is potential to increase farmer incomes further, not only from buffalo milk production, but also from sale of culled buffaloes for their meat.

Although local demand and marketing opportunities for buffalo meat are limited, processing and marketing buffalo meat for exports to other countries could grow further, as well as to other Indian states. Currently around 4,300 buffaloes per day on an average are being processed in 4 export abattoirs, and there are private investment plans to build more export abattoirs (DAFR, 2018). Improving buffalo production for meat and milk could be a key means of improving per capita incomes and reducing poverty in rural areas, including marginalized communities and women.

The current and projected serious feed shortage in the state, however, would not support an emphasis on increasing the buffalo populations. Therefore, the major focus of the buffalo VC improvement interventions considered in the LSA was to increase the productivity of buffaloes, not to increase their numbers. Buffalo numbers are nevertheless expected to continue to increase, largely due to increasing demand for milk.

However, along with the shortage of feed, further productivity increase and modernization of the buffalo value chain is constrained by inadequate supply of improved buffalo dairy stock, breeding services, and other support services (DAFR, 2018). More productive buffalo breeds would need to be introduced, and AI services expanded. Greatly increased semen production and AI delivery through more PPPs and private service providers where appropriate would also need to be enabled, with incentives for operating in remote rural areas. Under the WI scenario assessed in the LSA, such additional investments to achieve improved genetics would be needed.

Moreover, animal health would also need to be addressed. High calf mortality and morbidity exists due to high roundworm infestation, negligence or poor animal husbandry, lack of awareness of and access to veterinary services and drugs by owners, and lack of adequate information/knowledge of buffalo diseases and their prevention and treatment. The quality and availability of animal health services and improved producers' access to these services would also need to be improved through encouragement of private service providers

and/or PPPs or public services in remote areas. Social inclusion strategies to make sure interventions reach and benefit marginalized communities would also increase benefits.

According to DAFR and sector experts, other factors constraining growth in farm income and the development of the buffalo meat value chain also exist and include insufficient access to credit facilities, inadequate abattoir and processing plant capacity, and lack of marketing know-how and access to buffalo meat markets inside and outside the state. Moreover, poor sanitary and phytosanitary conditions in abattoirs are also major constraints to realizing export potential, and the potential to market to surrounding Indian states.

Under the foresight analysis carried out in the LSA of whether the investment returns would warrant the cost of modernizing the buffalo value chain in Bihar, a WI scenario or “with additional investments scenario” was developed to address these constraints and was compared to the BAU scenario or “business as usual” scenario that entails continuing the current types and level of investment.

Under the BAU scenario, the 15-year increase in meat production to 2032–33 (from the base year of 2017–18) was projected to be 45%, while it would be 62% under the recommended interventions of the WI scenario. The 15-years projections of the LSA showed that surplus buffalo meat of approximately 22% and 50% respectively, under the BAU and WI scenarios could be produced. WI also included increased investment in buffalo meat processing capacity for export, as well as the technical assistance needed to help enforce sanitary and phytosanitary regulations.

The 15-year increase in meat production under the WI scenario would also result in about 10% greater income per animal, compared to BAU. Meanwhile, both the BAU and WI investments in buffalo production and VC, based on the 15-year discounted incremental cash flow analysis, would generate marginally attractive returns. Under WI, the IRR investment results for the buffalo meat investment were found to be 15%. Lastly, under both the BAU and WI scenarios, a projected surplus over local demand would be generated by 2032-33, but a bigger one under WI. Thus, only if the buffalo meat markets outside Bihar can be exploited would it seem worthwhile to invest and implement the WI scenario. Moreover, the additional investments to increase buffalo production would need to be complemented with investments in buffalo slaughterhouses and meat processing, raising the cost per kg and lowering the meat contribution to GSDP, as earlier alluded to.

Lastly, under WI, by 2032–33 the GSDP contribution of all buffalo products would increase by 67% compared to the base year (2017–18). The per cent change in GSDP contribution of buffalo meat alone in the WI scenario is projected to be 31%. Buffalo meat consumption in Bihar state, meanwhile, is projected to increase by 45% over the 15 years period of the LSA, from 76,000 t/year in 2017–18 to 110,000 t/year in 2032–33, pointing to a potential surplus under WI. But to market this surplus would require either the sale or export of live animals, or processing buffalo meat through additional investments which would not be included under BAU. For farmers to reap greater income benefits from growth taking place in demand mostly outside Bihar, additional investments such as those in processing which have already taken place or planned and are included in the WI scenario for further modernizing buffalo meat processing and marketing would most likely be required.

6.2 Five-year LMP vision for the buffalo VC

Buffalo meat production increases by 2022-23 under the WI scenario by 21%, generating 17% more contribution to state income (GSDP), while helping to increase incomes of rural people, including women and marginal communities. Buffalo meat production increases are achieved through improved breeding, feeding, health care and extension, contributing thereby to greater food and nutrition security.

6.3 Investment scenarios analyzed

In the investment analysis done to create the medium-term or 5-year LMP roadmaps, two levels of investment scenarios and their implications for buffalo meat production and the contributions of the buffalo meat sub-sector to GSDP were examined to provide two choices for the investment decision makers in Bihar state, the government, private investors and development partners (donors). These scenarios already explained above are referred to here as BAU (Business as Usual) and WI (with additional Investment).

BAU presents the base case scenario analysis reflecting the implications of continuing the current level of investment and technology interventions on buffalo meat production, GSDP, annual incremental household income and the return on investments (ROI) throughout the LMP analysis period of 5 years. WI, meanwhile, is the recommended level of investment which could help achieve the agreed state development objectives.

6.4 Description of the buffalo production systems

As mentioned before, buffaloes are found across the three major livestock production zones of Bihar, the northern, central and southern zones. The northern and southern livestock production zones are characterized as flood and drought prone areas, respectively. The Central zone is densely populated and is suitable for both cropping and livestock keeping, including buffaloes. The main buffalo breeds are indigenous dairy types with an average daily milk yield of 4.5-5.5 liters.

Table 43: The buffalo systems

Livestock production zone	Sub-system	Average no. of heads in a household
Northern	Indigenous buffalo small size ²⁶ family farm	2
Central	Indigenous buffalo small size family farm	2
Southern	Indigenous buffalo small size family farm	2

Table44: Herd structure and composition

Sex/Age category	% contribution in the herd
Female	
Juvenile	11
Sub-adult	18
Adult	60
Sub-total	89
Male	
Juvenile	7
Sub-adult	3
Adult	1
Sub-total	11
Total	100

²⁶ Herd size of 1 to 7

These animals are largely grazed but are typically also provided with some concentrate feeds, as well as fodder in the form of crop residues. Mortality rates, especially among young animals is high, and there is room for improvement through better feeding, health care; and breed improvement using the improved Murrah and Nili-Ravi breeds. Table 43 describes that the buffalo system and the average herd size at household level is 2. The herd structure shows a significant proportion of females - 89%.

6.5 Challenges and Strategies for Buffalo Meat

Although the local cow population in the state of Bihar is declining, the buffalo population has been growing marginally, and this is attributed to slow increase in productivity, and inadequate attention to making bulls and semen available (National Dairy Development Board 2008). In the following section, the challenges are presented-- categorized as feed, animal health, genetics and breeding, post production (marketing and processing), and gender and social inclusion challenges. Attempts are made to lay out the strategies to address the challenges outlined.

Table 45: Key challenges and strategies for improving buffalo meat production

Challenges	Strategies to address challenges
Feeds	
<ul style="list-style-type: none"> Diet not nutritionally balanced Feed shortage due to reduced access to grazing, because of rise in water level during rainy season Diet nutritionally low 	<ul style="list-style-type: none"> Utilization of crop residues for preparation of complete feeds (Total Mixed Rations, TMR) may also be tried. Supplementation of concentrate according to milk production; Provision of mineral mixture
Animal health	
<ul style="list-style-type: none"> Calf mortality due to high round worm infestation Lack of awareness on availability of veterinary services and drugs Lack of adequate information/knowledge of buffalo diseases by producers Mortality in juveniles 	<ul style="list-style-type: none"> Strengthen Vaccination programs Improve Housing and management Provision of veterinary service at village level Strengthen the animal husbandry extension facility
Genetics/Breeding	
<ul style="list-style-type: none"> Occurrence of silent heat, and inability to detect heat cases; Buffalo are majorly nondescript breeds; high dependence on natural service; little knowledge on AI 	<ul style="list-style-type: none"> Develop technique for silent heat Upgrading using Murrah²⁷ and Nili-ravi²⁸ breeds Provide one breeding bull²⁹ at every panchayat level

²⁷ The Murrah buffalo is a breed of domestic dairy buffalo which originated from India. The Murrah buffalo is very popular and a very good milk producer. For more information see: <http://www.roysfarm.com/murrah-buffalo/>

²⁸ The Nili-Ravi buffalo is a domestic breed which is like the Murrah buffalo. It is concentrated in Punjab. It is mainly a dairy buffalo breed so used principally for milk production. The Nili-Ravi buffalo breed dates back to the Indus River Valley civilizations when they were two different buffalo, Nili and Ravi. However, due to coincidental standards, both buffalo breeds looked very similar and it became hard to distinguish the two. The two breeds became one, Nili-Ravi in 1950. For more information see: <http://www.roysfarm.com/nili-ravi-buffalo/>.

²⁹ The dam line produces 3,000 lit milk/lactation

Challenges	Strategies to address challenges
Genetics/Breeding	
<ul style="list-style-type: none"> • Milk yield is low; local breeds need improvement; infertility is high 	<ul style="list-style-type: none"> • Developing training materials for farmers on housing, management and record keeping; • Strengthen the animal husbandry extension facility; • Awareness creation on AI efficiency; cost effectiveness; and processing and extending buffalo semen
Post production processing and marketing	
<ul style="list-style-type: none"> • Lack of awareness on alternative feed resources • Limited organized system for block-level model for fattening • Limited market access • Lack of transportation and market information from village to abattoirs • Lack of advisory services at local level • No organized local market for buffalo due to religious beliefs • Lack of collection and pre-processing facility for hides and skins 	<ul style="list-style-type: none"> • Establish feedlot co-operative societies and learn from the experience of COMFED in establishment of coops • Awareness raising regarding better upkeep of animals • Establish transport system for large ruminant movement • Establish a market information system to provide timely price/market <p>Information</p> <ul style="list-style-type: none"> • Implement a live weight pricing system with minimum support price (MSP) • Strengthen private sector engagement in the buffalo value chain; and support export of buffalo meat • Revitalize the livestock extension centres in Bihar to train producers on small-scale technology in value addition for hides and skins <p>Processing</p> <ul style="list-style-type: none"> • Invite private investments in small and medium abattoirs to support already established large meat processing plants in the Forbesganj area • Additional hide and skin processing tanneries to be established <p>Sales and retailing</p> <ul style="list-style-type: none"> • Participate in export of agricultural and processed food products • Undertake sponsored food trade shows by development authority to create interest • Departments of Industry and DAFR to further explore, develop, and establish

Challenges	Strategies to address challenges
Gender and social inclusion	
<ul style="list-style-type: none"> • lack of access to land resources by marginalized people including women leads to feed constraint • Lack of access to livestock services results in decreased productivity of stock • The existing gender-neutral approaches in marketing and breed improvement often neglects role of women • Lack of access to extension by women due to mobility issues, household burden, and neglected role 	<ul style="list-style-type: none"> • Feed interventions targeted at women and marginalised people (feed subsidy cards for fodder and concentrate feed) • Develop policies in cooperatives and breed improvement strategies to accommodate women and marginalized • Women/marginalized friendly extension manual and protocol development

6.6 Buffalo meat improvement interventions

Intervention areas (production zones): All the livestock production zones (northern, central and southern zones) are target areas for the buffalo meat improvement intervention. The interventions and targets, outlined in the subsequent section is categorized as feed, animal health, genetics, extension, research, and post production interventions.

