POLICY PAPER 131

Smart Animal Farming: Perspective Planning

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Preface

The livestock sector plays a pivotal role in India's economy, contributing 5.0% to the nation's gross domestic product. Since the productivity per animal is lower than global average, empowering smallholder farmers with digitized farm technologies is crucial for enhancing livestock production and productivity. Smart animal farming technologies can offer optimal solutions to various challenges in animal farming, including cost minimization, production maximization, and efficiency enhancement. Embracing the artificial intelligence technologies in the sector shall also be very vital in boosting animal productivity through precision farming. Additional research, evaluation, testing, and pilot-scale demonstrations of these smart technologies are essential for their widespread adoption in the field.

Amid the celebrations for 2024 being designated as the 'Digital Year' by the National Academy of Agricultural Sciences, which emphasizes the role of digital technology in enhancing agriculture, an expert consultation was convened on "Smart Animal Farming: Perspective Planning" during March 22, 2024 to explore the potential of smart technologies in animal sciences, emphasizing scalability and practicality to enhance farmers' socioeconomic status. I thank the Convener (Dr. Yashpal Singh Malik), Co-conveners (Dr. Inderjeet Singh and Dr. Suresh Kumar) and all the participants for their contribution in enhancing our understanding of the Smart animal farming and various technologies. The insights and recommendations shared during the consultation have been synthesized and are presented in this document. My sincere appreciations are due to the Reviewers, Dr. K. M. Bujarbaruah & Dr. R. K. Singh and Editors, Dr. V.K. Baranwal & Dr. R.K. Jain for their efforts in bringing out this Policy Paper**.** I am sure this publication will help in shaping appropriate policy agenda to encourage Smart animal farming.

February 2025
New Delhi

(Himanshu Pathak)
President, NAAS

Smart Animal Farming: Perspective Planning

1. INTRODUCTION

The livestock sector plays a pivotal role in India's economy, contributing 5.0% to the nation's gross domestic product (GDP) and accounting for 30% of the total agricultural GDP. Moreover, the sector supports the livelihoods of approximately 20.5 million individuals, serving as a vital source of employment and income for rural communities. However, the productivity per animal is lower than global average for which “Animal population driven dairying” will certainly not be a viable option for the future. Indian dairying needs to reorient towards “Technology driven dairying”, in which the application of advanced technologies can play a vital role for sustainable livestock production while improving the production efficiency. In this context, application of Precision Livestock Farming (PLF) involving advanced tools/techniques in animal farming will be the option to improve the production, reproduction status, and animal welfare (Wathes *et al.*, 2008; Banhazi *et al.*, 2012; Berckmans, 2017).

"Smart Animal Farming" using disruptive technologies like AI (Artificial Intelligence),Robotics, IoT (Internet of Things), Satellite Imagery, Blockchain technologies including GPS (Global Positioning System) and RS (Remote Sensing) etc. is the call of time for a transformative livestock production system. When applied with precision, expertise and need, these technologies are expected to improve not only the resource management but also the sustainability parameters and environmental safeguards through circular economy (farm waste to wealth) and carbon footprint reduction. By harnessing and modelling these technologies, farmers can foster a more precise, data-driven approach to animal husbandry, ensuring healthier livestock, increased productivity, and a more environmentally conscious and economically viable farming industry. Smart animal farming, if pursued with expertise and skill, would not only address the challenges of traditional animal farming but also open the path for much needed technologically advanced animal-agriculture. As has already been seen, these technologies have huge potential for continuous monitoring of multiple farm applications like monitoring the animal activities, inactivity period, rumination and disease symptoms in farm animals for immediate interventions leading to efficient and timely management for boosting productivity. Technological integration is no longer optional in agriculture but has emerged as a vital component for achieving sustainable, resilient, and productive farming practices that ensure food security in a rapidly evolving world. Animal scientists and experts in Smart animal farming need to work in tandem to develop and validate Smart animal farming technology models each for big, medium and small farmers, from production to consumption. While adopting these technologies, however, a balance between economic cost and productivity gains has to be struck for long-term sustainability.

Current contribution of agriculture, industry and service sector in GDP growth rate, sectoral weighted and GDP growth over the years is depicted in Figure 1 and 2, respectively. The correlation of service sector with the GDP growth for the last few years was on higher side compared to agriculture and industry and it is indicated in Figure 3.

