

# Synergizing academia, industry and clinical practice: Role of veterinary pathology

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Received: 06.1.26; Accepted: 21.1.26

**Clarion call:** "Building India a product-driven nation to become 'Viksit Bharat' (Developed India) by 2047 (100<sup>th</sup> anniversary of independence) and achieve a \$5 trillion economy" -Shri Narendra Modi, Hon'ble Prime Minister of India.

## INTRODUCTION

Industry-academia collaboration refers to partnerships between educational institutions (universities, colleges) and businesses or industries. These collaborations aim to leverage the strengths of both sectors, fostering knowledge transfer, innovation and practical application in research. This involves a mutually beneficial relationship where industries gain access to research, expertise and a pipeline of skilled graduates, while academia benefits from real-world insights, funding opportunities and the ability to translate theoretical knowledge into practical applications. Industry-academia partnerships result in a 'win-win' situation for both since each other's deficiencies are bridged through these linkages. The 'science' developed by the academic institution is converted into 'technology' by the industry which makes them available to the ultimate stakeholders. During this process, the industry has to make a 'profit' while the academia is 'incentivized' and they obtain satisfaction as their endeavours reach the end users. More recently, science and technology development needs to be complemented by the commercialization for the ultimate benefit. This entire process is called "productization". The vision of many world-class universities / research organizations have changed over the time from a mere "teaching-research" model to "societal contribution through innovation" approach. The 'driver' and the 'enabler' for such an approach is the industries readiness to adopt strategic innovations. Such a favourable ecosystem is created by increased two-way collaborations through industry-academia linkages. Industry should, not only highlight the issues that need to be addressed but also uptake the technologies available, scale up and market them to make them available to the stake holders<sup>1</sup>.

### Current focus on demand driven agriculture

Agriculture is to produce food, feed, fodder, and fiber for the country. There is an urgent need for commercial market driven techno savvy production with emphasis on value addition, quality, efficiency and export. Let our research be user/farmer friendly and marketable. Practicing 'Lab to Land' in the right spirit to achieve 'Farm to Fork'. In the light of these considerations, collaboration/partnership between universities and industries and other related organizations is critical for education and training, research, innovation and technology transfer and the promotion of start-ups and spin-offs (entrepreneurship). The trend of modernization of industries has set in, and the bases of competition have also changed. Agriculture and allied sectors can't be an exception to these pressures. With increased opportunities and competitive scenario in this open economy, agriculture sector has the power and potential of ensuring livelihood

**How to cite this article:** Balachandran, C. Synergizing academia, industry and clinical practice: Role of veterinary pathology. Indian J. Vet. Pathol., 50(1) : 1-14.

security to our people, providing employment opportunities to millions of people, and fostering agripreneurship. With proper planning, India can certainly rise as the proud food basket of the world<sup>2</sup>. The synergy between academic institutions and industry has emerged as one of the most significant components of India's research and innovation journey. Over the decades, these partnerships have demonstrated the ability to translate research outcomes into tangible societal benefits, spanning from advancements in healthcare and rural technologies to sustainable agriculture and digital solutions<sup>3</sup>.

In India, addressing collaboration challenges between industry and academia-such as the monetization of shared intellectual property, high commercialization costs of academic research and differing project management approaches-can help leapfrog the nation towards greater technological leadership. This is where the government can play a catalytic

role in strengthening industry-academia linkages to further bolster our innovation ecosystem. Long-term investment in both fundamental research and advanced technological pursuits, aligned with national priorities, is essential for creating a robust innovation ecosystem. These thoughts were echoed at the 26<sup>th</sup> meeting of the PM-STIAC (Prime Minister's Science, Technology, and Innovation Advisory Council), held on 18<sup>th</sup> October 2024, which brought together experts from academia, industry, think tanks and government who aligned on identifying certain mission-critical priority areas where such partnerships can drive significant multiplier effects in the country's growth<sup>3</sup>.

## **BASIC NEEDS<sup>4-6</sup>**

### **Focus on veterinary education**

Veterinary education provides human resource required for augmenting public good. In India, where up to 80% population is rural, and animal husbandry is the livelihood. Veterinary profession provides the desired professional coverage. Agriculture and livestock are turning towards a broader concept of "bio-economy". Bio-economy refers to all economic activities derived from scientific and research activities focused on biotechnology. State Agricultural/Veterinary Universities need to be well integrated with traditional universities that emphasize basic sciences. Veterinary education approach should be multifaceted to ensure the betterment of both humans and animals as individuals and populations with problem solving interdepartmental expertise teaching. It should also focus on animal welfare.

### **Scope of veterinary education**

- i. Livestock sector provides employment opportunities, livelihood and socio-economic security to small holding livestock farmers.
- ii. By 2050, the population in India would increase by 34%.
- iii. To fulfill the dietary recommended levels of the livestock products by ICMR for a population of 1.7 billion people, the livestock sector should produce 186.2 million tons of milk, 18.7 million tons of meat and 306 billion eggs per annum which is an increase of 1.5, 3.7 and 4.7 folds of milk, meat and eggs respectively.
- iv. The additional challenge is to fulfill the feed requirements for the increased livestock population from the same resource base of land and water
- v. India need to produce more food in the next 40 years than has been produced in the last 8,000 years
- vi. Agriculture and livestock is turning towards a broader concept of bio-economy
- vii. The evolution of the biotechnology industry and

its application to agriculture, health, chemical, or energy industries is a classic example of bio-economy. Thus, veterinary education can contribute towards fulfilling the above needs.

## **Veterinary Research Contribution**

### **Animal health**

- i. New generation vaccines: chronic infections bovine TB, JD, brucellosis in goats, Marker (e.g. Current indigenous LSD DIVA vaccine developed), Recombinant and multicomponent vaccines
- ii. Point of care diagnostics
- iii. Antimicrobial resistance
- iv. Food safety: Food borne pathogens
- v. Biomedical instrumentation
- vi. Lab on chip
- vii. Novel delivery systems
- viii. Traceability of foods
- ix. Stem cell and regenerative medicine
- x. Emerging diseases
- xi. Zoonotic diseases
- xii. Poultry disease diagnosis: Production integrated diagnostics; Conventional poultry diagnostic investigation is done as a response to increased mortality, impaired production and losses at processing. Although occurrence of a single disease is significant, the problem is mostly multifactorial in poultry farming.

### **Priorities for Veterinary Research**

Veterinary Research should implement the concepts of "One Medicine" and interdisciplinary and translational research in the broader biomedical research agenda.

- i. Widen our knowledge on detection and control of infectious diseases
- ii. Develop databases and other resources that are freely accessible to the scientific community
- iii. Improve research on the areas of human-animal interfaces
- iv. Optimize effective, sustainable and socially responsible food-animal production
- v. Implement the concepts of "One Health" along with interdisciplinary and translational research.