Feed

In addition to the feed interventions listed under the dairy value chain, the other major feed improvement focus areas are presented as:

- Support backyard, hedge and live fence fodder production
- Increase pasture productivity through over sowing with improved grass and leguminous forage seeds and use of fertilizer, where applicable. The area of land under permanent pasture/grazing during 2013–14 was about 15,000 ha. The targeted goal is to increase rehabilitated permanent pasture/grazing land, so these comprise 50% of the total permanent pasture land by 2022-23; and
- Improve production and marketing of forages and concentrates
- Strengthen existing regulatory bodies to improve quality of forage seeds and concentrates.

Health

- Veterinary hospitals/poly clinics, veterinary dispensaries and veterinary aid centres presented in the Cow dairy improvement intervention options section will also cater for buffalo
- Buffalo currently receive vaccinations for critical diseases at the following percentages: FMD 80% (starting 2015), brucellosis 90% (starting 2017), and 80% vaccination coverage for haemorrhagic septicaemia (HS) and black quarter (BQ). The targeted goal is to keep a vaccination rate of 80% by 2022–23;
- The major intervention is to maintain the current vaccination; improve deworming, sanitation, housing, control of flooding; and reduce drought risk;
- Increase the number of farmers that adopt the recommended rate of external and internal parasite. This will reach 80% in the coming 15 years;
- Private veterinary service providers will be supported; including more women service providers; and
- Mastitis control and prevention will be supported.

Genetics

- The number of AI performed for buffalo is usually reported with cattle inseminations. By 2016/17, total cattle and buffalo inseminations performed reached 27.96 lakhs. The targeted goal is to increase inseminations to 50 lakhs by 2022–23³⁰;
- Upgrading and/or establishment of semen production centres, frozen semen banks, liquid nitrogen storage plants and AI centres. These cater for cattle and buffalo; and
- Strengthen the existing buffalo breeding farm and establish a new farm by 2022–23. These breeding farms could serve as loci for breed improvement, and as nucleus and multiplication centres.

Extension

- Extension infrastructures listed under cattle will also cater for buffalo;
- By 2032/33, all the AI centres/veterinary aid centres will provide extension (training, input and marketing) services to farmers;
- Develop/improve necessary acts, regulations, guidelines and manuals in the first two years to support the rapid growth of extension service providers.
- Control of unregistered input, advisory and marketing service providers is also critical for survival of the legal service providers;
- The coverage of full package buffalo improvement training increases by an additional 15% points by 2022-23. Buffalo farmers will receive more intensive and continuous training in buffalo management (feeding, breeding, deworming, tick control, hygiene and milk handling and transport);
- Strengthen the telecommunication extension service
- Strengthen the animal husbandry extension facility through mobile veterinary clinics. The Pashi Sakhi do carry out mobile veterinary services, but the radius of their service provision can be expanded

Research

- The interventions listed under the dairy improvement also serve for buffalo;
- Quantitative and qualitative gender and social inclusion analysis in buffalo production to understand all gender roles, and the increase investment impacts on women and marginal communities

Processing and marketing

- Establish one integrated abattoir and processing plant by 2022–23

Animal and herd-level targets and assumptions for farmers adopting buffalo meat³¹ improvement interventions

- Parturition rate increase from 40% to 45%;
- Mortality rate decrease by 50%;
- Daily milk production of buffalo increases from the current 5, 5.5 and 4.5 litres/day in the north, central

³⁰ Assumptions include: percent of adult females=58% for cattle, 48% for buffalo, parturition rate=50% for cattle and 45% for buffalo, number of repetitions=2.

³¹ Note this also applies to Buffalo milk

and southern zones to 6, 6.5 and 5.5 litres/day, respectively (MAFW 2017; Vaidya 2017);

- Average live weight of buffaloes increases by 5–10%;
- Amount of fodder purchased increases by 10%;
- Amount of purchased concentrate/processed feed increases by 0.5 kg/day/lactating buffaloes (Vaidya 2017);
- Each buffalo will be provided with 40–50 gm/day mineral supplementation and 30 gm/day common salt;
- Expenditure for veterinary service is targeted to increase by an additional INR500 per animal/year; and
- The price of hide increases by 10% due to external parasite treatment/controls.

6.7 Investment budget

The major investment in terms of infrastructure for buffalo improvement relates to animal breeding and genetics, and marketing and processing. The investment is proposed to come from the public and private sector investments, through a public and private sector partnership. The estimated investment cost coming from Bihar state government amounts to INRs 8 crore. The corresponding amount from the private sector is in the quantity of INRs 20 crore, and this is associated with the establishment of an integrated abattoir, and rehabilitation and upgrading of existing Tannery.

Table 46: Five-year buffalo meat production improvement investment cost (2018-19 to 2022-23)

Investment Intervention	Unit	Qty	Unit cost	Investment planned year wise in (Crore INR)					Budget source			
				2018	2019	2020	2021	2022	Total for 5 years	Public	Private	
Breeding and Genetics												
Establish 2 new buffalo breeding farms, one by 2019 and another in 2024	Farm with a capacity for 500 animals	1	8.0		8.0				8.0	8.0		
Processing and marketing												
Establish integrated abattoir and processing plant by 2022-23 ³²	Abattoir	1	11.0	11.00					11.00			11.0
Rehabilitate and upgrade existing tanneries. Renovate 3 in the first phase	Tanneries	3	3.0		3.00	3.00			9.00	3.00		9.00

Source: Bihar LMP analysis

³² An integrated abattoir with processing plant, and with a capacity of 200 heads/day costs 11 crore INR (excluding land)

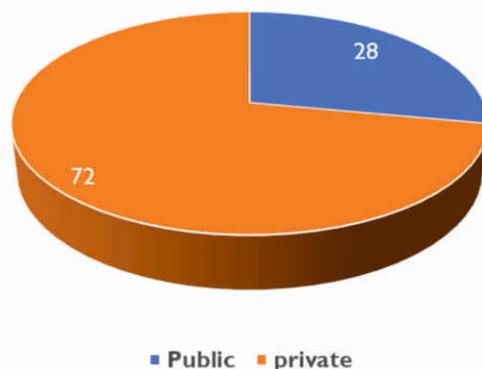


Figure 4: Share of investment by source

Source: Bihar LMP analysis

6.8 Impacts of interventions

Production

Investment in interventions to improve buffalo meat production result in meat volume amounting to 92,629 MT, which is an increase by 21% compared to the base year 2017-18. Changes were also noted for buffalo milk, organic matter and energy in the magnitude of 32, 12, and 12 percent, respectively.

Table 47: Change in production of buffalo meat and other outputs, with intervention (WI)

Products	Base year 2017–18	2022-23	% change
Buffalo meat (MT)	76,302	92,629	21
Buffalo milk (crore L)	340.7	448.5	32
Organic matter (crore MT)	1.09	1.23	12
Energy (thousand days)	41	46	12

Source: Bihar LMP analysis

Gross State Domestic product (GSDP)

The percent change due to investment shows variation by production zone. The overall change in the contribution of buffalo meat to GSDP goes up by 17%.

Table 48: Change in contribution to GSDP of buffalo meat production with intervention

Production zone	Buffalo Meat GSDP (crore INRs)		
	Base year 2017–18	2022-23	% change
Northern	220.4	254.3	15
Central	224.1	264.6	18
Southern	54.3	65.4	21
Total	498.7	584.3	17

Source: Bihar LMP analysis

Income change per animal

The change in net income per animal in Table 49 shows that investment in the selected interventions result in increased income across livestock production zones. The net income per animal in the southern production zone increases by 23% due to investment, whereas northern and central shows a 21 and 22% increase with intervention, as compared to the BAU scenario.

Table 49: Net income change per animal for buffalo under WI, by livestock production zone

		herd size	Average no. of heads	Net income/animal (BAU)	Net income/animal (WI)	Net income (% change)
Buffalo	Northern	small	2	9,436	11,384	21
	Central	small	2	10,686	13,047	22
	Southern	small	2	7,726	9,519	23

Source: Bihar LMP analysis

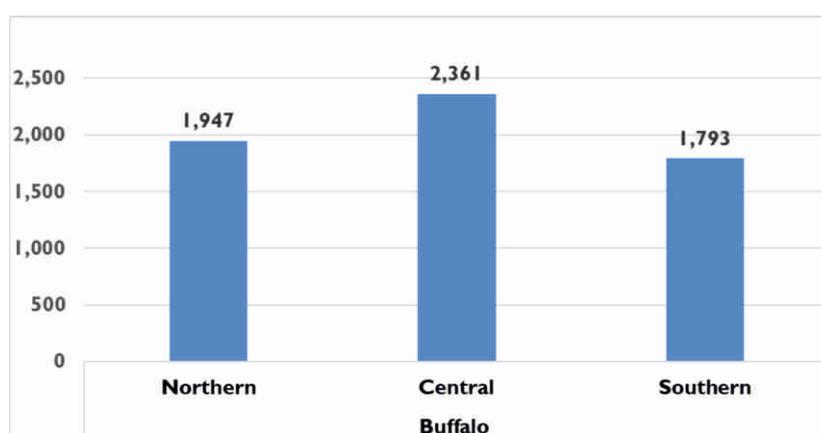


Figure 5: Annual incremental income due to the additional intervention for buffalo meat production

Source: Bihar LMP analysis

6.9 Activities timeline and sequencing: Gantt chart

Table 50: Intervention activities timeline and sequencing: Gantt chart

Investment Intervention	Activities timeline				
	2018	2019	2020	2021	2022
Breeding Investments					
Establish 1 ³³ new buffalo breeding farm with a capacity of 500 animals					
Post production processing and marketing investment					
Establish 1 ³⁴ integrated abattoir and processing plant					
Rehabilitate and upgrade existing tanneries					

³³ 1 additional new buffalo breeding farm with a capacity of 500 animals is needed in 2024

³⁴ 2 additional one integrated abattoir and processing plant is required. One in by 2022-23. The cost of an integrated abattoir and processing plant with the capacity of 200 heads/day is 110 mil INR (excluding land)

6.10 Complimentary success requirements

- Incentivise private investments on the supply side of the VC, especially in private abattoirs to produce meat for the export markets
- Develop a state-wide market intelligence system to assist in realistic planning at the micro and macro levels while avoiding disturbing the current scenario
- Regulations, guidelines and policy support for last mile animal health services need to be better implemented, especially Pashu Sakhi interventions
- Gender mainstreaming and social inclusion strategies at all levels, including capacity development of extension staff

6.11 Gender and social inclusion implication for buffalo meat value chain development

Women and all marginalise communities are involved in the buffalo meat value chain, both at production and marketing levels. As the meat value chain modernizes, with more use of external inputs and services, and as more formal marketing channels emerge, the proposed investments will need to include measures that consider and develop the capabilities of women and all members of the marginal communities, to ensure they are able to benefit in proportion to their time and resources invested. These measures for women would include supporting cooperatives to adopt governance structures that do not disadvantage women and supporting extension efforts aimed at women. Reservations for women for membership and in leadership roles in cooperatives is needed. As well, inclusive interventions need to be used and targeted, so that marginal communities, including women can take part of inclusive development.

