



Leveraging Environment, Social And Governance Framework (ESG) Together With Triple Bottom Line Principle (TBL) To Identify Potential New Business Opportunities In Assam, India

¹Arindom Hazarika , ²Dr Rashmita Barua,

¹Research Scholar, ²Associate Professor,

¹Department of Management,

¹Assam Don Bosco University, Guwahati, India

Abstract: North East India is affected by a deficit in animal origin protein. The region represents the highest per capita consumption however farmers are unable to meet the demand. The consumers rely on meat, fish and eggs imported from rest of India leading to high per unit price of protein. While ICMR nutritional estimates indicate a 25 Kg annual protein demand for adults, studies peg protein uptake in India at 5-6 Kgs annually. The Animal Husbandry department of Assam estimates a state wide shortfall of 316 thousand tonnes of meat. National Statistics data indicates that North Eastern states spend the highest share of household food budget on meat within India. Our study focussed on stakeholders, entrepreneurs and farmers from across Assam to identifying the animal protein with acceptable economic, social and environmental indicators for policy level support. The study focussed on Assam as the hub of production and North East India as the market. Environment, Social and Governance (ESG) parameters were evaluated in conjunction with Triple Bottom Line (TBL) Considerations and the results were analysed using CRISILS ESG scoring methodology.

Keywords: Protein deficit, Green House Gases (GHG) emission, Triple Bottom line (TBL), Environment, Social and Governance (ESG) New Enterprises, Agri Business Incubators, Women first commodity.

1. INTRODUCTION

Assam has a rich history of agriculture, education, trade and traditions. Post-independence Assam had a per capita income above the national average. It is blessed with natural resources, water ways and fertile soils. Currently, all of this abundance in resources does not translate into economic productivity as evidenced by the fact that Assam ranks 17th in the country in terms of Nominal GDP Contribution at 5.07L Cr as revealed by MOSPI GSDP data. The state fares poorly in the per capita figures of nominal production, clocking Rs 13587 compared to a national average of Rs 114958, placing us at 29th position as per MOSPI NSDP data. Assam also shows high rates of unemployment, 8.1% (Handbook of Statistics on Indian States, 2017). This puts Assam at a lowly 19th position in India. (Bidyut C Deka et al., 2020) indicated a growing protein deficiency in Assam and the North East Indian (NER) region. It is projected that by 2030; NER would face a 42% deficit in pulses production (3.12 production vs a demand of 4.43 lac tons) and a 86% deficit in meat production (3.26 production vs demand of 6.06 lac tons). In the light of the same, this study focusses on identifying gaps in the value chains of major commodities and possible focus sectors for policy intervention towards alleviating the economic challenges. Data from the National Statistics Office indicate that NER states spend on average 23.6% of household food budget on meat, which is the highest in the country. The meat deficit in NER region was estimated to be between 3 to 4 lac tonnes having a monetary value of over Rs 10,000 crores. Increasing livestock numbers and thereby localised meat production appears to be a low hanging opportunity for new enterprises. However, simply focussing on livestock numbers to achieve better protein availability is not a straightforward solution. Globally, livestock is responsible for contributing significantly to greenhouse gas

(GHG) emissions (H Steinfeld et al., 2006). The Food and Agriculture Organisation (FAO) estimates 15% of total GHGs and 66% of Agricultural GHG are generated by livestock. Ruminants like cows, goats, and sheep produce methane through enteric fermentation, which have a higher short-term effect on global warming. (M Herrero, 2010). Considering the same this paper focussed on 1) Sector identification, price trends, current market dynamics, demand supply gap and scope for new enterprises within the protein sector. 2) The GHG load, consumer preference, net effect on local value chains for 5 major meat (protein) types. 3) Ranking protein types using CRISILs ESG model to determine the most economically viable, environmentally friendly and socially relevant option.

2. DATA SOURCES AND METHODOLOGY

The study utilized comparative case studies to identify focus protein group, (Bartlett & Vavrus, 2017) The model was adapted to best reflect the relation between macroeconomics, regional preferences, environmental considerations and individual preferences. Schedule interviews with stakeholders and experts was carried out in 2023 and 2024. A stratified purposive sampling method with maximum variation was used for the initial selection of respondents. Secondary studies were used to shortlist possible commodities for new enterprises in Assam in stage 1 of study. Primary studies were used to identify a focussed commodity for new enterprise creation in stage 2

Population and Sampling. The study includes 2 sets of stakeholder interactions. The respondents were divided into work-based strata within their individual groups. The strata were constituted to represent components of the ESG as well as the TBL frameworks.

Environment (E)	Society (S)	Governance (G)	People (P)	Planet (P)	Profit (P)
ESG specialist	Farmers	Bank	Farmers	ESG Specialist	Entrepreneurs Start Ups
Agricultural scientist	Chef	Food Scientist	Chef	Agricultural scientist	Distributors
	Store owners	Veterinary Doctors		Doctors	Bank

Stakeholders were divided into 2 groups of 10 experts each.