There would be a dramatic increase in the demand for livestock products, driven largely by human population growth, income growth and urbanization. However, the changing scenarios and the need to adapt to climate change and to mitigate greenhouse emissions will add to the costs of production. Livestock production would become industrialized. The "vicious circle" involving the challenges of teaching, researching, publishing and competing for competitive grants, coupled with pursuing career aims and ambitions, can seem daunting. However, it can also be deeply satisfying when the fruits of the experimental laboratory research are translated into

improved healthcare delivery to our animal patients. To do this, the basic motive to do research has to change in terms of addressing a pressing problem and not to start with another publication. We need to be up to the challenge and above technologies is our tool box!!<sup>1</sup>.

We all know the disease triad. Disease occurs due to the interaction of host, pathogen and the environment. Similarly, the technology response to the prevention, therapy or control of disease has to encompass nanotechnology, immunotechnology or biotechnology for rapid and effective results. The application of these technologies, either alone or in combination, for protective and therapeutic interventions in translational veterinary medicine is required for the animal sciences sector, to achieve the goal of doubling the farmers income and to accelerate growth of this sector<sup>7</sup>.

#### **Animal Welfare Requirements**

In future, public would insist consuming animal food that is certified as produced with due animal welfare considerations. The welfare of animal on-farm, during transport, at markets and at slaughter has to be considered<sup>4,6</sup>.

#### **Vetpreneurship Development – the Need of the Hour**

Livestock business plays a crucial role in the economy of farmers. It is a major source of subsidiary income for farmers during off-season. But their income through this source is mainly affected due to a plethora of animal diseases. The demands for increased production of livestock and need to manage these diseases have become imperative. This could only be achieved by adopting novel technologies and sustainable practices. At the same time, many innovators in animal sciences need handholding in developing their ideas into commercializing products or services. Veterinary Start-up links innovators, mentors, investors, farmers and end users in a fashion that accelerates the adoption and exploitation of novel technologies for the betterment of human life. Start-up India builds a strong eco-system for nurturing innovation and start-ups that will drive sustainable economic growth and generate large scale employment opportunities. Start-ups like other companies have number of risk factors that hinders their growth in achieving their goals. They need to develop a business model that de-risks the known risk factors or at least mitigate the challenges<sup>6</sup>.

**Skill development:** The livestock farmers are effectively contributing to the GDP (Gross Domestic Product) of the country. Still they need to be imparted about certain skills to make the livestock business more profitable and sustainable. The gap between the raising technologies and adoption and utilization of those technologies shall be gradually reduced to attain maximum benefit from the novel technologies.

**Entrepreneurship development:** Government of India has taken definitive steps to encourage entrepreneurs in the country. Micro, Small and Medium Enterprises (MSME) Development Act was enacted in 2006 to promote entrepreneurship and to provide incentives, schemes or subsidies for the development of entrepreneurship in India. Market players in veterinary businesses are actively engaged considering the market size. Business opportunities in veterinary sector cannot be ignored anymore. They are also required for delivering veterinary clinical services and marketing novel veterinary products. Vetpreneurship help the innovators to translate the technologies for field exploitation while enjoying the monetary benefits out of it. Vetpreneurs can also involve in setting up of modern dairy farms and animal rearing centres<sup>6</sup>.

Encouraging entrepreneurship in animal husbandry sector will ultimately lead to high quality food, increased income for farmers and employment generation. This could be possible by providing access to information about technical advancement and market. Complex issues in making livestock entrepreneurship, a successful one, shall be addressed to realize the potential of this animal husbandry industry. Start-up culture in veterinary sector is gaining momentum as time passes thanks to the demand for increased productivity and emerging diseases. Services of livestock enterprises are much needed at this stage to enhance the livelihood of farmers. Skill development will contribute to effective adoption of novel technologies. Successful entrepreneurs in animal husbandry will greatly benefit all the stakeholders that mainly include farmers and innovators and will lead to the overall economic development<sup>6</sup>.

#### **The Academic's Dimension**

The advantages perceived by the universities or research institutions by the Industry-Academia partnerships ranges from obtaining extra-mural research funding, opportunities to work on cutting edge research, share biological resources, understand market requirements, assess technology feasibility, facilitate cGMP production and obtain regulatory approvals and so on. University research is usually 'curiosity-driven' and its market potentials are not immediately apparent. This strategy is the strength of these institutions and majority of their research are proof of concept studies. The outcomes of these studies most often contribute a new addition to the existing knowledge pool and most often are in its early stages and do not have immediate 'real-world' applications. A lot of additional work is essential to fine tune this technology and make it presentable, feasible and market-ready. Although these are less appealing from the industry's perspective, only universities can invest on basic 'blue-sky' research that companies cannot realistically do<sup>1</sup>.

Academia is more flexible e.g. working hours and autonomy in deciding where and how you work; disagreeing with the boss or the university's 'corporate line' is considered par for the course. Academia provides more room for intellectual autonomy (Reason choosing to pursue academic careers). As universities become more geared to industry-driven research and commercialisation opportunities, the tide may be changing. The only people in academia are those who can't make it to industry. Teaching: Students often don't respect if your focus is other than them. Industrialist do a guest lecture. Teaching in academia sets you up well for private industry training opportunities. Publications: Refereed, peer reviewed publications ('high quality' journals, if academia is the goal or industry publications, if industry is your goal) are the only ones that have considerable weight on an academic curriculum vitae; Ph.D., as a basis for publications. *Be flexible and visible*<sup>8</sup>.

**From academia side:** Apathy towards applied research and comfort zone of pure teaching restrictive internal policies, procedures and politics, leisurely-paced approach of academia v/s time-bound strategy of industry, lack of inner urge in academic fraternity due to absence of appropriate incentives/recognitions and absence of exclusive "University/Academia-Industry Interaction Cell"<sup>2</sup>.

### The Industry's Dimension

The advantages perceived by the industry by such partnerships are direct access to the knowledge pool and potential opportunities to utilize the wide range of expertise available in the university. Credibility and branding of the university are added advantages. In addition, the industries need not spend their resources on exploratory research instead can selectively obtain the leads that have real world applications from its academic partners<sup>1,6</sup>. Industry pays more. This is not convincing, and depends on the employment market, skills shortages/surpluses etc., and the knowledge market relative to your discipline and specialisation. Salaried versus specialist contract/consultancy work. How well you can sell yourself and your skills? Industry is more practical i.e. Industry is oriented to achieving practical outcomes in the short-term while academic work tends to have a long-term view. Industry-based professionals do not have the same level of insight into complex problems as academics<sup>8</sup>. Insensitivity to the resource potential of academia is unhealthy obsession with expensive 'so-called' consultants focus on short-term results, mostly quantifiable heavy dependence on easily available foreign 'know-how'. Earlier bitter experience with academia fear of losing competitive edge. Anxiety to keep secrecy of IPR and ensuring profit at least for some time<sup>2</sup>.