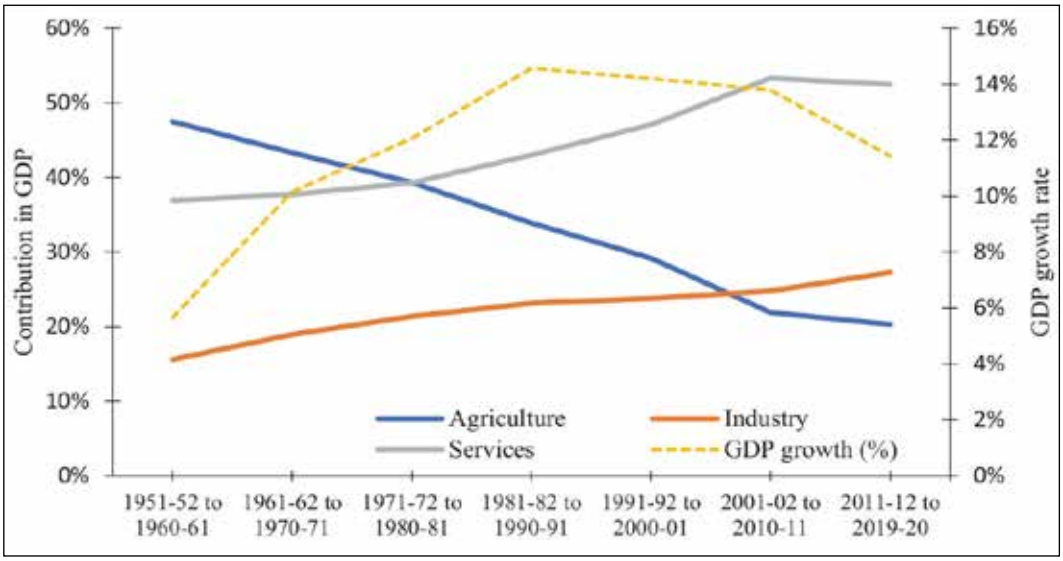

Fig. 1: Portfolio-wise contribution in GDP and GDP growth rate (DOEA, 2020-21)

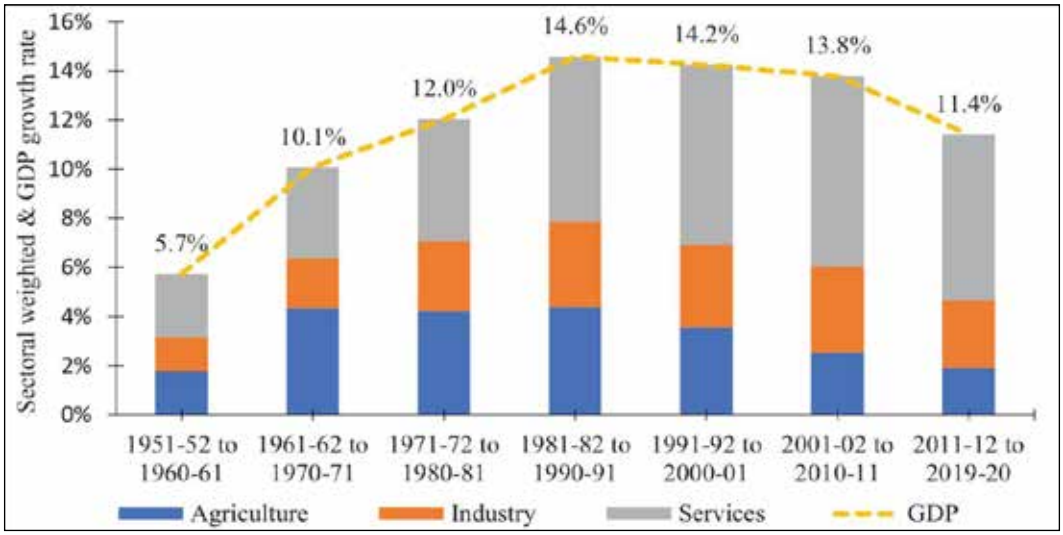

Fig. 2: Portfolio-wise sectoral weighted and GDP growth rate (DOEA, 2020-21)