Table 1 – Stratification of experts interviewed during the study

Group 1 – Focus on Market Dynamics, Trends, Consumers Preferences (10)		Group 2 – Focus on ESG, Sustainability, Feed Science, Value chain components (10)	
Chef	2	Agricultural Scientist	2
Food Scientist	2	Bank Officials	2
Food Entrepreneurs	2	Veterinary Doctors	2
Meat Distributors	2	ESG Specialist	2
Departmental Store Owner	1	Animal Husbandry Start Ups	1
Composite Farm Owner	1	Composite Farm Owner	1

Group 1 – Respondent selection criteria

- Experience of working with multiple meat categories as chef and with control of Food and Beverage (F&B) decision making process.
- Meat distributors stocking and reselling all 5 selected meat types. (Chicken, Pork, Chevon, Prawns and Fish)
- Departmental store owner dealing with frozen meats, meat products having experience in the 5 selected meat types
- Farm owner having experience with multiple livestock categories.
- Respondents with 10 years of sectoral experience in animal husbandry, animal protein, food and beverage sector value chains were considered

Our study used group 1 respondents to understand consumer behaviour, cultural nuances as well as future trends in markets and meat consumption.

Group 2 – Respondent selection criteria

- Experience in working with multiple meat categories in academic research.
- ESG expert having experience of working on DFI, World Bank, UN projects
- Bank Officials having experience of credit appraisal of cases related to Animal Husbandry and Agri sector enterprise such as farms, feed mills, processing units or logistics.
- Doctors with field experience with multiple livestock as well as feed types.
- Respondents with 10 years of sectoral experience in animal husbandry, animal protein, food and beverage sector value chains were considered

They study used group 2 respondents to evaluate ESG and TBL considerations, impact potential on local value chains, revenue retention within the region. Importance and value of women in the business and business turnaround times.

Our 2-stage study leverages on these archetypes for business modelling for new enterprise.

3. STUDY -STAGE 1

Sector identification, price trends, focus of the current market dynamics, demand supply gap and scope for new enterprises.

The study focussed on identifying commodities with high retail prices, large demand supply gap across the North East and wide acceptability with potential for production within Assam. Ministry of Statistics and Programme Implementation, National Sample Survey, 2022-23 (MoSPI, NSS) data indicate that urban households spend 40% while rural households spend 48% of their income on food respectively. This is also corroborated by Monthly Per Capita Consumption Expenditure (MPCE) studies published by MoSPI.

An analysis of the price movement of select commodities in India was done using publicly available MSP (minimum support price) data, primary records from processing facilities and secondary studies.

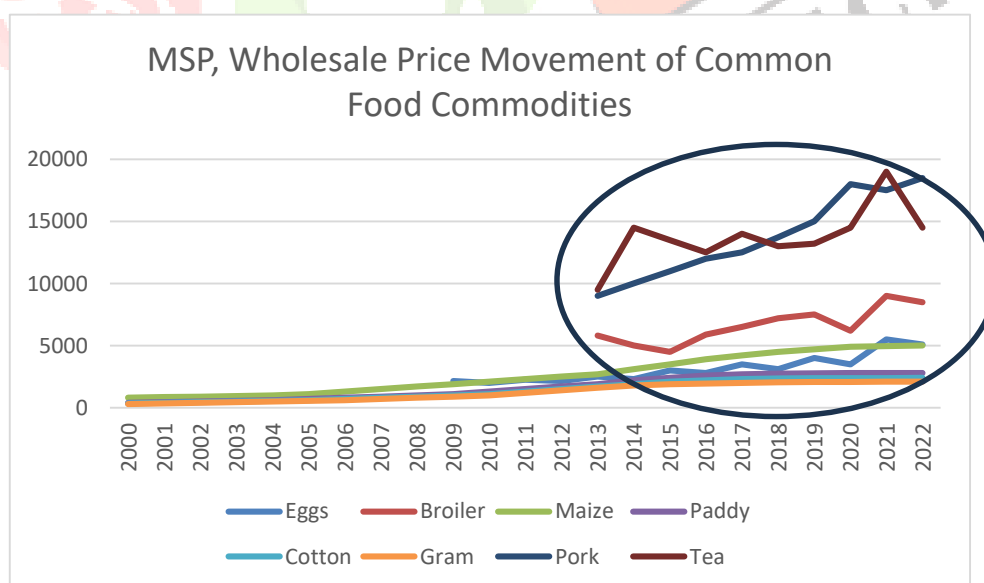


Figure 1 - MSP, Wholesale price movements of food commodities.

Source: (Vaishnavi et al., 2024), (Karthikeyan & Nedunchezian, 2024), (Pradheeshwaran, 2025), (Mubeena et al., 2021) and primary data

Primary data for Pork and Broiler collected from meat sector enterprises Arohan Foods Pvt Ltd, (AFPL) DPIIT recognised meat processing enterprises, SAAR Pig Producing Company, Farmer Producer Company, FPC with 2500 members. . MSP data was available from 2000, primary data for pork, chicken and eggs were available from 2013.