### The Cultural Divide – 'critical acclaim' vs 'block busters'

There exists a large difference between the working cultures of the academia and industry. Such cultural divide is largely driven by the way research is focused in these sectors. The academics more often want their research to be published in peer reviewed journals since the number and impact of their scientific publication evaluate their merit. On the contrary, industry research aims to develop an intellectual property that is marketable. Such innovations are not published but are protected by patents etc. Since the academia's research questions are not based on market requirements, the academics have the comfort of not working in a time frame. In addition, the academics are not incentivized enough for engaging in marketable technology development which in-turn leads to disinterest in the part of the academics. But the industry works on a strict time line and driven by result oriented work plans. Such difference in work cultures largely impact the way these two entities interact. The industry wants to tap into a marketable idea at the earliest with minimal investments and aims at large profitability from such ideas. This is obvious by the way the industry adapts the foreign 'know-hows' instead of relying on 'in-house' research and development e.g. the universities, particularly those that are government funded have a lot of internal constraints in the way of handling funds, obtaining permissions, utilization of external consultants, outsourcing research components etc. These restrictions heavily delay the output in terms of the industry's time frame<sup>1</sup>.

### Bridging Disconnect: The Government's Initiatives

In recent years, Government of India has initiated many activities to bridge this large disconnect between the industry and academia by providing suitable funds e.g. DBT, Biotechnology Industry Research Assistance Council (BIRAC), a not-for-profit Public Sector Enterprise, The Biotechnology Ignition Grant (BIG), Start-up's or an incubator who have an exciting idea which may be in the nascent and planning stage and there is an unmet need for mentorship and initial funding. The BIG would help to support and nurture these high-risk early starters and their concepts. The DBT-Small Business Innovation Research Initiative (SBIRI) scheme of the DBT is facilitating innovation, risk taking by small and medium companies and bringing together the private industry, public institutions. The Biotechnology Industry Partnership Programme (BIPP) promotes partnership with industries for support on a cost sharing basis for path-breaking research in frontier futuristic technology areas having major economic potential and making the Indian industry globally competitive. BIRAC has launched Promoting Academic Research Conversion to Enterprise (PACE) scheme<sup>1</sup>. This list is not exhaustive. There are additional schemes viz., to contribute to the vision, Government has established National Missions

- i. ANRF-Anusandhan National Research Foundation
- ii. The Manthan digital platform
- iii. The National Quantum Mission
- iv. The Deep Ocean Mission v. The National Mission on Interdisciplinary Cyber-Physical Systems
- vi. India AI mission promotes synergistic efforts between academic researchers and industry experts.
- vii. The National One Health Mission is a testament to how these partnerships can address complex challenges at the intersection of human, animal, and environmental health, fostering comprehensive and sustainable solutions<sup>3</sup>. About 13 government-facilitated initiatives to promote industry-academia partnerships are
  - i. Uchhatar Avishkar Yojana (UAY) – 2015
  - ii. IMPRINT-2015
  - iii. DBT-BIRAC Amrit Team Grants-2024
  - iv. Biotechnology Industry Partnership (BIIP)-2008.
  - v. IIGP 2.0-2017
  - vi. Industry Relevant R&D Scheme
  - vii. TIDE 2.0-2019
  - viii. SERB-Industry Connect-2021
  - ix. RUSA-2013
  - x. National Biopharma Vision-2017
  - xi. Skill Vigyan Programme-2022
  - xii. Biofoundries and Biomanufacturing Hubs-2024
  - xiii. DRDO Industry Academia Centres of Excellence (DIA-CoEs)-2022 and so on<sup>9</sup>. There are two elements in an industry-academia partnership. Industries today include multinationals, Indian industries, industry associations, MSMEs etc. Academia includes both private and public institutes and 300 Incubators as well as their thousands of incubated startups. These stakeholders are large in number with distinct specialisations<sup>10</sup>.

### Industry-Academia Collaborations

Academia-industry partnering relationship is not like technology donator-acceptor; but of interactive and collaborative nature. For a “Win-Win” partnership, the prerequisites are: Paradigm shift in the attitude and approach of both the entities for obtaining mutually beneficial outcomes<sup>2</sup>. Networks are the key: Start with your supervisors. Don’t be afraid to contact other academics to discuss opportunities. Ask around at the relevant research institute<sup>8</sup>.

### Evolution of Industry-Academia Partnerships in India

1941: Dr. Shanti Swarup Bhatnagar established the Industrial Research Utilization Committee and in 1942 this evolved into the Council of Scientific and Industrial Research (CSIR), a crucial bridge between scientific research and industrial application in India, India’s first institutional attempt to forge meaningful connections between research, development (R&D) and industry needs. Then established, 1950-60: Indian Institutes of Technology; 1971: DST; 1986: DBT; 1991: Economic liberalization marked another pivotal shift. These industry-academia partnerships in India have taken various operational forms viz., 1. Industry driven projects 2. Projects of mutual interest 3. Partnerships of scientific infrastructure with various expansions like i. Private industry and public academia ii. Public industry (PSUs) and public academia iii. Private industry and private academia iv. PSU and Private academia. Incubators and Technology Transfer, a Core Component of Collaboration. IIT Bombay supported 245 startups and Biomedical Engineering and Technology Innovation Centre (BETIC) and IIT Kharagpur’s Agri Business Incubation Foundation addressing agricultural challenges. Beyond incubators, this collaborative ecosystem’s strength lies in its diverse support mechanisms, as evidenced by IIT Madras Research Park, which houses over 200 R&D companies and facilitated more than 1300 patent filings. The vibrant ecosystem steadily dissolving traditional boundaries in this space<sup>11</sup>.

### IIT-Madras

In 1998, IITM-Research Park (IITMRP) was established for creating industry-academia-startup ecosystem, so far incubated 375 deep tech companies worth Rs. 50,000/ crores. Once the Industry-Academia-Startup Ecosystem works, it grows from strength to strength, attracting more industries, international organizations and governments and also youngsters dreaming big could do the impossible. The Venture Capital finds the ecosystem increasingly attractive and is willing to take up big bet<sup>12</sup>.

### Deep Tech

The future of innovation lies in “deep tech”. Deep tech refers to technologies rooted in substantial scientific research and engineering breakthroughs. Breakthroughs in transformative fields such as quantum technologies, artificial intelligence and advanced biotechnology are set to revolutionize almost all sectors, drive sustainable solutions, and create unparalleled societal impacts. Unlike incremental innovations, deep tech solves complex challenges and disrupts existing markets by introducing ground breaking solutions e.g. development of CRISPR-Cas9 genome editing technology. This groundbreaking innovation allows precise editing of DNA, paving the way for curing genetic disorders, improving crop yields, and tackling diseases like cancer and revolutionizing fields like medicine, agriculture, and bioengineering.