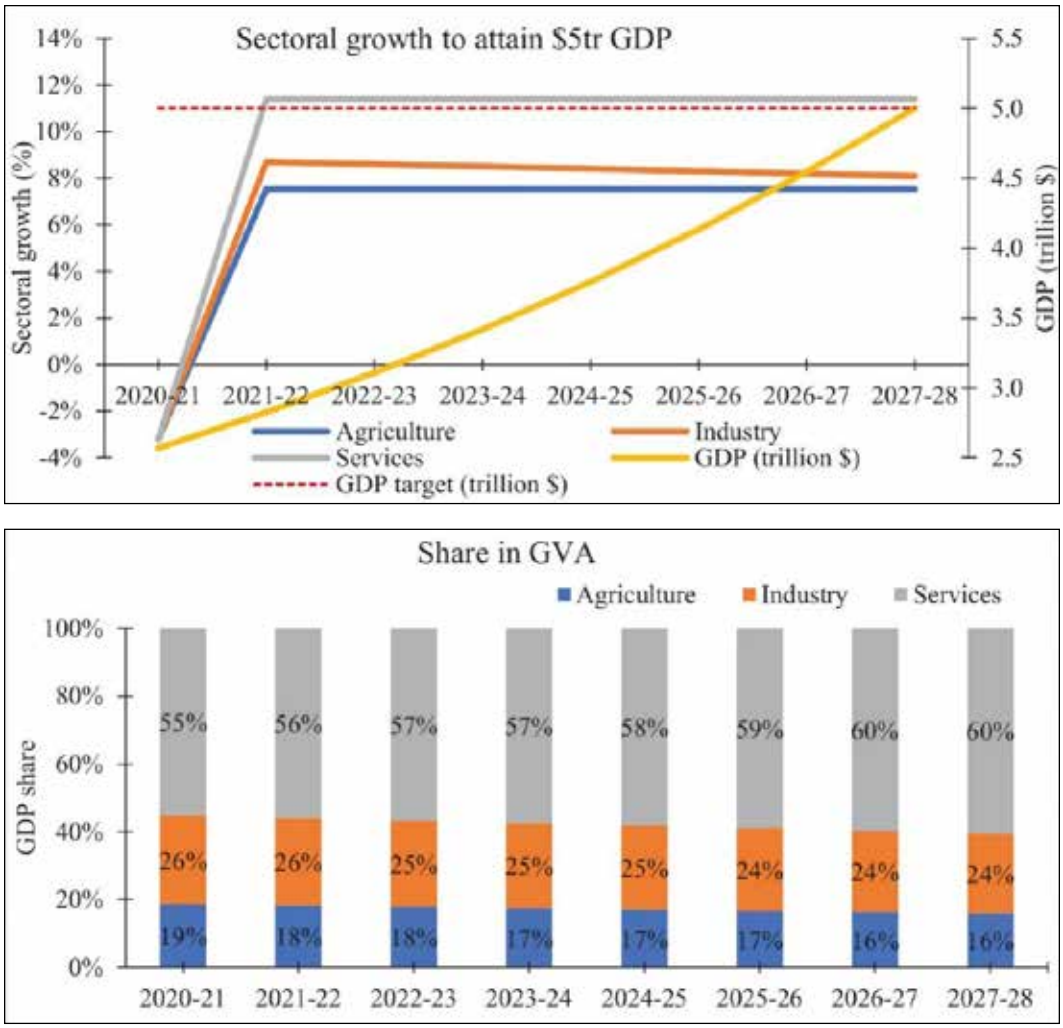

Fig. 3: Agriculture, Industry and Services growth along with GDP Share (DOEA, 2020-21)

While the service sector is further expected to grow up to 60 percent by 2027-28 from 55 percent in 2020-21, the industry and agriculture sectors are likely to witness a marginal fall during this period. Since the Indian economy is now projected at 30 trillion by 2050, the agriculture and allied sector has to contribute more than 16 percent, which is possible only through development and adoption of digitally empowered cutting edge technologies in agriculture including animal farming systems. In view of the above, this Policy Paper has been developed on the scope and desirability of developing, validating and using the Smart animal farming practices and technologies to contribute towards the growth trajectory of the country.

2. SMART ANIMAL FARMING –PRESENT AND FUTURE

The present status of Smart animal farming reflects a growing interest and adoption of advanced technologies within overall agricultural sector. Past discussions have revolved around the urgent need for more sustainable and efficient animal farming practices to meet global increase in demand for animal products and heightened awareness of environmental and ethical considerations. The integration of smart digital technologies is now at the forefront of these discussions, with a focus on enhancing precision in livestock management system. The existing policies in various regions often support the integration of smart technologies in agriculture, recognizing the potential benefits for farmers, animal welfare, and environmental sustainability through the adoption of digital solutions, addressing data privacy and security concerns, and promoting responsible resource management. However, challenges still persist, including issues of affordability, access to technology, and the need for comprehensive training programs to empower animal farmers with the necessary skills to leverage the benefit from these advancements effectively. Ethical considerations, particularly in ensuring the humane treatment of animals in the context of technological interventions, have been part of ongoing discussions shaping policy frameworks.