6.12 Conclusions

The current annual growth rate (i.e. under the BAU scenario) of the buffalo population is about 2.3%. In the WI scenario, it is targeted to remain the same. This is necessary due to the serious present and expected future feed shortage. This feed shortage simply does not allow for increasing production through any increase in livestock population. Thus, the major focus of the buffalo meat improvement interventions is to increase productivity of buffaloes, not to increase the population.

Under the WI scenario for buffaloes, by 2022-23 the change in meat production from the base year (2017–18) is projected to be 21%. Moreover, the GSDP contribution from buffalo meat by 2022-23 is expected to increase by 17% over the base year (2017–18).

Surplus buffalo meat production is projected with additional investment (WI) or the current level of investment or BAU. Moreover, the increase in buffalo meat production which would result from the additional investment or WI scenario over the BAU scenario is relatively small for the 5-years period of the LMP. However, under the WI investment scenario, meat production in Bihar is projected to increase by 45%, in the 15-year LSA period to 2032–33. Thus, whether WI or BAU is chosen as the preferred investment scenario under the 5-years LMP period, these results indicate that markets external to Bihar would need eventually to be accessed, whether the additional surplus goes to other states or is exported. Moreover, tapping these markets external to Bihar, under BAU or WI, would require additional investments in buffalo abattoirs and meat processing, raising the cost per kg, but resulting in higher incremental incomes per animal, as shown in the LMP analysis. Thus, it would be both necessary and worthwhile to invest and implement the WI scenario rather than staying with the BAU scenario so the buffalo meat markets outside Bihar can be exploited most profitably.

In conclusion, due to limited local demand for buffalo meat, extra investments could contribute to opportunities for increased access to markets external to Bihar, including exports, and help to raise the incomes of the many households in rural communities engaged in buffalo production, including scheduled castes and women. Interventions, extension of better animal husbandry, and management and marketing training would also need to be targeted at strengthening coops to provide marginalized peoples and women with better practical knowledge to empower the coops and members to increase their market access and make increased sales to surrounding states and exports to nearby countries.

The analysis thus points to the need for private investments in buffalo abattoirs to facilitate marketing, including exports to increase the value of their buffalo milk and meat. Additional investments to increase buffalo production (WI) would seem preferred to BAU and would need to be complemented with increased investments in buffalo abattoirs and meat processing, mainly by the private investors. Such investments in value addition processing have been shown to induce increased investment by farmers in technologies to increase productivity and production since they create more assured markets for both milk and meat. Assured markets would then help production increases to result in income increases being realized by buffalo owners. Male calve fattening could also be expected to be introduced and adopted by farmers as productivity increases and mortality could be reduced.

7 Pig and pork value chain roadmap (2018-19 to 2022-23)

7.1 Key LSA results and conclusions – the basis for the LMP recommendations

The gender and social inclusion analysis carried out under the LSA showed that pigs are mainly produced by the marginalized communities in Bihar and typically the pigs are managed by women, since 50% of the men in these communities are migratory labourers. Pig productivity and production improvement interventions in the LSA thus mainly target improving production management in traditional backyard systems, as well as improving pig breeds and intensifying the backyard production.

The demand for pork also presently exists mainly in rural areas among the marginalized populations, but the LSA results show this demand will increase over the coming 15 years, including in urban markets. This urban demand will need to be met mainly by commercial pig operations, where sanitary and phytosanitary standards can more easily be met. There is thus also a need to increase the number/units/farms for commercial pig systems, as well as to create more intensified and better managed smallholder backyard operations to meet the increasing demand. The pig population in Bihar in the 15-year period between 2017-18 and 2032/33 is projected to grow by about 13% in the BAU scenario, but 46% in the WI scenario. Under the WI scenario, the pig population is projected to almost double from the current 6.85 lakhs to 9.97 lakhs in 15 years. The proposed productivity increasing interventions in WI are also projected to result in improvements in pork production. It is projected that pork production by 2032-33 will increase to 1.62 lakh MT from the 2017-18 production level of 0.46 lakhs t, a 350% increase. Moreover, the ex-ante impact assessment of the WI improvements on pig production shows IRR values of 63% and 60% for the commercial piggery system, and commercial pig fattening system, respectively.

The LSA results show that the investment focus for smallholder producers in Bihar needs to be on improving the genetics of the pigs they rear, on increased training how to manage their pigs better, and how to intensify their production in stalls, including as a stepping stone for some of them to become commercial producers. There is also a role for investors to go into commercial pig production. Surplus production could thus be produced in 15 years by implementing the WI scenarios, but more investment will also be needed to create more pig cooperatives which can help rural producers to bulk market their pigs. The smallholder producer cooperatives will need to be provided with marketing skills and help in establishing market linkages to band together to sell to urban areas. The commercial producers will also mainly sell their pigs live, to urban markets in Bihar and nearby states, at least for the 5-year period of the LMP, but over the long-run some value-addition processing and marketing of pork meat can also be expected to take place to increase sales over time to other states, as well as to nearby export markets.

7.2 Fifteen-year Vision for the pig VC

Improved pig productivity, production, processing and marketing results in about a 264% increase in pork production and an increased contribution of 173% to GSDP or state income. The pig industry in Bihar becomes a far more efficiently functioning industry, involving both largescale commercial producers and also many more smallholder pig producers. For smallholder producers, including those in the marginalized communities, the WI investments contribute to household food and nutritional security, rural household income growth and poverty alleviation, including among women. This would occur through improvements in feed and feeding, genetics, and health of pigs, through training by the extension services, as well as through better marketing achieved by forming and training of pig coops.

7.3 The Five-year LMP investment context

In the investment analysis done to create the LMP pig roadmap, two levels of investment scenarios and their implications for total pig production and contributions of the pig sub-sector to GSDP are examined to provide investment choices for the decision makers in the Bihar state: the government, private investors and development partners (donors). These scenarios are referred to here as BAU (Business as Usual) and the WI (with additional Investment).

BAU presents the base case scenario analysis or the implications of the current level of investment and spending profile on pig production and GSDP contributions throughout the LMP analysis period of 5 years. WI is the recommended level of investment which could help achieve the agreed upon national development objectives.

7.4 Description of the pig production systems

Despite Bihar's potential in pork production, pigs are managed by small and marginal livestock keepers with very low inputs. The main pig production system in Bihar state is backyard based. The backyard piggery is divided further into traditional backyard pig system (TBPS) and improved backyard pig system (IBPS). As shown in below, in both the TBPS and IBPS, the average herd size per household is one sow. The TBPS piggery has the lowest productivity performance. The litter size per sow in the TBPS is about five whereas in the IBPS, it is about seven.

The commercial specialized pig (CSP) system, which consists CSP – sow rearing and CSP – piglet fattening, is at infant stage. The average projected herd size per farm, number of sows and boars, in the in CSP – sow rearing is 50 while the number of piglets per fattening farm in the CSP – piglet fattening is 500 piglets.

Table 54: Herd sizes across the pig systems

Pig systems	Herd size
TBPS	1 sow
IBPS	1 sow
CSP- sow rearing	50 sows
CSP-piglet fattening	500 piglets

Source: Bihar LMP analysis

7.5 Overall LMP target under with intervention scenario

The overall LMP target is to raise pig meat production from the current 44,500 MT in 2017-18 to 47,000 MT by 2022-23, an increase of only 6% in the 5-year LMP period, whereas in 15 years we project that 264% more pig meat can be produced, according to the LSA analysis. This small increase in production in the first 5-year LMP period is due an expected reduction in local breed pigs as they are replaced with improved breeds, as farmers move from the traditional scavenging system to the improved semi-intensive system, or the commercial system. The production of pig meat from the improved semi intensive (IBPS) sub-system increases from 323 MT to 0.145 lakhs MT, a 348% change over the same 5-year LMP period. Moreover, while it will take more time (15 years) to realize the full changes in genetics, feed and animal health in the semi-intensive and commercial systems, the 5-year LMP period increase of 6% in total pork production from all systems thus sets the stage for the 264% increase in 15 years.

7.6 Targets for modernizing and transforming the traditional backyard pig systems (TBPS to IBPS)

Table 52: Total number of sows and MT of meat in traditional extensive and improved backyard (TBPS & IBPS) pig sub-systems

Pig system	Unit	2017-18 base year	2018-19	2019-20	2020-21	2021-22	2022-23	% Change
TBPS	Number	1,32,188	1,25,579	1,19,300	1,13,335	1,07,668	1,02,285	-23%
IBPS	Number	442	597	806	1,087	1,468	1,982	348%
Total backyard sows	Number	133	126	120	114	109	104	-21%
TBPS	MT	39,189	37,230	35,368	33,600	31,920	30,324	-23%
IBPS	MT	323	435	587	793	1,070	1,444	348%
Total pig meat from backyard system	MT	39,512	37,665	35,956	34,393	32,990	31,768	-20%

Source: Bihar LMP analysis

- Number of sows in traditional backyard pig system (TBPS) decreases from 1,32,188 to 1,22,285 a 23% decrease over 5 years as expected, due to the replacement of local pigs with improved breeds.
- Number of sows in the improved backyard pig system (IBPS) increases from 442 to 1,982, a 348% increase over 5 years, but still a very small number.
- Pig meat production from the TBPS subsystem decreases from 0.39 to 0.30 lakhs MT, a 23 decrease over 5 years.
- Pig meat from the improved semi intensive (IBPS) sub system increases from 323 to 1,444 MT, a 348 % increase over 5 years period.

