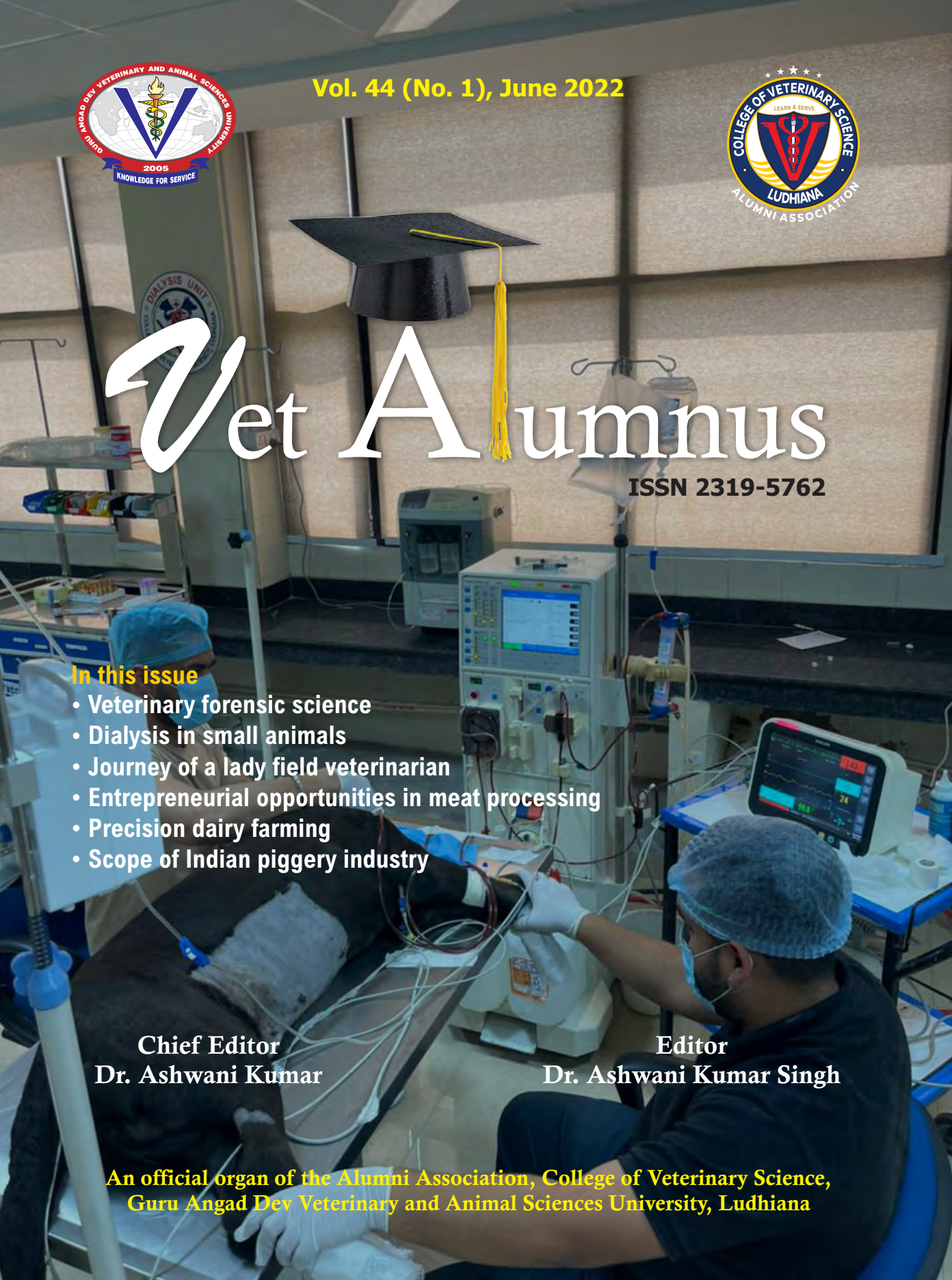
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Vet Alumnus