Other e.g. AI-driven diagnostic tools-Google's AI to detect diabetic retinopathy. In deep tech, no single stakeholder can achieve breakthroughs in isolation but with strong academia-industry government partnerships and needed infrastructure. One of the core characteristics of such partnerships is smooth bidirectional flow of knowledge, and technology transfer. Universities and research institutions often serve as incubators of breakthrough innovations. For India, moving towards a product oriented economy does not imply abandoning the existing strengths in IT and digital services but complementing<sup>13</sup>.

### Triple Helix Model

The triple helix model represents a transformative approach to innovation, where academic institutions, industry partners, and governmental bodies converge to drive technological advancement and economic development. This collaborative framework has emerged as a critical approach for addressing complex challenges across diverse sectors, enabling knowledge transfer, research commercialization, and sustainable innovation. This is a proven framework for fostering research and innovation. This dynamic partnership leverages the complementary strengths of each stakeholder to address pressing societal and sectoral challenges. This covers life sciences, agriculture, defense and sustainable energy. Life sciences: Invention of library of organic small molecules with violet-blue absorption and bright green emission in the solution state, greatly helped bioimaging in fluorescence microscopy compared to conventional dyes in biological research with great market potential in the biotech, pharmaceutical and clinical research. Agriculture: Chemical pesticide challenges: Pesticide-resistant pests, environmental pollution, and soil degradation leading to development and deployment of a pheromone-based bio-insecticide system (ATGC Biotech, a pheromone chemical synthesis company with Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR) and University of Agricultural Sciences (UAS), Bengaluru resulted in a nano-matrix pheromone dispenser. This dispenser broadcasts synthetic pheromones to disrupt mating cycles of pests, offering an eco-friendly and effective alternative to traditional pesticides and is validated in field in Karnataka<sup>14</sup>.

### National Funding

The key imperative is for Indian industry to increase its expenditure on R&D. In FY2023, the total expenditure on R&D by Indian industry was USD 7.4 billion. This was less than a fifth of what Alphabet as a single firm spent on R&D. If India has to see high economic growth of 8 to 10 percent over the next two decades to cross the USD 20 trillion mark, Indian industry would need to lead the way through its investments in R&D. A multi-policy approach would be needed that goes beyond funding models and

incentives for R&D and innovation. One that prioritizes building the talent pipeline, addresses regulatory bottlenecks, considers trade policies on a case by case basis (not only protectionism), focuses on supply chains, invests in skilling the workforce on AI complementary skills, and guides firms on good management practices to integrate into global value chains. We must collectively and continuously engage in this effort to help India fulfil her R&D and innovation ambitions<sup>15</sup>.

Public-private partnership being seen as a synonym to industry-academia partnerships. Large grants often come from the government and the scientific facilities get established. Once you create the facilities, this is where industries come in. They give the relevant problem statements, and then use these facilities created through government funding to do work which will be of interest to the industry. In India, even the government funding is just 0.6-0.65% of GDP which is less than what other BRICS (Brazil, Russia, India, China, South Africa) nations support in their countries<sup>16</sup>.

### The Barriers to Academia-Industry Collaborations

These can be categorized into two main types: transactional and orientation-related. Transactional barriers primarily involve intellectual property rights and conflict resolution mechanisms among stakeholders. Orientation-related challenges stem from fundamental differences in how academia and industry operate. Academic research typically follows PhD student timelines, which may not align with industry's need for immediate results. Additionally, academia thrives on publishing and sharing knowledge, while industry often requires confidentiality. There should be flexibility and overcome the limitations e.g. Fraunhofer operate on a unique model where professors divide their time between university and applied research, enabling efficient translation of academic work into industry applications and was highly successful, generating 600 patents annually and €3 billion in revenue, with 70% from industry-driven, demand-focused research. The more crucial opportunity lies in supporting MSMEs (Micro, Small, and Medium Enterprises), forming India's economic backbone but lack the resources and confidence to approach major institutions. Government intervention is essential for facilitating these connections, as demonstrated by initiatives like RuTAG-Rural Technology Action Group<sup>16</sup>.

### Overcoming the Impediments

Breaking mental barriers on the part of industry and academia. Industry should build confidence in capabilities of universities. Public policy (may influence the propensity to collaborate through a direct role) in providing funds for R&D projects to universities. Necessary infrastructure for technology transfer offices, and business incubation centers. Action steps for long lasting, symbiotic relationship between the academia,

industry and other related organizations:

1. Encouragement of efficient work flow, Creation of "Chairs" in the name of renowned academicians and industrialists, Provision of incentives establishing center of excellence in collaboration, Reformation of students' internships / training / projects / master seminars / RAWE / Student-ready, etc.
2. Setting up interface structures R&D incentives and grants for collaborative projects.
3. Performance-based funding of universities and reward systems for researchers.
4. Education, training, skill enhancement guest lectures, expert talks, training, discourses etc. by industry veterans.
5. Establishing in-house training centers for sharpening skill sets of industry personnel and other related organizations by offering customized skill development initiatives. Effective revenue sharing mechanisms for the concerned ones involved in training<sup>2</sup>.

#### Key Aspects of Industry-Academia Collaboration

*Knowledge Transfer:* Sharing of research findings, expertise, and best practices between academia and industry.

*Skill Development:* Providing students and researchers with opportunities to gain practical experience and industry-relevant skills.

*Innovation and Research:* Driving innovation through collaborative research projects, leading to new technologies, products, and services.

*Resource Sharing:* Pooling resources (funding, equipment, expertise) to support research and development activities.

*Commercialization of Research:* Facilitating the translation of academic research into commercially viable products and services.

*Talent Pipeline:* Creating a pathway for students to transition into the workforce, addressing the skills gap in various industries.

#### Examples of Industry-Academia Collaboration

*Industry-driven projects:* Industries partner with universities to solve specific problems or develop new technologies e.g. a pharmaceutical company might collaborate with a university research lab to develop a new drug. Joint research projects: Both industry and academia collaborate on research projects of mutual interest, sharing knowledge and resources.

*Partnerships for infrastructure:* Collaborations focused on building and maintaining research infrastructure e.g.

research labs, specialized equipment. Internships and placements: Providing students with opportunities to gain practical experience in industry settings. Consulting and advisory roles: Industry experts providing guidance and advice to academic institutions on curriculum development and research priorities.

*Technology transfer:* Licensing or commercializing academic research outputs to industry. Various permutation and combinations of collaboration can be had between and among the academia (Government or private), industries, government, government agencies etc.

#### Industry-Academia Collaborations in Veterinary/Science/Pathology

This involves partnerships between universities and research institutions with companies in the animal health industry. These collaborations aim to leverage expertise from both sectors to advance research, education, and ultimately, animal health. Such collaborations can take various forms as detailed above paragraphs.