- The total pig meat from the backyard system decreases from 0.39 to 0.32 lakhs MT, a decrease of 20%, as TBPS producers become IBPS producers.

Key assumptions for improving the traditional backyard piggery system (TBPS)

- Number of piglets at birth will increase from the current five to seven litters/sow.
- Mortality rate of young animals before weaning to decrease from 20–12%.
- Average marketable live weight of pigs to increase from 80–85 kg.
- Veterinary service expense of the farmer will increase to INR 350 and
- Per cent of feed purchased will increase from the current 0% in traditional piggery to 20% in the improved piggery.

7.6.1 Opportunities and challenges in pig production

Opportunities of pig production

- Prolific breeders.
- Income opportunities for small and landless marginalized farmers, unemployed educated or uneducated young people, and rural women.
- Growing level of awareness about the economic value of pigs like other domestic livestock animals.
- Majority tribal population, already keeping livestock— pig keeping is integral to their way of life.
- Increasing per capita income with urbanization and changes in lifestyle and food habits, can also be expected to contribute to growing demand for pork.

Table 53: Challenges to pig production in Bihar State

Challenges	Strategies to address challenges
Feeds	
<ul style="list-style-type: none"> • The corn feed needed to raise quality pork not grown cost efficiently to sustain domestic pig herds 	<ul style="list-style-type: none"> • Awareness raising on proper feeding and management; • Establish feeding methods
Animal health	
<ul style="list-style-type: none"> • The health status of the pigs is poor; • Disease outbreaks often devastate local pig populations 	<ul style="list-style-type: none"> • Establish state level department on piggery • Technical support, awareness, and training directed at producers, and vet service providers; • Strengthen the preparedness of relevant government health institutions

Challenges	Strategies to address challenges
Genetics/breeding	
<ul style="list-style-type: none"> • Low productivity of local breed; • lack of suitable pig breeds for commercial meat production according to the Bihar weather and climate 	<ul style="list-style-type: none"> • Upgrade the current breed of pig and crossbreeding; • Importation of suitable breeds and encouraging commercial piggeries
Post-production	
<ul style="list-style-type: none"> • Limited information on national investment on pig production; limited availability, poor quality and high price; low consumption of pork because of religious inhibitions; the movement of frozen, chilled swine meat is limited by poor infrastructure, transport systems and cold storage 	<ul style="list-style-type: none"> • Promote preparation and consumption of pork; • Establish slaughterhouse and processing plants • Establish a model farm with training facility • Collection system • Create live animal market infrastructure at each block level and develop swine cooperative/SHG models at the village level. • Existing infrastructure of Agricultural markets could be used by allotting space on Rental basis. • Sales and retailing • Create Cold chain facilities for transport and retailing. Promote Pork products such as Ham, Bacon and Sausages among the HORECA chain.

7.7 Interventions to achieve targets in backyard pig sub systems

The investment context

Pig production in Bihar is divided into three main categories. The first and the most predominant type of pig production is the traditional scavenging system followed by semi-intensive and intensive production systems. The traditional piggery is characterized by very minimal/zero input where pigs obtain their feed by scavenging locally available feed resources/vegetation, crop residues and kitchen wastes (Chauhan et al. 2016). Housing and management is also very poor—pigs are exposed to extreme weather conditions and rain. The semi-intensive pig production on the other hand has better management, shelter and feeding, while the intensive system is a commercial piggery. The intensive pig system is either specialized in fattening piglets or involved in breeding and fattening pigs, especially sows.

Pig improvement interventions and targets

Transforming the traditional backyard piggery production

Intervention areas (production zones)

Transforming the traditional family pig to improved family pig throughout the state and all the livestock production zones (northern, central and southern zones)

Priority interventions (for TBPS and IBPS)

The main objective of the traditional family piggery improvement intervention is to replace it with semi-intensive production management. In semi-intensive pig production, farmers provide better management and feeding to pigs and improve the genetics through selection and breeding with locally adaptable exotic or improved local pig breeds.

Feed and feeding

- Improve availability of feed (produced agro-industrial by-products and processed feeds).
- Make land available for production of pig feed and raw materials for processed feed production.
- Provide incentives for suitable investments to support agro-processing industries and feed processing factories.
- Improve quality assurance of agro-industrial by-products and processed feeds, as well as pork.

Genetics

- Improve breed performance through crossing with improved breeds.
- Establish a breeding farm to enhance breed improvement and multiplication of improved breeds.
- Establish improved breed piglet multiplication and distribution centers.
- Provide extension services to farmers on how to improve productivity of pig breeds through selection.

Health

- Institute disease surveillance and quarantining when needed.
- Advocate and provide periodic vaccinations against important pig diseases and control of internal and external parasite.
- Encourage private health service providers, or public providers where private providers will not go.

Extension

- Educate farmers to improve the pig management in the traditional piggery and move to improved and semi-intensive production. It is expected that farmers will adopt improved and semi-intensive production and move away from the traditional piggery.
- The number of pigs in the traditional piggery is expected to decrease annually by 5% while the pig population in the semi-intensive piggery is projected to increase from the current almost nil situation (Table 54 below).

Table 54: Population projection in traditional and semi-intensive pig productions

Production type	Base year (2017–18)	End of first five year (2022–23)
Traditional piggery (TBPS)	1.32 lakhs	1.02 lakhs
Semi-intensive piggery (IBPS)	442	1,982

Source: Bihar LMP analysis

Processing and marketing

- Create market linkage between pig producers and pig slaughterhouses/abattoirs/pork processors;
- Establish pig producers' cooperatives to facilitate marketing of inputs and outputs;
- Establish pig slaughterhouses/abattoirs and pork processing factories; and
- Assure the quality of live pig, pork and pork products marketed.

Farmers moving away from the traditional piggery to improved semi-intensive piggery will get the following changes in benefits and costs:

- Number of piglets at birth will increase from the current five to seven litters/sow
- Mortality rate of young animals before weaning to decrease from 20–12%
- Average marketable live weight of pigs to increase from 80–85 kg
- Veterinary service expense of farmers will increase to INR350 due to additional health care, vaccinations and parasite treatments
- Percent of feed purchased will increase from the current 0% in traditional piggery to 20% in the improved piggery

7.8 Impacts of interventions (TBPS & IBPS)

Rate of return on investment (ROI)

The 15-year ex-ante impact assessment of improvements on pig production results in a very high IRR (not computable) and a BCR of 1.87 for improved backyard pig production system.

Production impacts

Pork production from the TBPS subsystem decreases from 0.39 lakhs MT to 0.30 lakhs MT, an 23% decrease over the 5-year LMP period. However, the production of pork from improved semi intensive (IBPS) sub system increases from 442 MT to 0.2 lakhs MT, a 348% change over 5 years period.

GSDP impacts

The GSDP contribution of the TBPS decreases from 176 crore INR in 2017-18 to 162 crore INR in the 5-year LMP period. However, because of the additional intervention (WI) in the IBPS, the GSDP that comes from IBPS increases from 16.9 crore INR to 24.5 crore during the same period. Since a very large GSDP contribution in the backyard system comes from the traditional system, the overall GSDP contribution of the backyard pig subsystem decreases from 193 crore INR to 187 crore INR, a 3% decrease in 5 years.

Table 55: Backyard pig GSDP contribution from meat or pork with additional investment

Products	Pig meat GSDP 2017-18 (INR crore)	Pig meat GSDP 2022-23 (INR crore)	Change in %
Family pork contribution	176	162	-8%
Specialized pork contribution	16.9	24.5	45%
Total meat contribution	193	187	-3%

Source: Bihar LMP analysis

Projected Income per animal

Table 56 below presents the income per animal in 5 years for TBPS and IBPS. The results show there is very slight or no increase in income per animal due to the investment intervention impacts in the pig backyard system in the coming five years. The 15-year LSA analysis indicates that the significant improvement in income from pigs will only come from moving from both the TBPS and IBPS to the commercial specialized pig system (CSP), an expected increase of over 90% per pig.

Table 56: Projected income per animal in 5 years (TBPS and IBPS)

Pig-backyard system	BAU	WI	% Change
TBPS	25,291	25,291	0%
IBPS	14,191	14,449	2%

Source: Bihar LMP analysis

7.9 Expanding the Commercial/Specialized Pig production subsystem (CSP)

7.9.1 Targets for CSP

Table 57: Population growth of piglets fattening and meat production

Pig subsystem	Unit	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	% Change
Piglet numbers	number	3,500	4,350	5,408	6,723	8,361	10,399	197%
Piglet meat	MT	5,009	6,256	7,814	9,760	12,190	15,227	204%

Source: Bihar LMP analysis

The number of sows in the commercial specialized pig subsystem increases from 3,500 to 10,399 sows. This is a 197% increase.

Pig meat production from the specialized system increases from 5,009 MT to 15,227 MT over the 5-year period and constitutes a 204% growth.

The key challenges and strategies related to commercial specialize pig (CSP) system are the same as for the backyard pig systems (TBPS & IBPS)

7.9.2 Expanding specialized commercial intensive piggery (CSP)

The intensive pig production system is planned to emerge and increase in size over the next 15 years; and this intensive pig production has two forms: sow rearing and fattening of pigs (Table 58).

Table 58: Population projection in intensive pig productions

Production type	Base year (2017–18)	End of first five year (2022–23)
Intensive sow rearing	3,000	9,155
Intensive piglet fattening	500	1,244
Total	3,500	10,399

Source: Bihar LMP analysis

7.9.3 Impacts of interventions (CSP)

Rate of return on investment (ROI)

The results of the investment analysis show high IRR values for the specialized commercial piggery systems. The 15-year ex-ante impact assessment of the improvements in CSP pig production results in IRR values of 63% and 60%, and BCR of 3.12 and 1.28 for commercial sow rearing and commercial pig fattening, respectively. These are big enough to justify the proposed investment.

Production and GSDP impacts

Because of the additional recommended level of investment (WI), the total pig meat production from the commercial specialized pig system (CSP) increases from 5,009 to 15,227 MT, a 204% increase, while the GSDP contribution of pig meat production increases from 16.9 crore INR in 2017-18 to 51.5 crore in 2022/23, an increase of 206%.

Table 59: Pig meat production and GSDP contribution

Pig system	2017-18	2022-23	Change in %
Total pig meat from the CSP (MT)	5,009	15,227	204%
GSDP contribution by the CSP in crore INR	16.9	51.5	206%

Source: Bihar LMP analysis

Total Pork Production

The total pork production from the backyard and commercial specialized pig system

increases by only 6% over the 5-year period (2017-18 to 2022-23). This can be attributed to the increasing number, and higher production, of the commercial specialized pig system, which is establishing slowly. This small increase in production in the first 5-year LMP period is also due an expected reduction in local breed pigs as they are replaced with improved breeds, as farmers move to the improved semi-intensive system, or the commercial system.