- Tea prices have remained bound in the Rs 140/Kg range for almost 10 years.
- Egg prices while volatile, have moved from Rs 2/Pc to Rs 5.5/Pc
- Broiler prices are also volatile, but have moved up from Rs 60/Kg to Rs 90/Kg
- Pork has steadily moved from Rs 90/Kg to Rs 180/kg.
- Multiple commodities display unnatural price movement during covid years of 2020 to 2022

Although there is no established mechanism for MSP or floor price for animal origin protein, they still maintain a market driven price above most agri commodities with MSP, indicating that the prices are demand driven and stable. The price analysis indicates that animal origin protein represents a high value commodity with a positive price trend.

Indian council of medical research recommends a minimum of 1 gm protein per kg of bodyweight per day. This equals to 25 Kgs annually for a 70kg individual. Multiple studies peg per capita Indian meat consumption to be around 5-6 Kgs annually. This indicates a deficit of almost 80% per capita thus making meat one of the high growth potential agri commodity for consideration in new enterprise creation.

The strategy paper on piggery sector in Assam, Animal Husbandry and Veterinary Department AHVD 2019, states that Assam has an estimated meat requirement of 363 thousand tonnes while 47 thousand tonnes is available. The single largest contributor in current production is pork or pig meat. The strategy paper further enumerates a total deficit of 316 thousand tonnes of meat for the state of Assam to meet ICMR recommendations.

Additionally, the Household Consumption Expenditure Survey (2023-24), National Statistics Office indicates that Arunachal Pradesh - 19%, Assam -19%, Meghalaya -25%, Tripura – 25%, Mizoram – 22%, Manipur 23%, Nagaland 32% spend the highest share of their food budget on meat within the country. Meat presents a current business opportunity within the region as well as a significant latent demand within the country basis spending data and ICMR recommendation.

Using the historical price movement and consumer spending the study reduced its focus onto **animal origin protein or meat as potential area for new agri enterprise**

Identifying the potential animal origin proteins for new agri enterprises.

National Family Health Survey (NFHS) classifies animal protein into three main categories - eggs, fish, and meat. The study explored the possibility of new enterprises across all 3 categories.

Table 2 – Comparative animal population and extraction rates in India.

Animal Species	Population (million)	No of Animals Slaughtered	Extraction Rate %	Carcass Yield (Kg)	Meat Production (MT)
Cattle	192.5	3	1.5	103	0.33
Buffalo	109.9	12	10.8	138	1.55
Goat	148.9	97	65	10	1
Sheep	74.2	50	68	12	0.68
Chicken	851.8	812	95	1.4	4.06
Pig	9.1	9	99	35	0.40

Source : Department of Animal Husbandry, Dairying and Fisheries, Government of India data and (MUTHUKUMAR et al., 2021). Extraction % refers to % number of animals being used for meat annually.

It is evident from the table that Cattle and Buffalo are not primarily reared for meat and just 1.5% to 10.8% extraction is seen annually. While chicken and pork are almost exclusively reared for meat, meaning more commercial orientation with focus on identified commodity. Bovine meat was therefore not selected for the study.

As per the strategy paper for Poultry sector Assam, published by Animal Husbandry and Veterinary Department AHVD of Assam, the state only produces 47.50 Cr eggs vs a demand of 560 Crore eggs annually. Eggs production shortfall mitigation was suggested via establishment of commercial grade farms with capacity of up to 40,000 birds as well as backyard farms. However, the following key challenges meant the sector had significant entry barriers for new enterprises

- Commercial layer farms are capital intensive. A report from Director of Animal Husbandry and Veterinary Services, Govt of West Bengal estimates project cost of Rs 3.6 crore for a 40,000 layer farm.
- Backyard farms depend on hatching eggs or DOCs sourced from government farms or commercial brands. The strategy paper on poultry Assam, states that government farms are able to cater only to a small number of these farms, thus increasing dependency on imports of eggs and DOCs from other states.
- Egg production in India is dominated by 5 states. Andhra Pradesh, Tamil Nadu, Telangana, West Bengal and Karnataka that control over 65% of market share.
- Setting up a new layer farm while competing with large corporate players, whilst importing feed and technology from rest of India was considered not a viable model for promoting new SME ventures under the scope of this study.

After initial shortlisting as per NFHS classification of Eggs, Fish and Meat, Bovine meat and Eggs were not considered due to commercial and scalability reasons. The study focussed on Fish and Meat as the potential protein categories for new enterprises in Assam.

To ensure maximum variation and in accordance with feedback from stakeholders the study considered fish as a 2 component commodity (fish and prawns) and meat as a 3 component commodity (Goat meat or chevon, Chicken and Pork).

Stage 1 Outcome –

Sector Identified – Animal Protein.

Commodity Shortlist - Fish, Prawns, Pork, Chevon and Chicken

4. STUDY -STAGE 2

Identification of protein commodity with a positive Social (People), Environmental (Planet) and Economic (Profit) profile – triple bottom line.

The study approach is based on Crisil's ESG scoring methodology. The same assigns scores of 35%, 25% and 40% to Environmental, Social and Governance respectively. The study dealt exclusively with MSME sector and new enterprises. Our consideration for governance was focussed on business and commercial scope including confidence level of key ecosystem members like chefs, distributors and end users.