#### Key Aspects of Industry-Academia Collaboration in Veterinary Pathology

**Research:** Joint research projects are a cornerstone of these collaborations, allowing researchers to pool resources and expertise to tackle complex problems in veterinary pathology e.g. a pharmaceutical company might collaborate with a university to study the efficacy of a new drug in treating a specific animal disease, or a diagnostics company might partner with a university to develop new diagnostic tools.

**Education:** Industry-academia partnerships also play a crucial role in training the next generation of veterinary pathologists. These collaborations can provide students with valuable hands-on experience in industry settings, access to specialized equipment and technologies, and mentorship opportunities with experts in the field.

**Knowledge transfer:** These collaborations facilitate the transfer of knowledge and technologies from academia to industry, and vice versa. This can lead to the development of new products, services, and improved practices in animal health.

**Funding:** Industry funding can provide a significant boost to research and training programs in veterinary pathology. This can be in the form of grants, sponsored research agreements, or donations.

#### Types of Partnering Relationship between Academia and Industry

- High intensity of partnering:* Inter-organizational research partnership-collaborative R&D projects; Research services-Commissioned by industries like contract research, consulting, quality control, testing, certification and prototype development. Shared

infrastructure- Use of university labs and equipment by companies, business incubators and technology parks located within universities.

- ii. *Medium intensity of partnering*: Academic entrepreneurship- Commercialization of technologies developed by academic inventors own (spin-off companies), student start-ups through incubation centres supported by industries. Human resource training and transfer-At universities, internship / training/ visits for students in industries and research staff to industry and appointing adjunct faculty from industry.
- iii. *Low intensity of partnering*: Commercialization of intellectual property-Transfer of university generated IP/Patents to industries via licensing. Scientific publications- Use of codified scientific knowledge within industry. Informal interactions-Formation of social relationships e.g. conferences, meetings, social networks, farmer exhibitions<sup>2</sup>.

#### **The TANUVAS Experience – Linkages vs Convergence<sup>1</sup>**

Translational Research Platform for Veterinary Biologicals (TRPVB), a vision of the DBT, GoI, was formed in partnership with one of the premier Animal Science Universities of the country, TANUVAS with an ultimate aim of converting science into commercializing technologies in animal sciences by creating an inclusive ecosystem involving academia, industry, biosafety personnel and regulatory agencies etc., to have all the requirements needed to traverse the path of idea to market under a single roof. This is a 'convergent' strategy Vs a 'linkage' interconnect. This would enable conversion of leads / vaccine candidates / kits in to prototypes for industry and thereby foster 'productization' in the field of veterinary vaccines and diagnostics. TRPVB was functioning at TANUVAS since 2012. In its 14<sup>th</sup> year of existence, TRPVB has fostered collaborations with various industries and has commercialized and produced >30 products and also commercialized most of them and offered biotechnology services including unique cell culture facilities. A sizeable number of these technologies have reached the market and are presently used by various stakeholders. TRPVB has obtained various BIRAC, CRS and SBIRI grants for joint product development with the industries. It holds the Schedule-M Current Good Manufacturing Practices certificate for its manufacturing unit with required state-of-the-art infrastructure facilities for formulating and manufacturing external veterinary products such as ointments, creams, gel, spray, shampoos. TRPVB supplies many of these products to the Department of Animal Husbandry, Government of Tamil Nadu for use by the veterinarians. Veterinary Incubation Foundation @ TANUVAS, to nurture budding entrepreneurs, has been established as a not for profit company with funding support from the Tamil Nadu Manufacturing Business

Incubation Infrastructure Development Project of the Entrepreneurship Development & Innovation Institute of Tamil Nadu (EDII -TN)<sup>1</sup>.

#### **Benefits of Industry-Academia Collaboration**

Industry-academia interaction is one of the key determinants of a nation's competitiveness. The most prosperous and technologically advanced nations, which have achieved innovation-led growth, are those where industry-academia interaction is the strongest. Globally, we see this cycle: Money is invested into research, generating new knowledge, and then the industry innovates to convert that knowledge into economic value, taxes, and further investment in research. Academia can generate ideas, but to make an impact on society, the industry must play a significant role. Secondly, academia strives for excellence, while industry focuses on relevance, economic gain and societal impact. Competition drives this. When we talk about the economics of knowledge, the generation, production, consumption, and conversion of knowledge are all equally crucial.

*Two track systems*: i. Public research-CSIR, ICAR, ICMR ii. Higher education institutions and universities. Sometimes these two tracks align and collaborate effectively, but at other times, they operate in silos, limiting the collective impact of academic R&D. Think of opportunities, challenges and ways to collaborate between them and interact with industry. Overall, the framework is semi-quantitative, combining both quantitative and qualitative elements, making it rigorous yet practical. This framework helps build trust, which is crucial in India. Talent and technology are abundant, but trust is the biggest challenge. By incorporating frameworks like this into our policies, monitoring systems, and evaluations, we can start creating trust, which ultimately fosters innovation and progress<sup>17</sup>. For academia: Access to funding, real-world problems for research, practical training for students, and opportunities for commercialization of research. For industry: Access to cutting-edge research, a pipeline of skilled graduates, innovative solutions to problems, and potential for new product development.

*For society*: Economic growth, technological advancements, and solutions to societal challenges.

#### **Benefits of Industry-Academia Collaboration in Veterinary Science/Pathologists**

Veterinary pathologists actively engaged in research are well trained. Industry-academia collaboration involves partnerships between veterinary institutions and commercial entities, enhancing veterinary education with curriculum development incorporating industry-relevant knowledge and practical skills. Graduates are better prepared for their careers, gain practical experience and knowledge in real-world applications.

Industry partners offer internships, mentorship and job opportunities and providing students with practical experience and career guidance. Joint research projects and knowledge exchange foster innovation and facilitate the transfer of new technologies from the academic setting to the commercial market leading to development of new/ improved products, technologies and practices in animal health field covering areas such as disease diagnosis, treatment and prevention. Thus, industry-academia partnerships bridge the gap between theoretical knowledge and practical application with economic growth and job opportunity. Industries benefit from accessing specialized knowledge, research findings and training programs from academic institutions to address specific challenges and improve their operations. American College of Veterinary Pathologists (ACVP) promotes collaboration between veterinary pathologists and industry which outline the scope of work, funding and IPRs.

### Challenges

It's important to manage potential conflicts of interest that may arise from industry-academia partnerships. Intellectual property: Establishing clear guidelines for intellectual property rights is crucial for successful collaborations. Communication and coordination: Effective communication and coordination between academic and industry partners are essential for successful collaborations.