Table 60: Total pork production

Products	Pig meat 2017-18 (in MT)	Pig meat 2022-23 (in MT)	Change in %
Total pig meat from the backyard system	39,512	31,768	-23%
Total pig meat from Commercial specialized pig system	5,009	15,227	204%
Total pig meat production	44,521	46,994	6%

Source: Bihar LMP analysis

Total GSDP contribution

Overall the GSDP contribution of the total pig meat production could decrease from 193 crore INR to 190 crore INR in the 5-year LMP period, a decrease 1% from the base year contribution. This is due to the anticipated decreasing contribution of the currently dominant backyard pig sub system.

Table 61: Total GSDP contribution Backyard (TBPS and IBPS) and Commercial/Specialized Pig (CSP)

Products	Pig meat GSDP 2017-18 (INR crore)	Pig meat GSDP 2022-23 (INR crore)	Change in %
Backyard pig meat contribution	176	139	-21%
Specialized pig meat contribution	16.9	51.5	206%
Total meat contribution	193	190	-1%

Source: Bihar LMP analysis

Projected Income per animal

The income per animal in the category of commercial piggery is not significantly higher under the WI scenario since pig improvement interventions result in additional income of only INR 1,008 per animal. Thus, increases in income are expected to come from increasing the number of sows per unit of operation and the number of units of operation or pig farms. This finding is similar to the result found in chicken broiler and layer systems (CSC), whose technology is well known and when implemented the income increases come mainly from increasing the number of birds per unit of operation and the number of units of operation or broiler and layer farms.

Table 62: projected income per animal in 5 years

	BAU	WI	% Change
Intensive sow rearing	46,944	47,952	2%
Intensive piglet fattening	1,775	1,774	0%

Source: Bihar LMP analysis

7.10 Investment budget

The total investment requirement for the first 5 years amounts to 85.2 crore INR (Table 63). Overall the major portion of the investment is on establishment of new pig farms (92%), followed by marketing (4%) and breeding investments (2%). It is anticipated that the pig value chain will benefit from the investments on animal health and feed in other sub-sectors, particularly the poultry sub-sector.

Table 63: Total investment and recurrent costs for pig production VC development

Investment category	Responsible actor		Total investment cost (crore INR)	Proportion of total investment
	Public	Private		
Establishment of new farms	15	63.6	78.6	92%
Breeding Investments	2	0	2.	2%
Extension services	1.2	0	1.2	1%
Marketing Investments	0	3.5	3.5	4%
Total investment	18.2	67.	853	100%

Source: Bihar LMP analysis

As shown in Table 64, the major share of the investment for the establishment of the new pig farms (81%) and marketing (100%) is expected to come from private sector. While all the investment related to breeding and extension services will come from public investments.

Table 64: The percent contribution of public and private investments by investment areas for improving the pig production VC

Investment category	Proportion (%) by responsible actor	
	Public	Private
Establishment of new farms	19%	81%
Breeding Investments	100%	0%
Extension services	100%	0%
Marketing Investments	0%	100%
Total investment	21%	79%

Source: Bihar LMP analysis

Table 65: Investment interventions and costs in feed/ breeding/ health/ research and extension improvements in Bihar

Investment Intervention	Unit	Quantity	Unit cost	crore INR						Total	Public	Private
				2018	2019	2020	2021	2022				
Investments to improve feeding	Shown in ruminants and chicken interventions (2 Commercial Feed plants under AH and 3 Feed plants under Poultry could support this industry too) besides the HORECA waste											
Establishment of new farms												
Establish new commercial pig farms	Commercial farms with 50 sow capacity	300	0.25	15	15	15	15	15	15	75	15	60
Establishing 9 new pig fattening feedlots (export oriented)	Feedlot with a capacity of 500 pigs	9	0.4	0.8	1.2	0.4	0.4	0.8	0.8	3.6		3.6
Sub-total										78.6	15	63.6
Breeding Investments												
One pig breeding farm (cost of establishing one breeding farm including mini feed plant and shelters is 2.0 crore INR)	500 animals capacity	1	2.0		2.0					2.0	2.0	
Extension services												
Establishing three large pig producer cooperatives (1 in north, 1 in central and 1 in South) with branches in each respective district. Cost of establishing one cooperative is 0.4 crore INR including furniture and fixtures in a rented premise.	Cooperative	3	0.4		1.2					1.2	1.2	

Investment Intervention	Unit	Quantity	Unit cost							Total	Public	Private
			2018	2019	2020	2021	2022	Total				
Health												
Marketing Investments												
Slaughter houses (one slaughter house costs 0.39 crore) (1 in the north, 1 in central and 1 in south) – 50 – 100 per day	Slaughterhouse	3	0.39	0.39	0.39					1.17		1.17
Establish 2 Processing plant with cold store – (cost of one processing plant is 2.3 crore INR) 200-250 per day	Processing plant	1	2.3				2.3			2.3		2.3
Total Investments in Pig Value Chain										85.3	18.2	67.

Source: Bihar LMP analysis

7.11 Activities timeline and sequencing: Gantt chart

Table 66: Activity sequencing (Gantt chart)

Investment Intervention	Activities timeline				
	2018	2019	2020	2021	2022
Establishment of new farms					
Establish new commercial pig farms					
Establishing 9 new pig fattening feedlots (export oriented)					
Breeding Investments					
One pig breeding farm (cost of establishing one breeding farm including mini feed plant and shelters is 2 cr. INR)					
Extension services					
Establishing three large pig producer cooperatives (1 in north, 1 in central and 1 in South) with branches in each respective district. Cost of establishing one cooperative is 0.4 crore INR including furniture and fixtures in a rented premise.					
Marketing Investments					
Slaughter houses (one slaughter house costs 0.39 crore) (1 in the north, 1 in central and 1 in south) – 50 – 100 per day					
Establish 2 Processing plant with cold store – (cost of one processing plant is 2.3 crore INR) 200-250 per day					

7.12 Gender and social inclusion implication for pig value chain development

Pigs are presently being reared in the tribal belts of Bihar, especially South and North Bihar, by scheduled tribe communities. The existing production system is based on small scale backyard pig production using household waste and agricultural residues. Most of these pigs are managed by women as more than 50% of household men from the tribal regions migrate to other areas for livelihood earning. The improvement of backyard pig farming with improved breeds and moving to semi-intensive feeding could be a low hanging fruit for tribal income improvement. This will benefit for women and youth for employment in trading, veterinary service, decentralized feed mills. As in the goat sector, it would be worth promoting community based last mile service delivery from community members (Pashu Sakhi).

Efforts to upgrade backyard systems should be complemented by the recommended investments in moving

tribal pig producers to more capital intensive and commercially oriented systems. As pork production grows, getting a better understanding on the gendered roles and responsibilities and mainstreaming gender in future projects will be needed.

7.13 Complementary success requirements

- Investment conditions continue to be attractive enough to go into commercial pig production
- The consumption of pork and other processed products continues to increase over time
- Pig producer cooperatives are established and trained to be able to link to and sell commercially in live pig markets

7.14 Conclusions

Improving traditional pork production with the WI investment interventions do not show substantial increments in income per animal or in total production over 5 years, only an increase of 6%. As shown in Table 67, it is projected, moreover, that the total contribution of pork to Bihar GSDP will decrease by 1% over the 5-year LMP period. Moreover, while the increase in pork meat production would also not contribute significantly to fulfilling the state meat requirement, it could, however, continue to contribute to the nutritional requirements of marginalized communities.

Moreover, the 15-year LSA analysis indicated that an improvement in income from pigs could come for smallholder producers, including those from marginalized communities by moving from TBPS to IBPS, which would enable them to produce more pigs and if they could be helped to invest in the commercial specialized pig systems (CSP), the expected income increase per pig would be over 90% when moving from either the TBPS or IBPS systems.

Table 67: Summary of total pork production and GSDP impacts

Production 5th year	Investment Scenarios		
			% change
	2017-18 (Base year)	2022-23	
Total pig meat production (MT)	44,521	46,994	6%
Total meat contribution (crores)	193	190	-1%

Source: Bihar LMP analysis

The pig/pork value chain (VC) in Bihar is now mainly meeting local rural demand, but the demand from urban hotels and restaurants, etc. is growing and is now being met mainly by buying pork from other Indian states. Increased investment in the pig VC in Bihar could thus help improve the livelihoods of marginalized groups and women, the main producers of pigs, by moving them from the traditional backyard pig system (TBPS) to the improved traditional backyard pig system (IBPS) and thereby increasing the number of sows and piglets they can rear. As well, those pig producers ready and able to move to commercial pig production could also be helped to do so by the investment interventions (WI) described for IBPS and CSP, the commercial sow and piglet rearing systems.

The transformation of the pig industry in Bihar will be driven by;

- Adequate quality feeds, assured animal health and breeding services and additional investments in breeding farms and breeding activities
- A greater focus on supporting existing pig producers to move from the traditional system (TBPS) to the semi-intensive IBPS system
- Moving some IBPS smallholders to the commercial pig sub-sector or CSP systems
- Encouraging investors to adopt the largescale CSP systems
- Additional investments that target the commercial piggery sub-sector with slaughter and marketing infrastructures, a necessary factor to increase pork production and supply pork to hotels, restaurants and cafeterias in Bihar and for eventually marketing to neighboring states.
- Strengthening pig producer associations with training to equip them with the knowledge and skills, as well access to credit and collective marketing, to be able to link to and sell commercially in live pig markets

8 Complementarity and added value of the LMP to the ARM

The Bihar LMP was prepared to complement and add value to the livestock sub-sector plan of the Bihar agricultural roadmap or ARM. to support the implementation of the ARM. In this LMP section, the complementarities of the ARM and the LMP roadmaps are first analyzed to highlight the added value of the LMP, then any overlaps in ARM and LMP strategies and activities are discussed, so that DAFR can rationalize the ARM and LMP where necessary to improve the implementation potential of the ARM.

8.1 *The Bihar Agriculture Roadmap (ARM)*

The first Bihar state agriculture roadmap (ARM) was launched in 2008 to help modernize and transform the agriculture sector of the state. After the first ARM, two subsequent agricultural roadmaps have been developed and implemented and include livestock components. The past ARMs have been successful in helping the livestock sector of Bihar to achieve significant development over the past 20 years. Each ARM encompasses agriculture sub-sector roadmaps such as crops, fisheries, livestock, cooperatives, water resources, minor water resources, land reforms, etc. In each sub-sector roadmap, such as the one for livestock development, includes targets, strategies, and activities to contribute further to developing the agriculture sector and the state.