Environmental considerations – Direct and Indirect (Planet || E)

Direct - lifetime GHG emission perspective – across protein sectors

While all livestock have significant carbon footprint, the comparative kgCO₂eq footprint of beef, mutton and prawns is 5 times, 2 times and 1.8 times, that of pork respectively. While Pork has foot print 12 times that of chicken. The high footprint of beef and mutton stems from the high amounts of methane produced as part of their enteric digestion process. Methane is estimated to be over 80 times more potent over the short term in trapping heat in the atmosphere.(M Herrero, 2013; Min Liu et al., 2022)

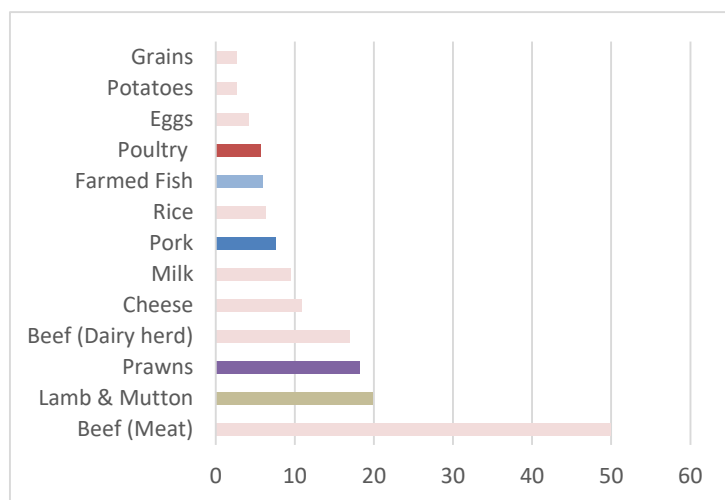


Fig 2.a

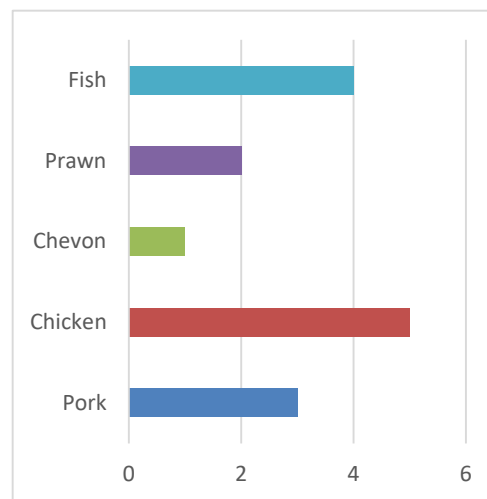


Fig 2.b

Fig 2a - Comparative kgCO₂eq footprint of various common protein sources. Adapted from(Poore & Nemecek, 2018) and ourworldindata.org

Fig 2b - Ranking selected animal origin protein sources on lifetime enteric GHG emissions. Adapted from (Poore & Nemecek, 2018) and illustration available from Our World in Data.

Pork received a rating of 3 while chicken received a rating of 5 by virtue of least lifetime ESG emission per kg equivalent of protein. A higher score reflects lower GHG emissions. Chevon or goats emit highest lifetime GHG thus getting the lowest score amongst the shortlisted meats.

Indirect - Carbon load of feed production per protein type, transport of feed as well as end product.

Feed is the single most important input for animal husbandry. How one produces or procures this feed is therefore a key consideration in assessing their impact. Majority of farmed Poultry, Fish and Prawns are genetically modified for maximum production in shortest time. Any deviation from the prescribed norms results in decreased production and mortality of livestock. (Jitendra R. Valal et al., 2021)

Majority of Pigs, Goats and Sheep are cross breed, localised and hardy. They can be raised on non-standard feed with minimal loss of performance. Some studies show same or improved overall health in animals with optimised localised feed. (Johanna Friman et al., 2021; Natalie Carter et al., 2015)

A key consideration for North Eastern States is that majority of the pigs are raised in non-intensive small holder systems and fed feed produced in multi crop systems (MxC). Pigs across the world and in larger farms across India are fed from feed derived from monocrop systems (MnC). MnC has been found to deplete Soil Organic Carbon (SOC) which may be release to the atmosphere on the form of CO₂. MxC was shown to sequester more carbon and revamp soil carbon compared to MnC systems. (Hashakimana et al., 2023)

The mix of inherent lower GHG emissions of pigs and benefits of raising pigs in smaller MxC systems, indicate that industry that promotes production of animals in the local indigenous systems will have environmental benefits.

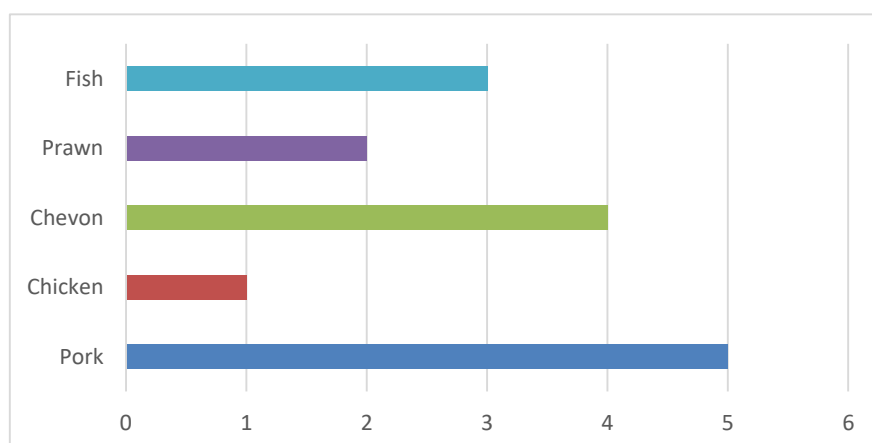


Fig 3 – Ranking protein on emission and carbon load of feed consumed. Pork received a rating of 5, while chicken by virtue of its dependence on commercial feed and logistics scored 1