### Industry-Academia Collaboration Successes

*India:* Since its launch in August 2022, the Manthan platform has successfully delivered over 350 projects and sourced over INR 8277 Cr for research and innovation, addressing 780 problem statements and supporting 285 R&D projects, 138 early stage innovations, and 66 market-ready challenges, awarding 2354 scholarships, benefitting 794 startups and 246 academic institutions. Notable collaborations: InDx COVID-19 and Dengue Diagnostics-Rockefeller Foundation; ChemAmaze edtech-Pune STI cluster by BASF Germany; by Rockefeller Foundation; Vaccine Immunology Studies and Analysis of Immune Protection by Hindustan Unilever; and Clinical Research Platform for Rare Infectious Diseases by HUDCO with National Centre for Biological Sciences. Manthan gathered global recognition wherein foreign universities like Cornell and Ohio expressed their interest<sup>10</sup>.

*Technologies developed/commercialized in India:* e.g. Animal health technologies/products developed. ICAR-IVRI: DIVA LSD vaccine, PPR vaccine, negative marker, thermostable FMD vaccines, canine distemper vaccine technology and alternative model for QC testing of vaccines; TANUVAS: Pentavalent blue tongue vaccine, RD vaccine, multiplex PCR diagnosis of MD, LL and ALV and *Babesia spp.*, *T. evansi* and *E. canis* in dogs, quick heal, ABT choice, Bovine TB Alert kit, Nano ND vaccine, CPV

VLP/2B vaccine, LSD virus strain, antibody detection ELISA kit for *Babesia gibsoni*; SVVU, Tirupathi: Blue tongue and foot rot vaccines, molecular diagnosis for malignant catarrhal fever, FAT for ante-mortem diagnosis for bovine sarcocystosis and screening of meat.

*By other nations:* The Silicon Valley, USA epitomizes how strategic partnerships between universities and industry can not only meet market demands but can also position a country as a technology leader. Research conducted by Germany's Fraunhofer Institutes indicates that their targeted research collaboration model between industry and academia yielding 18 times return on investments through improved regional economies, enhanced workforce capabilities, and higher firm and government revenues<sup>3</sup>.

### ICAR initiatives on Industry-Academia collaborations<sup>18-21</sup>

The Indian Council of Agricultural Research (ICAR) - Indian Veterinary Research Institute (IVRI) organized series of industry-academia interface meets to foster collaboration and discuss research and product development opportunities. In the ICAR-IVRI "Industry-Academia 1<sup>st</sup> Interface Meet, the major decisions made were, MoU between institutions and industries to formalize partnerships, facilitate knowledge exchange, and collaborate on specific projects; Establishing dedicated Industry Liaison Cells or Corporate Relations Offices within veterinary colleges; Joint research projects: Academia and industry can collaborate on research projects that address specific veterinary challenges, such as disease outbreaks, drug development, or animal welfare i.e., is crucial for advancing the field, improving animal health, and ensuring a skilled and knowledgeable veterinary workforce. The 2<sup>nd</sup> ICAR-IVRI Industry-Academia Interface meet insisted use of IVRI animal health products such as negative marker, thermostable FMD vaccines, canine distemper vaccine technology and alternative model for QC testing of vaccines by the industry. As vaccination not only protect animal populations, but also safeguard public and environmental health<sup>22</sup>. Recently, Agrinnovate India Ltd, an ICAR commercial wing, facilitated successful transfer of three Foot and Mouth Disease (FMD) vaccines developed by ICAR-National Institute of FMD, Bhubaneswar to the industry (January, 2026).

In the ICAR-IVRI organized 3<sup>rd</sup> Industry-Academia Interface meet academia urged industry participation in CSR-funded initiatives aligned with ICAR guidelines, emphasizing on the mutual benefits of supporting teaching and research infrastructure development, and extension and social welfare activities, dealt on significance of the events for all stakeholders and the contemporary challenges confronting the livestock sector and the delegates to collaborate effectively for

the collective betterment of livestock farmers across India. ICAR-NMRI National Workshop and Industry-Academia Interface meet discussed on key findings from ICAR-NMRI's collaboration with Sealed Air Packaging, Mumbai, ICAR's crucial role in ensuring food security and safety and importance of standards and best practices for maintaining global competitiveness are stressed and consensus in harmonizing Indian meat and poultry standards with internationally recognized benchmarks to strengthen the industry and enhance its global competitiveness.

### **Role of Veterinary Pathologists in Industry-Academia Set UP**

In the field of veterinary pathology, this is further driven by the fact that traditional funding sources cannot keep pace with the innovation needed in digital pathology and artificial intelligence. The role of pathologists during different phases of an Academia Industry Projects<sup>23</sup> and the top three goals are "feasibility, verification and validation".

### **Man Power and Training Needs**

Veterinary pathologists traditionally have been actively engaged in research as principal investigators and as collaborators. Pathologists frequently obtain advanced training in research; however, it appears that in the last 10 years there has been a reversal of a previous trend toward increasing numbers of pathologists obtaining PhD degrees. This has arisen despite an established shortage of veterinarians engaged in research<sup>24</sup>. Employability in the veterinary context is a set of personal and professional capabilities that enable a veterinarian to gain employment, contribute meaningfully to the profession, and develop a career pathway that achieves satisfaction and success. The congruence of stakeholder responses was notable, regardless of age and geographical location, with minor differences noted in academics and para-veterinary staff responses, and gender. The most important capabilities were honesty, ethical behaviour, communicating effectively and collaboratively with clients, knowing when to ask for help, and the willingness to learn. The categories of communication and teamwork ranked the highest<sup>25</sup>.

The man power shortage in veterinary profession including pathology have been highlighted for about two decades<sup>24,26-28</sup>. The various factors attributed are globalization, urbanization, changes in agriculture, pandemics of zoonotic diseases, changing demographics, an altered economic landscape, new and continually advancing information technologies, the pending retirement of a broad swath of veterinary medical professors, and other outside pressures are all affecting veterinary medical education. The recommended core competencies for all veterinary medical students to achieve by graduation include: i. multispecies knowledge plus clinical competence in one or more species or disciplines;

ii. "One Health" competency related to the intersection of animal, human, and environmental health and iii. The development of professional competencies which include communication, collaboration, management, lifelong learning related to scholarship and research, diversity and multicultural awareness, and the ability to adapt to changing environments<sup>28</sup>.