The agricultural landscape is dynamic, with ongoing research and development fueling innovation in Smart animal farming. Research initiatives should focus on refining existing technologies, exploring new applications, and addressing concerns related to economic viability, ethical practices, and environmental impact. As Smart animal farming continues to evolve, collaboration between policymakers, technology developers, and the agricultural community remains crucial to foster a sustainable and technologically advanced future for animal agriculture.

While the Government of India has launched several schemes such as Information Network for Animal Productivity and Health (INAPH) and Animal Health System Support for One Health (AHSSOH) project, as such there is no policy framework on Smart animal farming. Hence, there is a need to develop a road-map for policy framing at country level on Smart animal farming technology development support. This would benefit the researchers, farmers and animal husbandry sector to increase farm productivity and efficiency; improve animal health and welfare; optimal use of resource, data-driven decision making and cost–benefit balancing.

2.1 AI and Its Applications

In the current scenario of labor shortage and high wage demand particularly to work in animal farms, adoption of smart technology like AI is essential. It has immense role in improving farm productivity, thereby the farm efficiency. There are numerous benefits of AI in livestock sector and some of them are listed below:

Livestock Identification: AI has significant role in animal identification and the farmers can access complete information of their animals through sensor and unique code.

Weighing Animals: AI has brought new era by automatic weighing and providing interpretation about the health status of animals. Through interpretations, manager can easily manage the animals and can improve the condition through appropriate actions.

Animal Welfare: AI system will provide insight about the frequency and duration of feeding and watering behavior facilitating the dashboard manager to interpret the alteration and possible cause of aberrations. Feeding patterns may be monitored and correlation between feeding amount and feeding requirement can be estimated through the developed algorithms. The overall farm productivity can be monitored through smart collars deployed on animals.

Fecal Examination: Any abnormalities in fecal samples could be detected and thereby prompting prevention and spread of disease.

Heat Stress: The sensors used in AI system can analyze the stress level caused by heat, facilitating immediate and appropriate actions.

Animal Vocalization: Animals have particular vocalization patterns and algorithms may be developed to know any abnormalities in the vocalization pattern. These algorithms will provide data about any change in animal vocalization and correlate them with the abnormalities.

Pasture Examination: Algorithms developed may be used to know the status of pasture whether the quality of pasture is good or have any sort of fungal infection or any other problem. Therefore, on the basis of images and algorithms, farmers can know about the status of pasture.

Hatchery: Temperature and humidity have important role in hatchery and any sort of changes may alter the hatchery operations. Algorithms may be used to know the embryo development and there by fertility and hatchability. Detection of non-hatch-able and infertile eggs will save lot of resources.

Insemination: AI may be used in animals to timely inseminate for better results. This technology facilitates the monitoring of animal reproductive cycles, enabling the precise identification of optimal insemination periods through algorithmic analysis.

2.2 Sensor Technologies and Internet of Things (IoT) Applications in Livestock Management: Enhancing Efficiency and Productivity

Continuous monitoring of animals from pre-production to product consumption chain is of utmost importance for efficient farm management. By the application of sensors and smart collars, it is easy to continuously monitor the productive, reproductive and health status of animals. The technology can also be used for assessing and curtailing carbon footprints of animals. The information from end node or sensor are collected and analyzed further through algorithms in order to assess productive and reproductive attributes and welfare of farm animals. Similarly, monitoring and containing a disease free animal herd has remained a problem which has now to be targeted through smart collars comprised of End node sensors, gateway and cloud system. End node will collect data, send data to gateway and then by cloud system data analysis and interpretation will takes place. Through the dashboard activity, eating, rumination and inactivity periods can be assessed easily and by the algorithms, data may be analyzed and interpreted as to whether the animal is taking feed, fodder to the optimum amount. Any difference in their activity is captured and indicated by an alarm which can be sent to the farmer through mobile or computer. Similarly, if animal comes to heat period the alarm may be created for on time insemination of dairy animals. Thereafter, alarms are sent to the manager on the health and breeding status – thus addressing the issue of missed heat /precise detection of heat onset time leading to production efficiency and income. Overall productive and reproductive parameters on the continuous basis may be checked and appropriate action may be taken to combat any sort of problem in farm which, ultimately improves the farm efficiency.