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In this issue

- Veterinary forensic science
- Dialysis in small animals
- Journey of a lady field veterinarian
- Entrepreneurial opportunities in meat processing
- Precision dairy farming
- Scope of Indian piggery industry

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VETERINARY FORENSIC SCIENCE: AN EMERGING AREA

Varinder Uppal*, S.P.S. Ghuman, Anuradha Gupta, Neelam Bansal and Devendra Pathak

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Abstract

Veterinary Forensic Science is a new emerging area. Veterinarians are often called to identify the remains of carcass, bones, skin etc. to solve veterolegal cases. If the specimens are large enough they can be identified on the basis of their gross morphological features. But if the samples are small they can be identified by histological, electron microscopic and other molecular techniques. DNA profiling is the most reliable method of species identification. Forensic Science requires interdisciplinary approach to establish systems and protocols similar to those used in human forensic medicine.

Keywords*: DNA profiling, forensic science, veterinary, veterolegal*

Veterinary forensic Science is a relatively new and emerging area. The word 'forensic' was derived from the Latin word 'forensis' meaning 'before the forum'. Fortunatus Fidelis, an Italian doctor, is regarded as the first person to practice modern forensic medicine in 1598. Forensic Science is an interdisciplinary Science which involves the application of knowledge of Veterinary and other life sciences to solve the veterolegal cases with reliable and scientifically proved facts. Though the use of veterinary forensic science has increased during the last few decades but the Veterinary forensic medicine in India is still an infant specialist area.

The Veterinarians, many a times, are presented whole or partial bones, carcass, blood samples, teeth, claws, tusks, hair, hides, fur, feathers etc. for identification to solve vetrolegal cases. If the samples are large enough they can easily be identified on the basis of their gross morphology as each species has its own characteristic features. The sex of the species can be determined from the bones like pelvis, skull, mandible, teeth, vertebrae and long bones extremities with the varying degree of accuracy (Isik and Blachelioglu 2003). It has been reported that even Foramen magnum (FM) dimensions are very important anatomical landmark in sex determination (El Barrany *et al.* 2016). If the fragments of bones are large enough their species can be identified. Histologically, the concept of plexiform bone has been considered to be a general determinant of human and nonhuman bone tissue. Human cortical bone can be differentiated from large mammals like cattle, buffalo, horse and deer on the basis of absence of plexiform bone in humans. Besides this histomorphometry (Haversian system diameter and Haversian canal diameter) can also play an important role in species identification (Hillier and Lymne, 2007; Uppal and

Bansal 2008; Uppal *et al.* 2015). Species can also be identified on the basis of morphology of hair. Hair shaft has outer cuticle, cortex and inner medulla. The diameter of medulla of human hair ranged between 5 to 20 µm and the diameter of medulla of animal hair between 20 to 100 µm (Kshirsagar *et al.* 2009). The scanning electron microscopy of hair surface provides very valuable information regarding species identification (Broeck *et al.* 2001). Like, the bovines show a thin cuticle, coronal scales in mosaic with serrated edges and flattened irregularly whereas in equines it is thin and imbricated with irregular waves and intermediate spaces. The cortex in the bovines is thin crust dark brown and not pigmented whereas in equines the cortex is dark brown, with light texture and isolated dark brown and black pigments (Mendiburta *et al.* 2021). The species can be identified on the basis of morphology of the blood cells mainly RBCs, eosinophils and neutrophils. The most appropriate way of identification of different species is by testing the genomic DNA by polymerase chain reaction (PCR) amplification. The TP53 gene can be used as a potential animal species identifier as it produces fragments of different sizes between species (Bellis *et al.,* 2003; Uppal *et al.*, 2011). Two complementary techniques, simple sequence repeat anchored (SSR) PCR and PCR-restriction fragment length polymorphism (RFLP), could be used successfully as routine methods in forensics for sensitive, rapid, simple and inexpensive identification of the species in bloodstains (El-Sayed *et al.* 2010). DNA profiling is the most reliable method of species identification. STR (Short Tendem Repeat) loci are listed on various websites for different species like dog, cat, sheep and bovine (Linacre 2021).