Source: Tabulated from findings

Table 3: Environmental load of protein type and feed correlation

Considerations	Pork	Poultry	Chevon	Prawns	Fish
Feed Origin	95% localised	90% commercial	95% localised	95% commercial	95% commercial
Circularity in Feed	Very High	Low	Medium	Low	Low
Feed is derived from Mono cropped farms or Muti cropped farms MxC Vs MnC	MxC	MnC	MxC	MnC	MnC
Inherent Feed Logistics	Low	High	Low	High	High
% of Commercial Grade Ingredients	Low	High	Low	High	High
Carbon Load of feed processing	Low	High	Low	Very High	Very High

Table 3 – Considerations for determining environmental load of feed associated with protein type. Circularity represents % of farmers household and farm produce that can be used as feed after proper treatment. Poultry, fish (commercial carps, catfish) and prawns need specified feed with specified controlled characteristics to provide acceptable return on investment.

Source: Tabulated by researchers

Consolidated Impact on local economies and society (People || S)

How much does an enterprise contributes to the local economy depends on how much of the revenue in retained within the community. Circularity in production with local input suppliers using endemic raw materials ensure that revenues are localized. Livestock is an age-old cultural practice in majority of households. An approach to commercialize and organize aspects of the same with focus on small holders can benefit a large section of society. (Banda & Tanganyika, 2021)

Small holder livestock production systems focused on localized inputs may have a positive impact on not only economies, but also nutritional outcomes in pregnant women and children. However, care must be taken to avoid pathogen exposure and associated hygiene concerns. (Chen et al., 2021).

To assess the actual and perceived impact on local value chains and to understand the potential for localized revenue share the study interacted with respondents from Group 2. The survey focused on how much of the revenue generated was retained locally, capital requirement, turnaround times for small businesses, ease of women to earn a share of the revenue, pollution and zoonotic risks. 5-point Likert scale used where 5 represents strong positive sentiment and 1 represents a strong negative sentiment for local impact across 10 parameters. Commodities where women were involved in production and had no barriers to entry scored high.

The study considered aspects which act as cost and revenue centres, and where the revenue eventually moves. For purpose of our study, the act of buying feed from a village store where the feed brand is headquartered in Delhi and feed is manufactured in Punjab signifies that majority of revenue moves outside the region and will tend to score low for local impact.

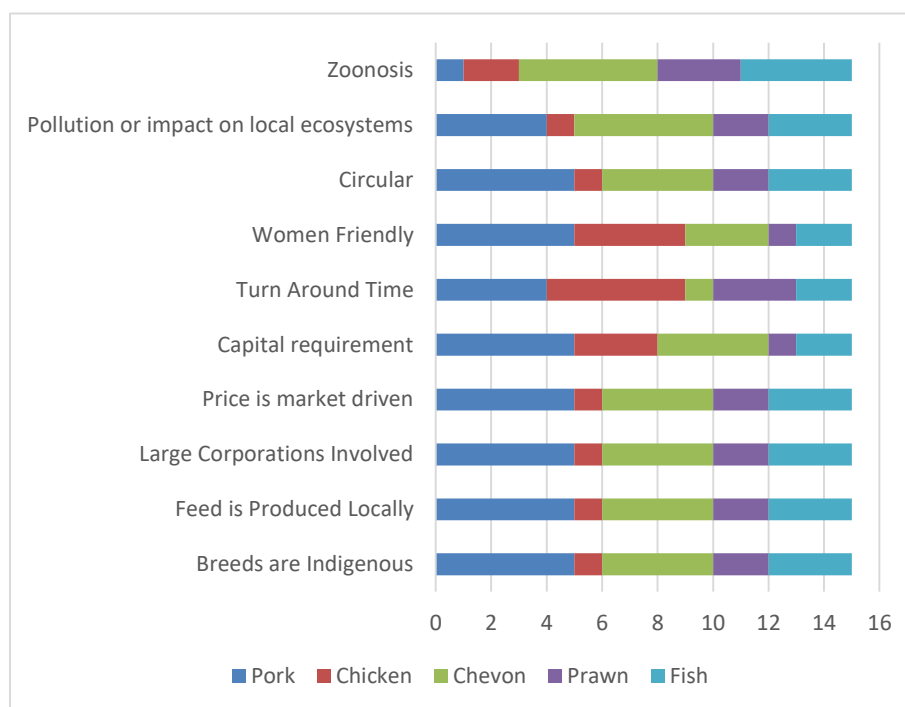


Fig 4 – Ranking protein on consolidated impact on rural economies. Pork received a 4.4 mean score.