### **Benefits of Research Training for the Veterinary Pathologists**

Widest spectrum of job opportunities and potential for crafting responsibilities to satisfy personal career interests: The 2008 ACVP Demographic Survey indicated that more than one-third of employers considered research training an important requirement, whereas only 24% considered such training unimportant. There is a high demand for veterinary pathologists with research training to evaluate safety and efficacy of new tests and treatments in animal models, including bringing these advancements into human veterinary and human medical practice in the form of clinical trials. Most veterinary pathologists have acquired both pathology (anatomical and clinical) and experimental research training in their backgrounds which greatly influenced the accomplishments and stature of the discipline. Research training provides a unique opportunity for developing critical thinking and problem-solving skills, learning laboratory methods and experimental design in the context of hypothesis driven experimentation, enhancing knowledge of disease and normal biology, evaluating safety and efficacy of new pharmaceuticals, designing new biomedical devices, diagnostic tests, and instruments, contributing to drug discovery and developing and evaluating new teaching strategies and enables veterinary pathologists to be more competitive for most professional positions, enriches their work experiences regardless of the ultimate career pathway and will continue to enhance our ability to interact with the larger biomedical community. To maintain our role in advancing biology and medicine and remain relevant in the world of global health with animals as potential sources of zoonotic disease or novel infectious agents and the reliance on information from animal studies for major medical advances, comprehensively trained veterinary pathologists will continue to be critical to the design and interpretation of research studies. Some pathologists will focus their careers on research as principal investigators, but many pathologists will continue to seek a career that includes both research and diagnostic pathology. Trainees are encouraged to consider the personal and professional value of research training as being equal to or greater than the necessary investment both for their own careers and for veterinary medicine and global health. Mentors and training institutions should engage in continual reflection on mechanisms for optimization

of educational programs<sup>24</sup>.

Coalition of ACVP and Society of Toxicologic Pathology established resulted in 13 new training positions for veterinary pathologists with the financial support of the biopharmaceutical industry and dissolved<sup>29,30</sup>. The Royal College of Pathologists involved in board certification with the support of Veterinary Pathology Specialty Advisory Committee.

### Biomedical Devices/Research

For veterinary pathologists to continue to make critical contributions to biomedical research and collaborative efforts such as the One Health Initiative, it will be important for the discipline to increase the number of pathologists who have the knowledge and skills to function as primary investigators as well as collaborative researchers<sup>24</sup>. Because the focus is on the development of the fundamental technology in medical devices, little effort is placed on product performance, reliability, manufacturability, robustness, or the cost of an eventual commercial device. Often, these devices are little more than an alpha prototype developed to verify a hypothesis. Thus, a large gap exists between the discovery of a new medical technology and a commercial device available for public use. These include low-cost products for the developing world and custom medical devices for people with disabilities e.g. Eyeglasses for vision correction that use water-filled lenses that are inflated to change optical properties and a prosthetic arm for a limbless child<sup>31</sup>.

### Toxicological Studies

Different toxicological experiments are briefly dealt

- i. *Discovery toxicology*: Evaluating the safety of potential drug candidates throughout the drug development process. Early screening and lead optimization: To identify compounds with unacceptable toxicity profiles, allowing researchers to focus on more promising candidates. Studies may involve *in vitro* assays (using cell lines) and *in vivo* animal studies to assess genotoxicity (potential to damage DNA), cytotoxicity (cell toxicity), and other potential adverse effects; to identify early warning signs, like target organ toxicity, specific toxicities, and maximum tolerated doses (MTD), to eliminate unsuitable compounds early
- ii. *Preclinical toxicology / Exploratory toxicology / Non-GLP toxicology*: Studies on selected candidate drug-toxicity profile, dose-response relationship, target organs, and potential mechanisms of toxicity and on its behaviour in different systems-Absorption, Distribution, Metabolism, and Excretion (ADME), vital for designing safer clinical trials and identifying parameters to monitor for potential side effects
- iii. *Clinical trial support*: Toxicology studies provide

crucial information for designing and conducting clinical trials for safe starting doses for human trials and determine appropriate monitoring parameters risk assessment and to decide on continuing or discontinuing studies

- iv. *Post-Market Surveillance*: Toxicology plays a role even after a drug is approved and marketed, with ongoing monitoring for adverse drug reactions (ADRs). This helps identify rare or long-term toxicities that may not have been apparent during preclinical or clinical testing
- v. *Safety Pharmacology*: Studies that assess the effects of a drug on vital organ systems e.g. cardiovascular, respiratory, central nervous systems.
- vi. *Genetic toxicology*: Studies that evaluate the potential of a drug to cause mutations or damage DNA
- vii. *Organ toxicity*: Studies that identify which organs are most susceptible to the drug's toxic effects. ADME on drugs
- viii. *Reproductive and developmental toxicity*: Studies that assess the potential of a drug to affect fertility, pregnancy, or fetal development. *Carcinogenicity*: Studies that assess the potential of a drug to cause cancer
- ix. *GLP toxicology / regulatory toxicology*: Crucial role in drug discovery and development by ensuring the safety of potential drug candidates before they are used in humans by rigorous testing to assess the adverse effects of drugs in animals
- x. *Safety assessment*: The primary goal of regulatory toxicology is to assess the safety of drug candidates through various studies, including *in vitro*, *in vivo*, and *in silico* methods
- xi. *Non-clinical studies*: Before clinical trials: Genotoxicity, general toxicity, and safety pharmacology, are conducted to support the safety of the drug candidate.
- xii. *Specific toxicity studies*: Regulatory toxicology - Assess different types of toxicity, including carcinogenicity, reproductive toxicity, and drug-drug interactions. Regulatory guidelines for animal experimentation and drug development for human use in pharmaceutical industry-Safety. Regulatory agencies are many: Fulfil according to the conditions of the country e.g. USA: FDA- Food and Drug Administration; *The Federal Food, Drug, and Cosmetic Act*: Basic food and drug law, most extensive law of its kind in the world. **Code of Federal Regulations (CFR) for Investigational New Drugs (INDs), New Drug Applications (NDAs), Abbreviated New Drug Applications (ANDAs) and Biologics License**

**Applications (BLAs);** The International Council for Harmonization (ICH-1990): Technical Requirements for regulatory body - increasingly global face of drug development. OECD (Organization for Economic Co-operation and Development) Guidelines for the Testing of Chemicals (OECD TG)-Internationally accepted specifications for the testing of chemicals. The European Medical Agency's Committee; India: Central Drugs Standard Control Organization (CDSCO); Good Clinical Practice-Guidelines for biomedical studies<sup>32</sup>.

### Lessons from an academician's experience in industry<sup>33</sup>

A Medical Pharmacologist after 30 years of academic service entered industry discusses her experiences. Leadership means how am I doing than others? Humility is facing the failures. By resilience (learning from failures) achieved success and developed 20 new products. Selecting a company by you or the company? Career advancement in industry is by active contribution and experience but may seem initially less intellectually stimulating than an independent faculty position. Academic faculty is primarily evaluated by their individual contributions while in industry it is part of success of a team. If the project the team fails, the performance evaluation and compensation will be affected. Academia is salaried class as per rank. In industry workers have a base salary, a bonus and incentives. A misperception is that industry science is inferior to that in academia. But actually the opposite is true. All the works are rigorously monitored, reviewed and evaluated internally and externally by regulatory authorities. Industry teams are under constant pressure to deliver and adhere to timelines. Hence, proceed with caution in choosing a career in the pharmaceutical industry, understand the job opportunity and discuss with members of the company<sup>33</sup>.