Veterinary Forensics also play an important role in Pouching (an illegal hunting of wild animal species for the aim of obtaining valuable), illegal collection and trade and wildlife trafficking. The trade in ivory is leading to the extinction of elephants from many Asian and African countries. An elephant tusk is a potential source of DNA. DNA typing from the tusk will open the possibility to identify the number of elephants slaughtered. Such knowledge will aid in forensic investigations, or at least in highlighting the extent of the illegal trade. The STR multiplexes have also been developed for many wild animal species like elephants, bears, wolves and badgers (Linacre 2021). The STR markers have also been created for the one horned Indian rhino *(Rhinoceros unicornis*) as a part of the official RhODIS-India program as this species has also suffered due to poaching for their horns (Ghosh *et al.* 2021).

Although veterinary students are taught jurisprudence yet scanty attention is usually paid to the role of the veterinarian as an expert or advisor in veterolegal cases. Veterinary Forensic has a ubiquitous role but it is not a bonafide subject within the veterinary curriculum and is given little or no recognition. There is still lack of definite status, paucity and scattering of literature and data which hampers the ability of veterinarians to contribute their skills and knowledge. Keeping in view the need of this

emerging area, the educational institutions should provide opportunities in veterinary forensics by offering training/short courses for Veterinary Clinicians. A collaborative approach involving experts in different areas of Forensic Science like Anatomy, Pathology, Microbiology, diagnostic imaging etc. will strengthen this aspect. Till date the technological advancements made in human forensic genetics have been applied in animal forensic, but not successfully as unlike human forensic genetics, forensic DNA analysis for animal protection suffers very low genetic markers and secondly lack of validity in the animal forensic analysis (Mgimba, 2017).

The Veterinary practitioners have to play an important role in this emerging field of Veterinary Forensic Science. There is a need to enhance the awareness of veterinarians and to introduce teaching and specialized training regarding Veterinary Forensic. We need to establish systems and protocols similar to those used in human forensic medicine. Research and development of new techniques are essential. We need to compile the available data. Although the Veterinary Forensic is yet not a recognized discipline but is rapidly evolving and new challenges demand new approaches.

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DIALYSIS: AN EXCITING AND GROWING SPECIALTY IN 'HIGH TECH' VETERINARY THERAPEUTICS

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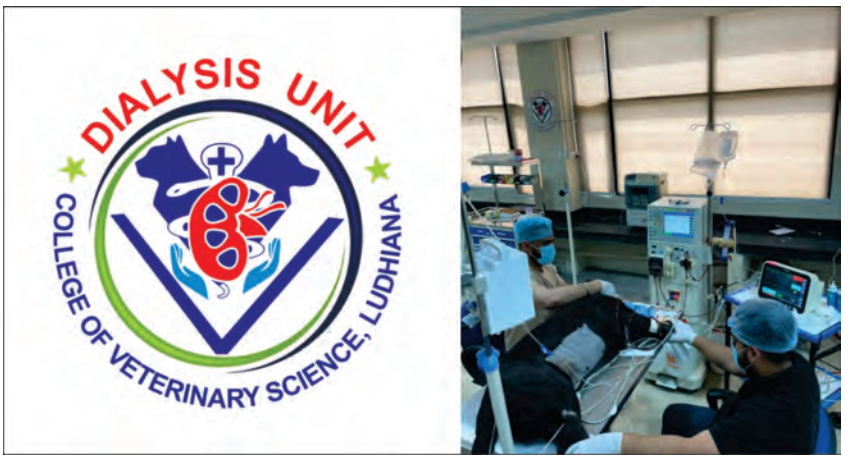
Abstract:

Hemodialysis is an extracorporeal renal replacement therapy that involves repeated hemodialysis sessions over a period of time with aims to strike balance between the patient metabolic profile and homeostasis that otherwise would likely succumb due to the pansystemic ramifications of severe uremia. The primary goal of dialysis in dogs with CKD is to improve the chronic progressive azotemia, correct acid-base, fluid, and electrolyte imbalances along with, removal of nitrogenous compounds and other toxins. Recently, a state of the art dialysis unit is made fully functional for clinical cases in multi speciality veterinary hospital of GADVASU which is also first of its kind in whole north India.