Source: Tabulated by researcher from primary and secondary research.

Stake holder Survey – Economic, Business and Governance (Profits || G)

A comparative analysis was done between the 5 major commercially viable protein varieties commonly used in restaurants and food industry – Pork, Chicken, Chevon, Prawns and Fish.

The key questions across 8 sections were aimed at capturing their feedback on a 5 points Likert scale. The mean scores across all 10 respondents are represented in Figure 5

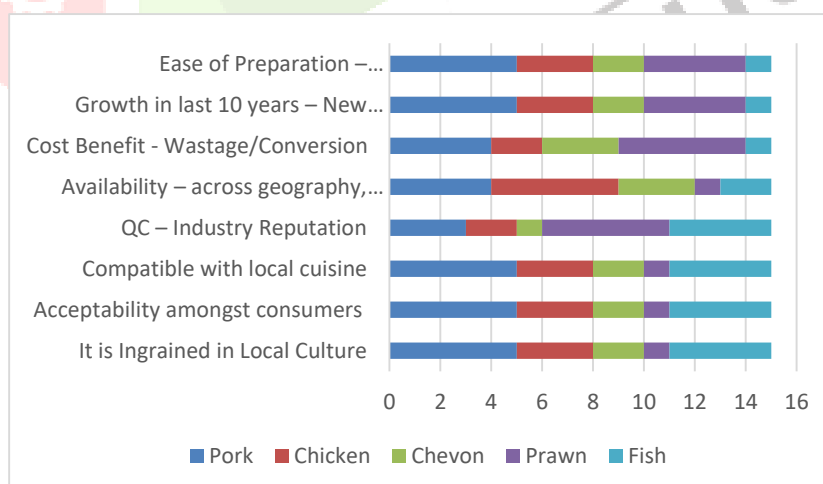


Fig 5– Ranking protein on feedback scores from respondents – Chefs, Scientists, Stakeholders. Pork received average feedback of 4.5

Source: Source: Tabulated by researcher from primary and secondary research.

5. RESULTS AND DISCUSSIONS

Data and feedback on environmental (E), local economic impact and economic scale (S), as well as consumer and stakeholder preferences including business potential (G) was assessed using a simple weighted mean technique. The weights for ESG components were assigned as per CRISILs recommended analytical module (35%: 25%: 40%)

$$PA_{score} = \sum_{i=1}^t \left[\sum_{p=1}^p \{ PR_{score} \times w_p \} \right]$$

i = increment variable, w_p = Weightage of the principle (ESG)

p = number of parameters in principle assessment, w_t = Weightage of the theme in the pillar

t = number of principles per protein class, PR_{score} = Mean Protein Score. PA_{score} = Protein Assessment score

Table 4: Consolidated results across E, S and G

	Pork	Chicken	Chevon	Prawn	Fish	Parameter	Weight
						p	w_p
GHG environment, emissions	3	5	1	2	4	2	35%
GHG feed, emissions.	5	1	4	2	3	1	
Mean - PR_{score}	4	3	2.5	2	3.5		
E – Environment (Weighted score)	1.4	1.1	0.9	0.7	1.2		E
Impact on local value chains – Economics. PR_{score}	4.4	2	3.8	2	2.8	10	25%
S – Society (Weighted score)	1.1	0.5	1.0	0.5	0.7		S
Suitability of Pork - Market side. PR_{score}	4.6	3	2.1	2.8	2.6	8	40%
G – Governance (Weighted score)	1.8	1.2	0.8	1.1	1.0		G
PA_{score}	4.3	2.8	2.7	2.3	3.0		ESG

Consolidated protein assessment score using CRISILs ESG scoring methodology (Nov 23) Emission levels, environment and feed considerations were considered under E. Potential impact on local value chains were considered under S. The potential for economic success and ecosystem were considered under governance G. The CRISIL study proposed using company score as G, to make the analysis constant across sectors.

Pork is found to be the most suitable protein for new enterprises with low initial capital outlay, high social impact, acceptable environmental considerations and high projected demand with a composite score of 4.3.

Estimating the potential demand and therefore the market potential for Pork

Total demand of meat in the region is estimated to be close to 5,44,000 tonnes (Bidyut C Deka et al., 2020) and deficit is estimated to be 3,00,000 tonnes (Deka et al., 2020) (NSSO unit level data). The national action plan on Piggery, Department of Animal Husbandry Government of India estimates the national deficit in pork to be about 4,80,000 tonnes. The AHVD department of Assam estimates a pork deficit of 3,16,000 tonnes at 2019 demand levels.

Given the above information the shortfall of pork for the North East region can be considered to be in the region of 3,00,000 to 4,00,000 tonnes annually. At wholesale prices of Rs 380/kg this deficit translates to a value of Rs 11400 Crores on lower estimates. The deficit estimates derived by the AHVD Assam, are by benchmarking against ICMR protein consumption recommendations for India (10.7 Kg). The real demand for a primarily meat eating region like North East India is likely to be incrementally higher.

6. CONCLUSION

Our study finds pork to be a suitable focus commodity for new enterprises in the region.