### The Way Forward

1. Successful industry-academia collaboration needs to cater to the interests and needs of both the partners with mutual benefits and also respect each other's role and contributions.
2. The academics should be incentivized to promote their research appetite, greatly promoting industry oriented research and directly linked to their career development.
3. Universities should encourage academics to create 'spin offs' and should allow them to act as 'Directors' for such spin off companies.
4. The industry scientists can be incentivized by means of monetary benefits, can also be given adjunct/honorary faculty positions at universities.
5. University administrative regulations governing the

industry collaborative research to be made flexible to accommodate to promote and nurture such collaborations.

6. Industries can set up specific funding for university collaborative research, by making policy decisions that gives tax rebate (or exemptions) for such funds.
7. Partnerships with industries should be long-term and multifaceted with increased faculty/ scientist exchange between the partners for training.
8. Universities/ industries can provide mutual consultancy services with their technical / manufacturing/ regulatory expertise.
9. Create adequate awareness on Regulation, Translational Research, Biosafety, GMPs etc., for the students to feel comfortable with entrepreneurship<sup>1</sup>.

The clinical practice undertaken by the practicing veterinarians is also a form of entrepreneurship and is an expertise-driven business model. VETPRENEURSHIP is hopefully going to be the buzzword for the veterinary research institutions in the near future, ensuring that the research outcomes of these institutions are taken to the users and thereby the existence of these institutions are not questioned<sup>1</sup>. Higher education system is a powerful tool for social, political and economic change, which will have greater pressures because of demands for providing training ground for skilled manpower to meet the needs of industry or for self-employment. With very promising initiatives like "Skill India", "Start-up India", India has started taking big steps and all stakeholders to build the "New India" need to be brought together to achieve grand success in this direction<sup>2</sup>.

Best-practice recommendations for program infrastructure, mentorship, time management, and a team approach to research and research training are advocated to facilitate the development of successful programs and to encourage a continued emphasis on integrated training for pathologists as both clinical diagnosticians and experimentalists<sup>24</sup>. Such training programmes are offered by organizations like, ACVP, ECVP and Royal College of Pathologists, Japanese College of Veterinary Pathologists and in India by Indian College of Veterinary Pathologists (ICVP), the only board certifying body in veterinary science in India giving diplomat to the successful candidates after examination since 2008. As per the Global Innovation Index USA stands 2<sup>nd</sup>, China 6<sup>th</sup> and India 66<sup>th</sup>. Hence, India has a long way ahead and make us to be prepared for achieving the heights.

### Indian livestock sector growth

Projected 2025-2030 livestock sector contribution to CAGR for value addition is around 9.5%; animal health market: 13.9%; cattle management software: 14.8%; poultry sector: over 8%; animal feed market: 6.8%;

livestock population: overall 4% with specific growth in sheep and goat at an 8%; poultry population 12% (BAHS, 2025). Being first in world milk production, Indian dairy industry contributes around 4.5% to the national GDP accounting for over one-fourth of the agricultural GDP and growing at the rate of 10% per annum. Livestock sector GVA is expected to increase by an additional Rs. 2.5 trillion by 2030<sup>34-37</sup>. Indian edible meat market will reach over \$16 billion by 2030 (MoFPI). These developments will lead to industry-academia collaboration with disease challenges.

### Government of India Initiatives

#### Animal Husbandry and Dairying Dept:

- i. Rashtriya Gokul Mission
- ii. National Programme for Dairy Development
- iii. National Livestock Mission
- iv. Animal Husbandry Infrastructure Development Fund;
- v. Livestock Health and Disease Control Programme
- v. Expanding the network of Colleges for Veterinary Education- 39 in 2014 to 79 in 2024
- vi. Livestock Census & Integrated Sample Survey Scheme
- vii. Kisan Credit Cards for Dairy Farmers of Milk Cooperatives and Milk Producer Companies and through other fora. These schemes are supporting and encouraging quality veterinary education, animal husbandry services, cooperatives, farmer producer organizations, livestock farming to increase the animal production, quality feed, entrepreneurship, employment, women empowerment, quality livestock products, efficient use of animal resources, disease protection etc., for socioeconomic development of people and food and nutritional security, and safety (Livestock Production Statistics of India, 2024).

### CONCLUSIVE REMARKS

Collaborations among industry, academic and government organizations would result in better outcomes than work done independently in isolation. Collaborations can benefit industry by enabling them to hire a subject matter specialist knowledgeable on a given topic. Where, academics have the most flexibility and can pursue projects of interest, apply for suitable funding and are obliged to teach, serve the university and conduct research. Projects that could be completed in months in industry can take years to complete in an academic environment. Eliminating the normal commercial requirements for performance, quality, reliability and profitability enables these projects to be completed by students and faculty with little or no

industrial experience. While industry is the most focused group and must identify opportunities that meet a public need for a specific product or service, generate sufficient profit to sustain the business and maintain their fiduciary responsibility to shareholders and ethical responsibilities to customers and regulatory agencies. Investment are assessed based on the balance of these considerations. The government is a large comprehensive entity with multiple responsibilities and minimal overlap<sup>31</sup>.

Such strong growth is driven by increasing demand for animal-based products (milk, eggs, and meat), government initiatives and the adoption of modern technologies (like sex-sorted semen, IVF, genomics) in feeding and health management (BAHS, 2025) which will be hampered by the occurrence of diseases, wherein Veterinary Pathologists have a crucial role to play in imparting quality education, inculcate research aptitude, involving in diagnosis and control of animal and poultry diseases. Besides, the scenario of entry of organized sectors and the GoI initiatives to achieve various goals including FMD/PPR freedom by 2027, improving milk yield by 8% which will uplift the national economy and provide livelihood to the people and by supporting industry-academia-Government collaborations<sup>34</sup>.

*Let the HEIs in Agriculture and allied sciences take the lead and serve as the 'torch bearers' by fostering such 'education revolution' through integrated approach for building, strengthening and sustaining partnership between academia, industry and other related organizations<sup>2</sup>*

*"Sabka Saath, Sabka Vikas, Sabka Vishwas, Sabka Prayas (Everyone's support, everyone's development, everyone's faith, everyone's effort) through industry-academia partnerships that will continue to drive the nation towards realizing its highest aspirations in science, technology, and economic prosperity". Vision of Shri Narendra Modi, Hon'ble Prime Minister of India*

### ACKNOWLEDGEMENT

I sincerely thank Dr. G. Dhinakar Raj, Retired Professor and Head, Dept. Animal Biotechnology, Madras Veterinary College, Chennai, for the partly help rendered.

**Conflict of interest:** There is no conflict of interest.

**Financial assistance:** There is no financial support.

**AI:** The article is not AI based preparation.

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