Key words: *Dialysis, renal failure, chronic kidney disease, acute kidney injury, uremia*

Hemodialysis is a method of blood purification that removes blood from the body through a catheter and filters it through a dialyzer (artificial kidney) (Bloom & Labato, 2011). It is used to purify blood by eliminating toxic metabolites, balancing electrolytes and removing excess fluid that builds up in the body when the kidneys are unable to excrete it (Fisher *et al.*, 2004). Common indications of hemodialysis include oliguria / anuria due to acute kidney injury (AKI), azotemia due to chronic kidney disease (CKD) and AKI, intoxications, fluid overload, hyperkalemia and acidosis, which are refractory to conventional therapy (Cowgill and Francey, 2012; Cowgill, 2011; Roura, 2018).

In recent years, there is an abrupt increase in the sick dogs presented at the university hospital suffering from renal failure. On an average, 4-5 dogs are daily presented in medicine OPD which are diagnosed with renal failure and 2-3 such dogs (based on our selection criteria) are found usually suitable candidates for undergoing dialysis. The dialysis unit of GADVASU in housed in the multi speciality Veterinary Hospital and is fully equipped with latest state of the art dialysis machines, Doppler blood pressure monitor, multi parameter monitors and centralized oxygen supply. This unit is also backed by expert radiology, ultrasound, echocardiography and transfusion facilities. Here we present stories of a few cases which successfully underwent dialysis at GADVASU.



Case 1: Ms. Pallavi Goyal from Jalandhar is a proud owner of a 6.5 years old female Labrador 'Aarfa' that was suffering from anorexia, vomiting and fever from the last 7-8 days before referred to GADVASU by local Veterinarian in December, 2021. Her preliminary examination revealed severe uremia with BUN >200mg/dL and creatinine >13mg/dL. After its complete renal specific assessment (which included urine examination, CBC, LFT, RFT, X-ray, ultrasound, ECG and blood pressure monitoring) dialysis was chosen as the treatment of choice to stabilize the patient. After three dialysis sessions all the hemato-biochemical parameters were brought to normal physiological range. Today, Aarfa is living a normal healthy life and visits dialysis unit at every 1.5 months interval for routine follow-ups.



GADVASU's Dialysis unit team gave us new hope. Today my Aarfa is all healthy and her medicines have been stopped. Always thankful to GADVASU.

Pallavi Goyal

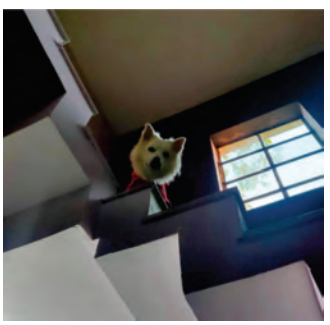
Case 2: Mr. Sojanye Singh from Chandigarh is a proud pet parent of a beautiful 11 months old Golden Retriever 'Olive'. Olive suffered AKI in January, 2022 and was treated at a private Veterinary clinic in Chandigarh for five days before being referred to GADVASU. On initial evaluation, Olive was anorectic from the past 7 days and was vomiting 8-10 times a day even after 5 days of treatment. Laboratory findings revealed BUN 215mg/dl, creatinine 8.5mg/dl and phosphorus 19.4mg/dl. After complete renal specific evaluation Olive underwent three dialysis sessions and recovered completely.



The dialysis team handled Olive very professionally and soft heartedly. Olive had been through a very tough time but by doctors' help and grace of God Olive recovered within a short period of time.