Bihar is currently implementing its third ARM for 2016-17 to 2021-22. Each sub-sector roadmap of the ARM outlines a broad vision for that sub-sector, as well as key strategies and activities, five-year targets for the output quantities to be produced during the plan, and the financial or investment costs required to achieve the targets. The ARM does not include targets for state development objectives, or analysis of the impacts of investment interventions on development indicators to prioritize investments.

DAFR is supporting the implementation of the current Bihar agriculture roadmap specifically for livestock, including through the elaboration of the Bihar livestock master plan (LMP) to provide a more detailed and complete set of 5-year livestock commodity value chain investment plans to help achieve the targets of the livestock roadmap of the ARM.

8.2 *The Livestock Master Plan (LMP)*

Both the LSA and the LMP have been produced through a quantitative analysis carried out using a herd and economic sector model (HESM) developed by the DAFR and ILRI team. The HESM and LSA made possible the elaboration of the detailed five-year investment plans or livestock commodity value chain roadmaps which make up the LMP, each roadmap having focused interventions, investment budgets and activity plans.

As had been explained in the introduction to the LMP, the objective of the Bihar LSA was to provide quantitative and evidence-based justification for greater public and private funding of sector investments. The LSA analysis resulted in a set of recommended and prioritized livestock value chains and investment interventions with the most potential to further modernize the sector. The recommended investments have been chosen based on analysis of the returns on investment (ROIs) in additional combined technology and policy options. The LSA

future impact analysis resulted in the five LMP livestock VC roadmaps for dairy, chicken, goats, buffalo and pigs presented in this LMP document. The choice of the 3 recommended livestock value chains in the ARM (dairy, poultry and goats, meanwhile, is not explained.

8.3 Value addition of the LMP process

The livestock VCs focused on for investment in the ARM are dairy, poultry and goats. Dairy is given the highest priority, and a detailed and excellent plan is laid out which will lead to even more development of the dairy sub-sector during the 3rd ARM than was even achieved in the first two ARMs. As has been stated before in the LMP, Bihar is rightly recognized for the growth and development of its dairy VC, and its high total milk production from cows, buffalo and goats (ninth highest milk producing state in India). This success has been accomplished largely through the efforts led by the Bihar Milk Co-Operative Federation Ltd. (COMFED), which is supported by the governments of Bihar and India. COMFED has played a key role in raising dairy cow productivity and milk production, as well as in raising dairy farmer incomes through the many coops and AI providers it has helped establish, as well as the other complementary services it provides (health, feed, extension training, etc.). The LMP results show that achieving such further improvements will also necessitate investment by private sector dairy processors, particularly in areas where COMFED has not reached and in the strengthening of public institutions that provide necessary support services.

In preparing the LMP, the DAFR and ILRI team tried not to duplicate the strategies and activities already covered in the ARM, but for the comparative analysis of VCs and interventions, the LMP did include the VCs analyzed in the ARM so the prioritization of VCs and interventions could be done, and recommendations made which are relevant to the ARM. The ARM investment activities focus on four livestock values chains or VCs: dairy, poultry and goats, and fish, as well as development activities for state livestock support institutions and the major cross-cutting issues: animal health, AI, vet services, fodder production and demonstration, and training. In the LMP, the prioritized set of livestock roadmaps recommended are five and are somewhat differently focused: dairy (from cows and buffaloes); chicken eggs and meat; goat meat, milk and skins; as well as pigs and pork, and buffalo meat. The choice of the recommended livestock value chains in the ARM is not explained, or the contribution of the livestock sector to state development objectives.

The LMP also adds more detailed analysis of the current state of the livestock sector and proposed future investment interventions which could help achieve the present ARM targets. In the LSA and LMP, the HESM was used to do the following additional quantitative analyses:

- project future demand for the specific livestock products and set production targets to meet this future demand
- identify the challenges and opportunities faced in achieving the targets
- make the links between the interventions chosen and their impacts on LMP and ARM targets
- calculate the expected returns from proposed investments (ROIs) in alternative interventions to achieve the targets
- calculate the intervention impacts on state development goals: poverty reduction, food security, state income growth (GSDP), surplus trade, employment, farmer investment
- specify the additional investments (public, private, and PPP) required to implement the interventions and reach the LMP and ARM targets

- identify the complimentary success factors needed to achieve the projected impacts
- identify policy changes needed to achieve the technology results to be combined with the technology interventions.

In the LSA and LMP, future demand growth was determined by rates of change in human population and urbanization, as well as in per capita income, and the income elasticities of demand for the various livestock food products. In the ARM, the demand projections are based on daily consumption requirements based on state or federal statistics, multiplied by 5-year projections of state human population. In the case of livestock production goals, the methods of calculation used in the ARM, are not provided.

In the LSA/LMP, the following measures were taken to ensure that the targets and results projections were reliable:

- In-state visits for data collection were undertaken, totaling 6 man-months of time, in which the LMP team cross-checked the data and model results
- Estimates of technical productivity parameters, population numbers and economic and financial data, as well as information on the opportunities, challenges, and interventions used to specify the HESM model were collected from published literature and cross-checked by Bihar experts.
- One-on-one consultations, and group-level technical discussions were held to get expert agreement on all data and parameters, as well as to ensure realistic model projections and results
- Data projections were made using the HESM and sensitivity analysis was carried out to identify critical data and parameters impacting the targets and projections of results
- Model results were further cross-checked by Bihar experts at a stakeholder workshop where representatives from government departments, research (e.g. state Institute of Animal Health and Production and ICAR experts), the Bihar Animal Sciences University, Bihar Livestock Development Agency, and private sector attended. All parameters, projections and results were endorsed.

Some of the more important examples of the added value of the Bihar LMP to the livestock sub-sector roadmap of the Bihar ARM include the following:

In the ARM the specific commodities of meat are not differentiated, but all meat is considered as one commodity, with a target for total meat. As well, the ARM does not differentiate meat and milk by the species from which they are sourced (cows, buffaloes and goats), whereas the LMP combines cow and buffalo milk since they are combined in processing, but treats goat milk and meat separately, in the goat value chain, and treats buffalo meat separately from milk in the buffalo meat VC.

The LMP analyzes the impacts of recommended interventions on gender, as well as on the social inclusion of other marginalized group members and provides strategies and activities for institutionalization of gender and social inclusion sensitive interventions.

The ARM presents impacts of recommended interventions on meeting daily federal consumption requirements. The LMP, besides presenting impacts of interventions on meeting future demand requirements, presents base year and projected impacts of interventions on HH income (or poverty reduction), GSDP (or state income), food and nutritional security, surplus production for exports, income for investment generation, etc.

In the ARM, challenges, opportunities and interventions are not disaggregated by production zones. In the LMP, three livestock production zones were identified and considered, thus enabling contextualizing of opportunities, challenges and interventions as appropriate due to agroecological differences in the zones.

In the LMP, base year and projected impacts of interventions on GSDP or state income growth are presented. GSDP contributions are also disaggregated by VC, species and breed. This disaggregation helps to prioritize value chains, species, and breeds; as well as prioritize allocation of funding. In the ARM, the projected impacts of interventions are not available for the contribution of livestock to state GSDP. Impacts of interventions can be traced from animal to state level

In the LMP, future livestock population is projected. Furthermore, since the uptake of the proposed investment interventions could be limited by the availability of input resources, especially feed and land, and an analysis of feed balance was done to see the potential increase in meat and milk production given the limitation of land and feed resources. Table 68 below, the full details of the analysis of the added value of the Bihar LMP to the livestock sub-sector roadmap of the Bihar ARM are provided.

Table 68: Summary of table on the value addition of the LMP to the livestock section of the Agriculture Roadmap (ARM)

Agriculture roadmap (ARM)	Value addition of the LMP
<ul style="list-style-type: none"> • No clear link exists between interventions and the resulting production and other targets. • The base year (or present) situation and projected impact of interventions at animal, herd and household levels are not available. • Production targets are not disaggregated by species or genetic potential, but given for milk, eggs and all meat • Intervention target-based approach is followed for livestock species • Investment interventions are given for dairy, poultry, and goats, as well as state livestock support institutions, as well as cross-cutting issues: animal health, AI, vet services, fodder production and demonstration, and training • Interventions impacts on gender and social inclusion (marginalized groups) are not considered • The chicken improvement targets look conservative, with no basis for the targets given • Pigs are not considered in the agricultural roadmap, but fish is considered in the ARM³⁵ • Challenges, opportunities and interventions are not disaggregated by production zones 	<ul style="list-style-type: none"> • Targets and impacts can be traced back to animal productivity and forward to state level production. • Animal, herd and household level impacts of interventions are presented. Changes in terms of productivity and income at animal, herd and household level are presented, and aggregate to production at the state level. • Production is disaggregated by species and by breed for cattle <ul style="list-style-type: none"> ○ Milk – from buffalo and cattle (indigenous and crossbred) ○ Meat – from buffalo, goat, chicken and pig • Value chain-based approach is used for evaluating interventions. The livestock products improvement interventions focus on production, processing and marketing of commodities • Investment interventions are disaggregated by species, as well as cross-cutting issues: animal health, AI, vet services, fodder production and demonstration, and training, but not specified in detail for state livestock support institutions (e.g. BASU, BLDA, etc.) • Impacts of interventions on gender and social

³⁵ The fisheries value chain is not considered in the LMP, but is covered in the agriculture roadmap or ARM

Agriculture roadmap (ARM)	Value addition of the LMP
<ul style="list-style-type: none"> • Projected impacts of interventions are not available for the contribution of livestock to state GSDP • Feed balance analysis has not been done • Livestock population projections are not provided • The impact of interventions on animal productivity, livestock population, and state level production targets are not detailed out, but only assumed • The ARM was prepared by a group of senior experts and presented to and circulated among stockholders and experts for review and comments. Then the ARM was revised and finalized based on the comments • Internal rates of return of investments (IRRs) and net present value (NPV) impacts of investments are not presented • Targets are set based on national/per capita availability of livestock products and population projections. The targets do not account for demand factors • Constraints and opportunities related to policies and institutions are general 	<p>inclusion of other marginalized group members, and institutionalization of gender and social inclusion sensitive interventions are presented</p> <ul style="list-style-type: none"> • The LMP ROI analysis shows that further investment in chicken meat production VC offers high potential for development and impact, but the state is already investing enough in egg production • Live pigs and pork are value chain is considered in the LMP value chain analysis, but not fish • Three livestock production zones were identified and considered in the LMP, thus enabling contextualizing of opportunities, challenges and interventions as appropriate due to agroecological differences in the zones • Base year and projected impact of interventions on GSDP are presented. GSDP contributions are disaggregated by value chains, species and breeds. This disaggregation helps to prioritize value chains, species, and breeds; as well as prioritize allocation of funding • Feed analysis is done to see the potential increase in meat and milk production given the limitation of land and feed resources • Livestock population is projected since the uptake of the proposed investment interventions can be limited by the availability of resources³⁶ • Impacts of interventions can be traced from animal to state level • The Livestock Sector Investment and Policy Toolkit (LSIPT) was used to create a livestock herd and economic sector simulation model (HESM). Data from censuses, surveys, reports, literature, gray literature, along with species value chain based expert consultations (at least 7) and stakeholder consultative workshops (2) • Internal rates of return of investments (IRRs)³⁷ and net present value (NPV) impacts of investments are presented, as well as expected