Pork displays

- Highest composite scores across our study parameters (4.3)
- Price protection characteristics without any MSP, APMC or government price floor mechanism
- Huge latent demand (3 lac tonnes)
- Steady wholesale and retail price rise
- ESG compliant in small holder traditional systems
- Women friendly
- Triple bottom line compliant
- Potential market scale of (Rs11,400 crores and more)
- This is equivalent to over 10% of Assam's GSVA in agriculture sector.

7. RESEARCH AND POLICY IMPLICATIONS

Discussion - Road map for new enterprises

It is evident from the study that Pork is a suitable agri commodity for new enterprises with positive environmental, social and economic indicators. However, the farmers and local enterprises are yet unable to leverage the economic opportunity estimated to be Rs 11,400 crores. Our study also indicates that ESG and TBL benefits are available for decentralised and small holder farms. Large industrial farms do not satisfy the environmental or planetary considerations.

During the course of the study, it was seen that no comprehensive value chain analysis with cost breakup across the pork production value chain for the region is available. No cost benefit analysis of the various inputs associated with pork production at small holder levels is available. It is hereby proposed that to enable large scale decentralised production of pigs across the state of Assam, the following interventions may be considered

Research

- Detailed value chain analysis of each segment in pork production value chain with social, economic and governance in focus
- Detailed gap analysis of the pork value chain
- Cost benefit analysis of pork value chain components (inputs) with focus on economic viability for enterprises within the region. (Feed, Piglets, Medicine and Services)

Policy

- Program in Agri Business Incubators (ABIs) with focus on input services for commercial pork production.
- With potential incremental business value of Rs 11,400 crores (10% of GSVA, Agriculture) of the state – a multi departmental committee may be constituted to provide single window support to the sector
 - Department of Planning
 - Department of Animal Husbandry and Dairy
 - State livestock corporation
 - Department of Industries
- Financial institutions, district level officers from DIC and MSME must be sensitised and appraised of the potential economic scale of the sector and may be directed to support new enterprises accordingly
- The state may recognise input suppliers and value chain players in the pork ecosystem as a focus sector.

References

- Banda, L. J., & Tanganyika, J. (2021). Livestock provide more than food in smallholder production systems of developing countries. *Animal Frontiers*, 11(2), 7–14. <https://doi.org/10.1093/af/vfab001>
- Bartlett, L., & Vavrus, F. (2017). Comparative Case Studies: An Innovative Approach. *Nordic Journal of Comparative and International Education (NJCIE)*, 1(1). <https://doi.org/10.7577/njcie.1929>
- Bidyut C Deka, AK Singha, Divya Parisa, & Amrutha P. (2020). *Prospect of North East Agriculture Post Covid*. ICAR- Agricultural Technology Application Research Institute, Umiam, .
- Chen, D., Mechlowitz, K., Li, X., Schaefer, N., Havelaar, A. H., & McKune, S. L. (2021). Benefits and Risks of Smallholder Livestock Production on Child Nutrition in Low- and Middle-Income Countries. In *Frontiers in Nutrition* (Vol. 8). Frontiers Media S.A. <https://doi.org/10.3389/fnut.2021.751686>
- Crowe, S., Cresswell, K., Robertson, A., Hubby, G., Avery, A., & Sheikh, A. (2011). The case study approach. *BMC Medical Research Methodology*, 11. <https://doi.org/10.1186/1471-2288-11-100>
- Dul, J., & Hak, T. (n.d.). *Case Study Methodology in Business Research*.
- Ferreira, D. F., Bernardino, J., Manjate, C. D., & Pedrosa, I. (2021, June 23). Business Intelligence and Business Analytics applied to the management of agricultural resources. *Iberian Conference on Information Systems and Technologies, CISTI*. <https://doi.org/10.23919/CISTI52073.2021.9476266>
- G. Kadirve, Bandita B. Banerjee, Surajit Meitei, S. Doley, Arnab Sen, & M. Muthukumar. (2018). Market potential and opportunities for commercialization of traditional meat products in North East Hill Region of India. *Veterinary World*, 4.
- Goswami, S. (n.d.). *A Study on Effect of Agriculture on Agro-Based Industries and Impact of Agro-Based Industries on Indian Economy*. www.ijfmr.com
- GUPTA, N., BHATTACHARJEE, M., & SAHA, A. R. (2022). SUSTAINABILITY AND DIETARY CHANGE: AN ANALYSIS OF INDIAN FOOD CONSUMPTION PATTERNS. *INDIAN JOURNAL OF APPLIED ECONOMICS AND BUSINESS*, 5(1), 85–105. <https://doi.org/10.47509/ijaeb.2023.v05i01.05>
- H Steinfeld, P Gerber, T Wassenaar, & V Castel. (2006). Livestock's Long Shadow: Environmental Issues and Options. *Food and Agriculture Organization of the United Nations, Rome, Italy*, 2006.
- Jain, V., Gohain, N., & Sekhon, M. K. (2024). An Introspection of Agricultural Marketing Reforms in India. *Journal of Agricultural Development and Policy*, 34(1), 163–173. <https://doi.org/10.63066/23220457.34.1.020>
- Jitendra R. Vala, S. S. and G. P. (n.d.). *Pragmatic Perspectives of Agricultural Development Programmes in Present Scenario*. <https://doi.org/2021>
- Johanna Friman, Torbjörn Lundh, & Magdalena Presto Åkerfeldt. (2021). Grass/clover silage for growing/finishing pigs – effect of silage pre-treatment and feeding strategy on growth performance and carcass traits. *ACTA AGRICULTURAE SCANDINAVICA, SECTION A — ANIMAL SCIENCE*, 70(3).
- Karthikeyan, R., & Nedunchezian, V. R. (2024). Analyzing Price Trends and Behavioral Dynamics in the Indian Poultry Sector with Reference to Egg Production. In *International Journal of Agricultural Sciences* (Vol. 14, Issue 9). www.mofpi.nic.in
- Kathiravan, G., & Chitrambigai, K. (2024). Consumer Preferences for Native Chicken Meat in India: Implications for Sustainable Production and Household Dynamics. *Current Research in Nutrition and Food Science*, 12(1), 166–180. <https://doi.org/10.12944/CRNFSJ.12.1.14>
- Léonidas Hashakimana, Toru Tessema, Fidèle Niyitanga, Athanase Rusanganwa Cyamweshi, & Athanase Mukuralinda. (2023). Comparative analysis of monocropping and mixed cropping systems on selected soil properties, soil organic carbon stocks, and simulated maize yields in drought-hotspot regions of Rwanda. *Heliyon*, 9(9).
- M Herrero. (2010). Smart investments in sustainable food production: Revisiting mixed crop-livestock systems. *Science*, 327.
- M Herrero, et al. (2013). The roles of livestock in developing countries. *Animal*, 7.
- Mahajan, S., Papang, J. S., & Datta, K. K. (2015). *Meat consumption in North East India: Pattern, Opportunities and Implications*.
- MAHAK SINGH, D J RAJKHOWA, & V K MISHRA. (2021). Balance sheet of pork production and consumption in Nagaland: Implications for strengthening of pork value chain. *Indian Journal of Animal Sciences*, 91, 313–317.