The rationale for embracing Smart animal farming lies in the urgent need to revolutionize traditional agricultural practices to meet the challenges of a rapidly evolving world. With the increase in population day by day, the demand for animal and animal products is shooting up. Simultaneously, concerns about resource scarcity, environmental sustainability, and animal's welfare are on the rise. Smart animal farming, which integrates advanced technologies, presents a compelling solution. By using the magic of AI for data analysis and predictive capabilities, and leveraging IoT for real-time monitoring and connectivity, end user can optimize farm management. This approach not only addresses the inefficiencies and ethical concerns of traditional animal farming but also leads to sustainable agriculture by reducing waste and enhancing the productivity. The rationale for Smart animal farming is rooted in the pursuit of a more humane, efficient, and environmentally conscious future for animal-agriculture. Digitalisation or automation in farm sector is restricted to some pockets of farmers so there is need to strengthen the research and extension system to promote AI in field conditions.

3. STRATEGIES AND WAY FORWARD

The application of smart livestock technologies would result in a greater efficiency only when the inherent problems associated with traditional production systems are adequately addressed. It is important that problems like Mastitis detection, identification of estrus, early pregnancy diagnosis and selection of males at young age for high fertility are adequately addressed. Further, on-spot or off-spot kits/methods need to be fine tuned to address these problems. Reproduction is a luxurious phenomenon and thus one cannot expect magic effects from the reproductive technologies unless the animals are nutritionally sound. Realizing the goal of "one calf per cow per year" necessitates a synergistic approach, integrating programmed breeding, enhanced nutrition, and optimal management practices, facilitated by effective public-private sector collaboration and stakeholder engagement. There is need to develop/ standardize scientific livestock farming technologies, train the professionals on its use, introduce special courses and laboratories in the Universities and adopt their pilot scale extension demonstration by the department, KVKs and Universities. Following way ahead indicators for enhancing the country's efficacy on Smart animal farming are proposed:

- There is an ardent need for reorienting research towards the development of smart animal production technologies keeping in view the country's animal production systems and a separate budgetary provision for undertaking research on AI is made.
- Investment in human capital specially to build their capacities and competitiveness on Smart Animal farming using different tools and techniques available and 'to be generated' will be a step forward to leverage the benefits from such technologies for a technology friendly transformed livestock production system.
- Involving forerunner animal science Institutes and Universities, develop teams comprising of animal science specialist, data processors/engineers, mathematicians and computer experts to collect, collate, interpret and use the data to further develop/ facilitate precision application of AI tools and techniques for use in Smart animal farming practices.
- While more than 70% of Indian animal farmers are smallholders and the smart livestock technologies available as of now are primarily suitable for commercial/ large scale livestock production, the way ahead will be to connect the smallholder producers also to this emerging technology after the research institutions validate/ develop such technologies for them.
- Designing and developing appropriate robots for animal farm operations and also for assisting in technologies like the production of sexed semen, transfer of embryos, preparations of quality silage, handling of highly infectious disease viruses etc.

- Large scale use of technology like blockchain for animal product traceability, product safety and marketing.
- Yet another area of concern in livestock farming is the cost and also wastage of feed. It is therefore extremely important that precision feeding system using advanced AI tools is adopted to feed only the required amount as per the requirement of animals either individually or in groups by taking into consideration the nutrient requirements (Pomar *et al*., 2019) as per age, body weight performance indicators etc. Advanced and automated farms use precision livestock farm techniques such as feeding management, breeding management etc. Automation will collect information and then trained algorithms will interpret the feed requirement of animal as per the stage and condition of the animal (Banhazi *et al*., 2012, Pomar *et al*., 2019). Precision feeding will also aid in managing carbon footprints by providing feeding individually or in group as per the requirement thus saving resources and contributing to environmental concerns.

4. RECOMMENDATIONS

- Identify Universities and ICAR Institutes with trained manpower, infrastructure and equipments to conduct research on different aspects of AI for future livestock farming with a provision to hire/ recruit data engineers, data processors, computer experts and a mathematician/ statistician of repute.
- ICAR Animal Science division may facilitate, through authorization of one of its Institutes, to collect, collate and analyze the data on different aspects of livestock production and health as recorded in various Institutes and Universities to create necessary data repository for effecting AI tools and technologies; & methods and methodologies for use in livestock sector.
- Undertake 'Science to Science' capacity building program of scientists, faculties and other mid-level State government officers in advanced laboratories with expertise in AI followed by Scientists to Stakeholder skill program at Institute level.
- Develop at least one cross-sectorial research program centrally involving ICAR Institute-IIT-NDDB-DBT-Private sector in one area like Genomic selection through AI or Assisted Reproduction/ Health to showcase the power of AI tools and techniques in shaping future livestock production.
- Undertake pilot studies on streamlining transformative use of AI technologies being currently used by large livestock farmers in small holder producers farm to assess the refinement/ readjustment needed thereof.
- Constitute a core team at ICAR level to coordinate, monitor and advice on the support and growth of AI use in livestock production.

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