³⁶ Projecting the livestock population consequences of investments is critical as it is constrained by limiting factors/resources like feed and land

³⁷ Based on return to investments livestock species and breeds, value chains, and investment interventions can be prioritized for funding for government institutions and private investors

Agriculture roadmap (ARM)	Value addition of the LMP
	<p>impacts on indicators of state development objectives</p> <ul style="list-style-type: none"> • Targets consider both production and consumption sides of livestock products. A detailed production-consumption balance analysis for each livestock subsector is presented • Detailed and species-specific constraints and opportunities related to policies and institutions are presented and analyzed for potential impacts on achieving targets

8.4 Complementarity of the Bihar LMP and ARM

Since the LMP is meant to complement the livestock sub-sector plan of the ARM to improve its implementation, it is necessary to avoid overlap in LMP and ARM activities and duplication in budgets. Thus, it is critical to rationalize the ARM and LMP and their investment budgets where necessary to avoid overlap and double spending. Thus, the following complementarity analysis of the key strategies and intervention activities, as well as the costs to achieve the ARM and LMP targets, are presented in this section:

- Comparison of the five-year targets for the physical quantities or volumes livestock commodities to be produced in the value chains covered in the LMP and ARM
- Comparison of the investment costs required to achieve the targets for each of the value chains to gain an understanding of the differences in the interventions and costs which make up the investment budgets in the ARM and LMP

To facilitate the analysis a summary of the quantity targets for the ARM and LMP commodities is presented in Table 69 and Table 67 below. As well, the full details of how the ARM and LMP activities chosen in both plans compare, including the five-year targets for physical quantities or volumes to be produced and the related investments needed for each intervention activity are then presented in Table 71 Table 72 in Annex.

We begin with a comparison of the overall livestock product targets for the ARM and LMP shown in Table 69 below for milk, eggs and meat. Table 69 shows that the projected targets for eggs are equivalent, while the LMP target for meat is 9% lower. However, it should be noted that the degree of complementarity between the targets for meat production are not exactly comparable, since the ARM does not differentiate all types of meat, including chicken meat. Meanwhile, the target for milk in Table 69 is 16% lower in the LMP than in the ARM. In the LMP, the milk production estimate is made based on the achievable increase in milk productivity per animal over 5 years, as well as the growth rate of the state dairy herd, and the projected availability of feed.³⁸ The milk production target in the ARM, meanwhile, has been calculated by multiplying the national (not the state) daily average consumption requirement by the projected human population of Bihar in 2022. Thus, the two projected targets are not comparable, and we stand by the LMP target and the way it was calculated. It should be noted however, that the LMP milk production projection is still quite close to the ARM milk availability intended target.

³⁸ The herd and sector model or HESM used in the sector analysis (LSA) projected the increase in number of indigenous and crossbred cattle and buffalo due to the with intervention scenario, including the impact of the availability of feed projected for the coming five years.

Table 69: Production targets for quantities of livestock commodities in the agriculture roadmap (ARM) and livestock master plan (LMP)

Livestock Products	Agriculture roadmap	LMP roadmap	Percent positive (+) or negative (-) difference in LMP
Milk in thousand MT	15,990	13,436	-16%
Eggs in Lakhs	5,462	5,464	same
Meat in thousand MT	403,000	366,100	-9%

Source: Government of Bihar, MAFW, 2017 & Bihar LMP analysis

As mentioned above, the contribution of the livestock sector to GSDP could not be compared since the VC impacts on GSDP have not been provided in the ARM.

The differences in the financial investment costs of the VC plans of the ARM and LMP have also been assessed to see the degree of complementarity between the plans. Table 70 below presents the summary of the differences in the five-year investment interventions and costs for each recommended commodity value chain. The key differences in the crosscutting intervention investments (health, genetics, feed, education institutions (to increase and improve manpower availability), and training and extension, as the basis for rationalization of the plans. Table 71 Table 72 in Annex provides the details the five-year physical and financial targets for both the ARM and LMP, and the differences in the investment activities and costs to achieve them.

According to Table 70, the total investment cost of the ARM is about INR 26 billion while in the LMP it is about 62 billion, or about 240% higher. The major explanation for the difference in the total investment costs in the two plans is the difference in the cost of the chicken development scheme and interventions. The chicken development target in the ARM underestimates the number of layer farms required to get the targeted number of eggs. Also, the ARM assumes a lower investment cost required for establishing layer and broiler farms. Moreover, the proposed number of broiler farms needed to achieve the chicken meat production target under the ARM cannot be known since the target for chicken meat is reported in combination with all other meats in the ARM plan. Underestimating the number of chicken farms and assuming a lower investment cost of farms results in about a 9,000% difference in chicken development investment cost between the two plans.

Also, as detailed in Table 70, the two plans display mainly complementary investments for the other livestock species and livestock products covered in both the ARM and LMP (besides chicken and eggs), as well as for various production inputs: complementarities in the goat VC; complementarities in health and feed improvement interventions; and complementarity in government distribution of chickens and goats and education and training. There is, meanwhile, overlap in milk collection, marketing and processing plants. Of course, the complementarity and overlap in the investments for the pig and buffalo meat VCs cannot be assessed since these VCs are not included in the ARM.

Complementary activities in the LMP and ARM suggest that the investments proposed in the ARM and LMP could both be done, while overlaps would require rationalization of the investments in both plans to avoid duplication. This will be a key job for ministry investment decision makers, with input from DAFR, to get the most out of the ARM and LMP.

In conclusion, in most cases where overlap exists, including in the establishment of more broiler and layer farms, and where complementarity exists, the two plans could be easily rationalized to provide one coherent plan which would include the best elements of both, and this would likely enhance the impacts of the planned ARM investments in the Bihar livestock sector, as shown by the analysis of investment returns in the LMP.

Table 70: Summary of comparison of interventions and investment costs under the Bihar Agricultural roadmap (ARM) and Bihar Livestock Master Plan (LMP)

Interventions/ value chains	ARM	LMP	Comparison and explanation of the interventions which make up the investment costs in the ARM and LMP
	Investment costs (INR crores) (2016-17 to 2021-22) ³⁹	Investment costs (INR crores) (2017-18 to 2022-23)	
1 Chicken development	53	4,831.9	<ul style="list-style-type: none"> • Chicken development scheme in the ARM includes investment interventions for the establishment of layer and broiler farms and distribution of chickens. • Chicken investment intervention in the LMP include establishment of layer and broiler farms, feed processing plants, hatcheries, multiplication centres, chicken slaughter house and egg and chicken meat cold storage plants; strengthen feed quality control and regulation laboratories) • The investment cost estimate for chicken in the LMP is 9000% higher than in the ARM. The outstanding reasons are <ul style="list-style-type: none"> ○ Number of layer farms and additional chicken number projected in ARM is about 450% lower than number of chickens required to get the targeted number of egg production in the fifth year. ○ The investment cost estimate for establishment of layer and broiler farms is underestimated. The investment cost for layer and broiler is about INRs 0.85 and 0.4 crores in LMP while it is just about INRs 0.02 and 0.002 crores in ARM, respectively. I.e., layer and broiler farm establishment cost in LMP is 4,300 and 19,000% higher than the cost estimates in ARM.
2 Goat development	576	17.2	<ul style="list-style-type: none"> • Goat Development Schemes in ARM and LMP complement <ul style="list-style-type: none"> ○ Goat Development Schemes in ARM includes establishment of private goat farms, free distribution of goats, strengthening breeding farm ○ Goat Development Scheme in LMP includes strengthening/establishment of breeding farms, slaughter houses for local and export market.
3 Livestock health improvement	513.4	164.3	<ul style="list-style-type: none"> • Livestock health improvement schemes in ARM and LMP complement <ul style="list-style-type: none"> ○ Livestock health improvement investment cost in ARM includes protection program (cost of vaccination programs) and veterinary service costs (honorarium and other payments to veterinary employs and data entry operators ...) ○ Livestock health improvement investment cost in LMP include only capital costs and not recurrent costs. The investments include strengthening the capacity of existing hospitals, establishment of veterinary dispensaries
4 Breed improvement	110	243.5	<ul style="list-style-type: none"> • Breed improvement scheme in ARM include development artificial insemination scheme through establishment of livestock development centers and strengthening of BLDA. • Breed improvement scheme in LMP include development artificial insemination scheme through establishment livestock development centers, semen production center, breeding farms; make existing livestock development centers, liquid nitrogen cryovessel storages and semen banks functional and strengthen BLDA.) also breed improvements through selection by establishing new breeding farms.

³⁹ It should be noted that the years covered by the ARM and LMP do not match. The 2 plans only overlap 4 out of 5 years.

	Interventions/ value chains	Comparison and explanation of the interventions which make up the investment costs in the ARM and LMP	
		ARM Investment costs (INR crores) (2016-17 to 2021-22) ³⁹	LMP Investment costs (INR crores) (2017- 18 to 2022- 23)
5	Animal welfare	31.6	0
6	Establishment and strengthening of essential institutes	1,147.1	225.5
8	Training and extension	74	24
10	Feed improvement	3.7	8
11	Pig Development Scheme	0	85.3
12	Buffalo meat scheme	0	28
13	Dairy development scheme	1,323.9	643
	Grand Total	2,621.6	6,270.6

Source: Government of Bihar, MAFW, 2017 & Bihar LMP analysis

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10 Annexes

Table 71: Main physical and financial targets by intervention activity under the ARM and LMP

	Agriculture roadmap			LMP			Remarks
	Name of the schemes/ components	Total quantity targets (2016/17 - 2021/22)	Investment costs (crores INR) (2016/17 - 2021/22)	Name of the schemes/ components	Total quantity targets (2017/18 - 2022/23)	Investment costs (crores INR) (2017/18 - 2022/23)	
1	Poultry development scheme						
A	Establishment of layer poultry farm (5,000 capacity)	1,000	19.5	Establishment of new layer farms (7,500 capacity)	3500	2.960	
B	Establishment of layer poultry farm (1,000 capacity)	700	23.1				
C	Chick distribution	250,000	9.25				
D	Infrastructure development of broiler poultry farm (200 capacity)	534	1.12	Establishment of new broiler farms (1500-5000 capacity)	4000	1.600	
-	-	-	-	Encourage establishment of medium size feed processing plant with a capacity of 12 ton/hr.	10	30	
-	-	-	-	Upgrade the existing Poultry feed processing plants	5	5	
-	-	-	-	Improve the capacities of existing Poultry feed quality control laboratory (upgrading feed quality test laboratory) (cost of upgrading is 3 mil INR per laboratory)	1	0.3	
-	-	-	-	On farm built in feed processing plants	1000	50	
-	-	-	-	Establish hatchery with a capacity of producing 7 million Day Old Chicks per year or 20000 DOC per day	22	132	
-	-	-	-	Upgrade the current multiplication	3	0.6	