- Sojanye Singh

Case 3: Mr. Jaspal Singh from Kaithal, Haryana bought his loving 6 years old Pomerian 'Cash' to GADVASU in November, 2021 with the history of anorexia and vomiting from the past 10-12 days. Cash was treated by local Veterinarian for about 10 days without any significant improvement. On presentation, Cash was dull, dehydrated and suffering from hailitosis with bleeding oral ulcers. Its renal specific evaluation revealed CKD with BUN>200mg/dL, creatinine>13mg/dL and phosphorus>15mg/dL. Its ultrasound also revealed loss of normal renal architecture. As owner was determined to save his dog's life dialysis was initiated. After 2 sessions on alternate days, Cash showed significant clinical improvement and started eating and stopped vomiting. Till date (after >4 months), Cash has undergone 3 dialysis sessions and is maintained on renal specific supplementations. Its 3rd session was done after a gap of 1.5 months 2nd session and is being evaluated every month. It is eating normally with good quality of life.



Due to dialysis facility at GADVASU my family is still in company of our little Cash. God bless team of doctors dedicated towards saving lives of these speechless creatures.

- Jaspal Singh

Case 4: Tyson- *the silent sentinel* posted with 58 BN BSF Gurdaspur was brought in a very critical condition in late emergency hours to GADVASU hospital. After complete evaluation, which revealed severe AKI (BUN >140mg/dL, creatinine >6mg/dL and phosphorus >15mg/dL) due to E. *canis,* Tyson underwent two dialysis sessions and subsequently recovered completely after proper *E. canis* treatment protocol of 21 days along with weekly renal evaluation. At present, Tyson is actively providing its expert services at Indo-Pak border.



Its' our honor to treat Tyson who guard our borders.
- Team, Dialysis Unit

Frequently asked questions from pet owners:

Q. Is dialysis painful and require my pet to be anesthetized or sedated?

A. Actually, pet patients tolerate hemodialysis incredibly well even without sedation. Only aggressive pets require sedation and dialysis procedure as a whole is relatively painless.

Q. Will dialysis cure my pet's damaged kidneys?

A. No, dialysis does not 'fix' the damaged kidneys. Dialysis provides supportive care, taking the place of kidney until kidney function returns.

Q. How many dialysis sessions will my pet require?

A. The number of sessions will vary depending on the underlying disease condition and extent of kidney injury. Initially, 3 dialysis sessions on alternate days are recommended.

Q. How long dialysis session last?

A. A session usually lasts 4-5 hours of duration.

General referral guidelines for field Veterinarians/ Private Practitioners

- Early referrals will allow for assessment of patient's candidacy.
- Avoid using the jugular veins for regular blood sampling or fluid therapy in any potential candidate for hemodialysis. Due to smaller size of our patients, the jugular veins are used for vascular access and must be protected in any patient where dialysis is an option. Blood sample for haematology or serum biochemistry should preferably be collected from peripheral sites like cephalic / sephenous veins.
- Dialysis requires a huge financial and emotional investment for all involved and therefore careful discussion and counselling with the clients will take place before we agree to proceed with dialysis.
- Dialysis is fixed only after complete patient evaluation which generally take one whole day.

- Prepare and counsel clients to arrange another dog to act as a blood donor as many a times dogs requiring dialysis suffer from anemia and require urgent blood transfusion.
- Randhir Singh, *M.V.Sc.*, *PhD*. (Assistant Professor, Department of TVCC) is available 24 hours a day, 7 days a week to guide the referring Veterinarians.

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MY JOURNEY OF BEING A BEING A FIELD VETERINARIAN

Rana Preet Gill

Civil Veterinary Officer, Hoshiarpur, Punjab, India

I did my graduation in 2005. I joined MVSc in Gynecology and Obstetrics but did not complete it because of several reasons. I was preparing for GRE, I was finding the theoretical part difficult, I did not get enough marks in an important subject in the first semester which is basically what you say when you fail an exam. In nutshell, I had no idea what I was going to do in my life. I was not ready to study, not ready to put effort and not ready to shoulder responsibilities. I was not ready to face my choices. I started ghosting the calls of my professors who wanted to know what was wrong with me. Just because I had failed should not be a reason to leave the degree, they told me. It was not fear of failure but the lack of purpose which made me run away from the campus in the safe confines of my home.