- Min Liu, Wenli Xu, Hangyu Zhang, Huang Chen, Qiang Bie, Guodong Han, & Xiaohua Yu. (2022). Livestock production, greenhouse gas emissions, air pollution, and grassland conservation: Quasi-natural experimental evidence. *Munich Personal RePEc Archive*, 11574.
- Mubeena, M., Muthukumar, M., & Barbuddhe, S. B. (2021). *TRENDS AND SEASONAL VARIATIONS IN BROILERS PRICES* (Vol. 22, Issue 2). <https://cabidigitallibrary.org>
- MUTHUKUMAR, M., NAVEENA, B. M., BANERJEE, R., SINGH, V., & BARBUDDHE, S. B. (2021). An overview of Indian livestock and meat sector. In *Indian Journal of Animal Sciences* (Vol. 91, Issue 4, pp. 247–254). Indian Council of Agricultural Research. <https://doi.org/10.56093/ijans.v91i4.114324>
- Natalie Carter, Cate E Dewey, Ben Lukuyu, & Delia Grace. (2015). Silage based diets for local and crossbred pigs in Uganda. *ILRI Extension Brief*.
- Oluwatosin Omotola Ajayi, Adekunle Stephen Toromade, & Ayeni Olagoke. (2024). Data-Driven Agropreneurship (DDA): Empowering Farmers through Predictive Analytics. *Magna Scientia Advanced Research and Reviews*, 12(2), 001–007. <https://doi.org/10.30574/msarr.2024.12.2.0177>
- Poore, J., & Nemecek, T. (2018). Reducing food's environmental impacts through producers and consumers. *Science*, 360(6392), 987–992. <https://doi.org/10.1126/science.aaq0216>
- Pradhan, M. R., Taylor, F. C., Agrawal, S., Prabhakaran, D., & Ebrahim, S. (n.d.). *FOOD ACQUISITION AND INTRA-HOUSEHOLD CONSUMPTION PATTERNS: A STUDY OF LOW AND MIDDLE INCOME URBAN HOUSEHOLDS IN DELHI, INDIA*.
- Pradheeshwaran, U. (2025). Time series analysis of egg prices in various market centres of India. *International Journal of Agriculture Extension and Social Development*, 8(1), 210–215. <https://doi.org/10.33545/26180723.2025.v8.i1d.1530>
- Sharma, H. I., & Omena, T. (2024). Livestock economy in North East India: emerging patterns and its implications. *Journal of Livestock Science*, 15(1), 60–68. <https://doi.org/10.33259/jlivestsci.2024.60-68>
- Thomas, B., Sudheer, K. P., & Bonny, B. P. (2021). Performance Analysis of Agri-enterprises Facilitated through KAU-Agri Business Incubators. *Current Journal of Applied Science and Technology*, 30–40. <https://doi.org/10.9734/cjast/2021/v40i731325>
- Vaishnavi, H., L., K. B., V., M. N., V., Olekar., J., Somashekar, & H. S., S. (2024). Analysis of Trends and Forecast of Minimum Support Price (MSP) in India. *Archives of Current Research International*, 24(6), 426–438. <https://doi.org/10.9734/acri/2024/v24i6800>