Agriculture roadmap		LMP		Remarks		
Name of the schemes/ components	Total quantity targets (2016/17 - 2021/22)	Investment costs (crores INR) (2016/17 - 2021/22)	Name of the schemes/ components	Total quantity targets (2017/18 - 2022/23)	Investment costs (crores INR) (2017/18 - 2022/23)	Remarks
-	-	-	Establish new chicken multiplication centers	20		
-	-	-	Upgrade the capacity of IAHP to make it capable of producing vaccines	1	20	
-	-	-	Upgrade the capacity of IAHP to improve its disease diagnostic and surveillance capacity	1	1	
-	-	-	Promotion of exotic chicken and egg consumption (Use of FM radio)	15	3	
-	-	-	Encourage establishment of new chicken slaughtering house (1,000 bird slaughter house including chicken value added products)	3	9	
-	-	-	Establish 4 cold storage units for eggs and chicken	4	24	
Total (Poultry development scheme)		52.97			4,854.9	
2						
Goat Development Scheme						
Establishment of goat farm (20+1 capacity)	3500	35				The LMP incorporates the promotion of private (20+1 and 40+2) and facilitating distribution of goats to marginalized groups and women
Establishment of goat farm (40+2 capacity)	2000	40				
Distribution of goats	400,000	488				
Strengthening of Goat rearing cum-breeding farm, Maranga, Purnea	1	13	Strengthen the existing 1 farm and establish 2 new by 2022. Each goat and sheep breeding farm with a capacity of 500 animals.	3	8	

Agriculture roadmap		LMP			Remarks	
Name of the schemes/ components	Total quantity targets (2016/17 - 2021/22)	Investment costs (crores INR) (2016/17 - 2021/22)	Name of the schemes/ components	Total quantity targets (2017/18 - 2022/23)	Investment costs (crores INR) (2017/18 - 2022/23)	Remarks
-		-	Establish 3 local goat slaughter houses - capacity of slaughtering 500 goats	3	1.2	
			Establish 3 goat slaughter abattoirs - with a capacity of slaughtering 500 goats		8	
Total (Goat Development Scheme)		5,760			17.2	
3						
Livestock health protection program						
A	800 Lakhs	159.67	H.S. and B.Q. combined vaccination			
B	800 Lakhs	156.8	FMD vaccination – 1 st phase			
C	800 Lakhs	156.8	FMD vaccination – 2 nd phase			
D	191 Lakhs	18.6	PPR Vaccination			
E	34.05 Lakhs	19.82	Brucellosis Vaccination			
-		-	Strengthen the capacity of existing veterinary hospitals/polyclinics in the first 5 years	39	29.25	
-		-	Establish new 300 veterinary dispensaries	300	135	
Total (Livestock health protection program)					164.25	
4						
Artificial Insemination Scheme and genetic improvement						
A	205 Lakhs		Number of AI performed is targeted to increase to 5 million per annum by 2022–23	205 Lakhs		

The investment budget
in the Agricultural
roadmap (AR) is part of
recurrent costs. This
budget will be helpful
for developing detailed
annual plan.

Agriculture roadmap		LMP			Remarks		
Name of the schemes/ components	Total quantity targets (2016/17 - 2021/22)	Investment costs (crores INR) (2016/17 - 2021/22)	Name of the schemes/ components	Total quantity targets (2017/18 - 2022/23)	Investment costs (crores INR) (2017/18 - 2022/23)	Remarks	
B	Establishment of livestock development centres	2,000	60	Make existing nonfunctional AI centers (livestock development centers) operational and establish 500 new centres	1,000	150	
C	Strengthening BLDA, Patna	1	50	Establish a new semen production center with a capacity of 5 million straws production.	1	65	
D	Scheme for prevention of cruelty of animal		10				The budget in the AR for animal welfare is part of recurrent costs. This budget will be helpful for developing detailed annual plan.
	-		-	Renovate the 3 liquid nitrogen cryo-vessel storage	3	1.05	
				Strengthen the existing breeding farms and establish 2 new cattle breeding farms	3	20	
				Make the existing 2 non-functional semen banks functional and increase 2 additional semen banks	2+2	7.4	
	Total (Artificial Insemination Scheme)					243.5	
5	Goshala development scheme		10	-	-		The budget allotted in the AR is part of recurrent cost to run Goshalas. This budget will be helpful for developing detailed annual plan.
	Total		10				

		Agriculture roadmap			LMP			Remarks
	Name of the schemes/ components	Total quantity targets (2016/17 - 2021/22)	Investment costs (crores INR) (2016/17 - 2021/22)	Name of the schemes/ components	Total quantity targets (2017/18 - 2022/23)	Investment costs (crores INR) (2017/18 - 2022/23)		
6	Establishment of Bihar Animal Science University							
A	Establishment/ strengthening of BASU and other institutes	5	987.12	Strengthen the capacity of existing research centre and establish 1 new that can perform research in the livestock sector	1	200	The budget for Strengthening the capacity of Bihar Animal Sciences University in the roadmap can be revisited as per the achievement in the first year of the roadmap and the budget in the roadmap can be used. The LMP considers research centers required in Bihar	
B	Establishment of livestock development centres		150					
	Total (Establishment of Bihar Animal Science University)		1,137.12			200		
7	Strengthening of institute of animal health and production, Patna	1	10	Strengthening of the feed and forage seed quality control capacity of institute of animal health and production, Patna	1	2.5		
				Strengthen the capacity of milk quality and safety control laboratories (IAHP)	1			
				Upgrade the capacity of IAHP to make it capable of producing vaccines	1	20		
				Upgrade the capacity of IAHP to improve its disease diagnostic and surveillance capacity	1	1		
	Total (Strengthening of institute of animal health and production, Patna)		10			23.5		

		Agriculture roadmap			LMP			Remarks
	Name of the schemes/ components	Total quantity targets (2016/17 - 2021/22)	Investment costs (crores INR) (2016/17 - 2021/22)	Name of the schemes/ components	Total quantity targets (2017/18 - 2022/23)	Investment costs (crores INR) (2017/18 - 2022/23)		
8	Training Scheme							
A	Training of veterinary officers and para vets	1,500	1.35	-	-	Recurrent costs are not included as investment costs in LMP	The investment budget in the AR is part of recurrent costs. This budget will be helpful for developing detailed annual plan.	
B	Training under Kaushal Vikas Programme	50,000	72.6	-	-			
	-		-	Establish new training centres to increase their number to 8 (one training centre in each regional directorates) by 2022/23	8	24		
	Total (Training Scheme)		73.95			24		
9	Veterinary service and animal health scheme		250	-	-	Recurrent costs are not included as investment costs in LMP	The investment budget in the AR is part of recurrent costs. This budget will be helpful for developing detailed annual plan.	
10	Purchase of 50 new Ambulatory vans	50	11.6		-		The budget for purchase of Ambulatory in the roadmap can be revisited as per the achievement in the first- year plan of the roadmap and the budget in the roadmap can be used.	
11	Fodder production and demonstration scheme	150 acres	3.65	Establishing fodder seed production farms (to grow from current 0 to 3 private/public enterprises in 5 years)	40 ha	6		

Agriculture roadmap		LMP		Remarks	
Name of the schemes/ components	Total quantity targets (2016/17 - 2021/22)	Investment costs (crores INR) (2016/17 - 2021/22)	Name of the schemes/ components		Total quantity targets (2017/18 - 2022/23)
-		-	Commercial animal feeds plants – Construction of 2 plants under COMFED	2	2
Total (Fodder production and demonstration scheme)		3.65			8
12 Pig Development Scheme					
A Establishment of new farms			Establish 300 new commercial pig farms	300	75
			Establishing 9 new pig fattening feedlots (export oriented)	9	3.6
B Breeding farm			1 Pig Breeding farm	1	2
C Cooperatives			Establishing 3 large pig producer cooperatives	3	1.2
D Marketing and processing			Establish 3 Slaughter houses	3	1.17
			Establish 2 Processing plant with cold store	2	2.3
Total (Pig Development Scheme)		0			85.27
13 Buffalo meat scheme					
Breeding and genetics			Establish 2 new buffalo breeding farms, one by 2019	1	8
Processing and marketing			Establish an integrated abattoir and processing plant	1	11
			Rehabilitate and upgrade existing tanneries. To renovate 3 in the first phase	3	9
Total for Buffalo meat		0			28

Source: Government of Bihar, MAFW, 2017 & Bihar LMP analysis

Table 72: Physical targets for dairy under Agricultural Roadmap and LMP

S. No	Agriculture roadmap				LMP				Remark
	Name of the schemes/ components	Total physical (2016/17 - 2021/22)	Investment costs (crores INR) (2016/17 - 2021/22)	Name of the schemes/ components	Total physical (2016/17 - 2021/22)	Investment costs (crores INR) (2016/17 - 2021/22)			
1	Total milk producer cooperative society	28,191		Currently 22,191 registered milk producer cooperative societies (MPCS) - milk collection centres exist. Establishing additional 5,000 MPCS to improve their milk collection capacity.	27,191	100			
2	Women milk producer cooperative society	4,788	132.25						
3	Total membership	14,975							
4	Female members	4,485							
5	Milk collection	25.98 Lakhs kg/day	51.6	Establish new bulk milk chilling units (with 5,000 lt capacity - for areas more than 50km away from milk processing plants)	200	20			
6	Milk marketing	21.66							
7	Artificial insemination centres	4,930							
8	Processing capacity	50.7 Lakhs L/day	565	Construction of 3 UHT, 3 powder milk, 3 ice cream, 5 pasteurized milk and other milk products (Ghee, yoghurt ...) milk processing plants	50.7 Lakhs lt/day	521			
				Strengthen the capacity of milk quality and safety control laboratories (IAHP)	1	2			
9	Samagra Gavya Vikas Yojana and dairy entrepreneurship development scheme	45,058 114,784 dairy cattle	421.19	-	-			LMP promotes private commercial dairy farms establishment	
10	Training (Dairy development)	38,290	60.86	-	-			The training budget in the AR is part of recurrent costs. This budget will be helpful for developing detailed annual plan.	
	Total (Dairy)		1,323.94			643			

Source: Government of Bihar, MAFW, 2017 & Bihar LMP analysis



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