In 2006 came the government jobs. I did not want to do a job, I told my parents. I do not want to work in a village. I want to go abroad, I had told them. I had secured admission in a college in North America in Fargo but without scholarship. They were not happy with my decision to go abroad. I too was not sure of my choices as I doubted if I would survive an alien land without the shelter of home and support. I did not go abroad. I stayed put in Punjab.

On the last day of filling the forms for the job my dad took my reluctant self to Chandigarh. I was still clueless. I had no idea what I was going to do with my life.

When I joined my job on 13th October, 2006 I was surprised, rather shocked at the condition of civil Veterinary Hospital where I was stationed as Rural Veterinary Officer. The first day my dad took me in his car and made the sixteen-kilometer journey tolerable. He even helped me find a class 4 employee whom people in the village called Chachi. She assumed that I too would call her the same much to my chagrin. And this was only the start of my woes.

After a couple of days ferrying me to and fro, my dad gave up. You are a grown up girl, an adult, about to be married so face the world. The station where I was posted , Baghela was a village located in the interiors. There was no direct bus service to the village. I had to change the bus at Mehatpur, a township located almost in the centre of Nakodar (where I was living with my parents) and Baghela. My class 4 employee's home was near the bus stand where I had parked my faithful trendy scooter which I used to drive to my hospital. The one advantage of having hospital in such hostile conditions and far away from the maddening crowd was that I was never checked even once by a senior officer during my seven years of posting at that station.

During the start of my professional carrier being checked was the last of my worries. My worry was surviving this job. The bus service from Nakodar to Mehatpur was very good but from Mehatpur to Baghela was dismal. I was often left stranded at Mehatpur bus station like a cast away. It was distressing to wait for a bus and to be looked at like a foreign object. I was carrying the baggage of university life and used to be dressed in jeans with cropped hair. And this invited undue attention of drivers and conductors. I was name called and stared at. " This bus is not going to Chandigarh" once someone called at my back. My eyes singed with tears and my throat got chocked. I did not have the audacity to face those men but it did break my spirit.

That day I cried a lot. I told my parents I did not want to do this job. If the men in buses were abusive the people who brought their animals to my hospital were not trusting. They did not seem to have faith in me . They called me a nurse which was their way of addressing a female doctor and to which I took umbrage and thought I was not capable enough to treat their animals. Perhaps their lack of trust stemmed from the fact that I used to call my university professors for advice in front of them. I was not sure if the medicine was right, the dosage was right. I needed authentication from my teachers. I still thought I was a student. That confidence in self, that courage to take the right decision and stick to it, did not come just by being made the in charge of a hospital.

The courage came in small doses, one step at a time. One right insemination, one right pregnancy diagnoses, one animal healed, one perfect delivery were the little stepping stones. I would not say I did not fail. I did. I made mistakes but I learnt from them and accepted them. I made little notes of questions about which I would seek clarifications. I learned the Punjabi words for the English ones I used. I started being a little brash despite being polite to the owners.

So, when one owner told me once that my suit was beautiful I snubbed him by telling him that I am a doctor. I stared angrily at him and locked my eyes with him. His eyes dropped down and I knew it was a small win. For women, the challenges in the field are multiple. It was not only about treating animals, it was about treating the centuries old, dilapidated mindset of men who equated women with an image of beauty and looking good. That you are a professional becomes secondary. Once I started asserting myself such incidents lessened in number and eventually disappeared. But I was always guarded.

If I went to the homes of people to treat their animals I was always on alert. Not only from the animal but from the owner as well. The occupational hazards, if I may call them, of working in the rural hinterlands of Punjab. But by then I was much stronger than who I was when I joined the job. I worked at Baghela from 2006 to 2013 before I left the hospital and Jalandhar district to join my in-laws who after retirement had settled in Hoshiarpur.

The times of my first posting are tinged with bitter sweet memories which need to be written and perhaps someday I would turn them into the book. But those initial years of my job not only gave me the confidence and courage to be myself they made me who I am. During the last year I was asked by a farmer to encourage her daughter and make her aware about the admission process. And this was not a sole request by a random villager I received numerous such queries for guidance propped up. And this summed up it all.

I was not only an ordinary veterinarian doing my job I was the symbol of emancipation for some people in that village. The people who were progressive, who did not saw me as a female but as a working entity, a professional and who dignified my work. And this gave me the power, the power to not only do my job but the power to change the fate of women who might not have had the same opportunities in life but who might be able to change something about their lives.

Our society is patriarchal and it can change only when women are given enough chances and given the education to make those chances available to them and to know the difference. The people in the village volunteering their daughters to make those options available to them was a sign of courage and hope for me. Them wanting their daughters to venture into a profession which is deemed male dominated in our society speaks volumes of a change. It's always little steps which augur big changes. And I value my role as a working female, as a field veterinarian in this scheme of things, in this journey of change.

Since 2006 things have undergone a sea change. I see more number of female veterinarians in the field that too working with more determination and less hesitancy. I am sure each of them has a bundle of stories shaping them up, stories of courage, resistance, facing it all up. I hope to see more participation of lady vets in the region. I do not assure them a smooth ride, it is never easy, the walls of fortitude are not built in a day like Rome. It takes days, months and years to get the dose of courage sometimes. Keep standing tall, keep doing your duty and just grow stronger a little each day. For the little things when summed up make it big and make it worth.

(The writer is the author of four books: Those College Years, Finding Julia, The Misadventures of a Vet, Maya.)

NEED OF ONE HEALTH APPROACH: PREVENTION AND PREPAREDNESS FOR FUTURE PANDEMICS

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Abstract

One Health is the collaborative efforts of multiple health science professions, working locally, nationally, and globally to achieve optimal health for people, domestic animals, wildlife, plants, and environment. One Health recognizes that the health of people is closely connected to the health of animals and their shared environment. At present, the global issues that require One Health approach include zoonotic diseases, antimicrobial resistance, food safety and food security, vector-borne diseases, environmental contamination, and other health threats shared by people, animals, and the environment. Therefore, significant investments in development of infrastructure for early disease detection, development of integrated laboratory testing facilities, development of robust surveillance system, production of vaccines and use of artificial intelligence are essential to combat the future pandemic threats.

Keywords*: One health, preparedness, pandemic, surveillance, vaccine*

Introduction

Emerging infectious diseases (EIDs) have had devastating effects globally, despite breakthroughs in the development of counter measures (diagnostics, treatments, and vaccinations) and greater global inter-connectedness the control of the infectious diseases is still difficult. The emerging infectious diseases pose a risk to both human and animal health leading to global instability (Coker *et al.*, 2011). Across the globe, a slew of new global public health problems has emerged due to many factors such as international trade and travel, urbanisation, intensive animal rearing practices, antimicrobial resistance, climate change, global warming, ecotourism and recreational activities leading to emergence of new ecological niches for infectious zoonotic pathogens.

The zoonotic diseases account for 60% of known infectious diseases and up to 75% of new emerging infectious diseases. The majority (70%) of emerging diseases (eg. Ebola, Zika, Nipah, encephalitis) and all known pandemics (eg. influenza, SARS, MERS, HIV/AIDS) are zoonotic in nature/origin, predominantly originating from wildlife. Majority of respiratory viruses have pandemic potential if they are not controlled early. Thus, a multidimensional effort is required to identify the precursors, pathways and precipitants of zoonotic diseases, so that appropriate prevention and control strategies can be applied. There is need to develop the one health framework including infrastructure

for the preparedness of future emerging pandemic diseases (Frank *et al.*, 2021). One Health approach mobilizes multiple sectors, disciplines and communities at varying levels of society to work together to foster well-being and tackle threats to health and ecosystems, while addressing the collective need for clean water, energy and air, safe and nutritious food, taking action on climate change, and contributing to sustainable development (Lebov *et al.*, 2017).

Thus, significant investments in development of infrastructure for early disease detection, development of integrated laboratory testing facilities, development of robust surveillance system, production of vaccines and use of artificial intelligence are need of the hour to combat the future pandemic threats as illustrated in figure 1.

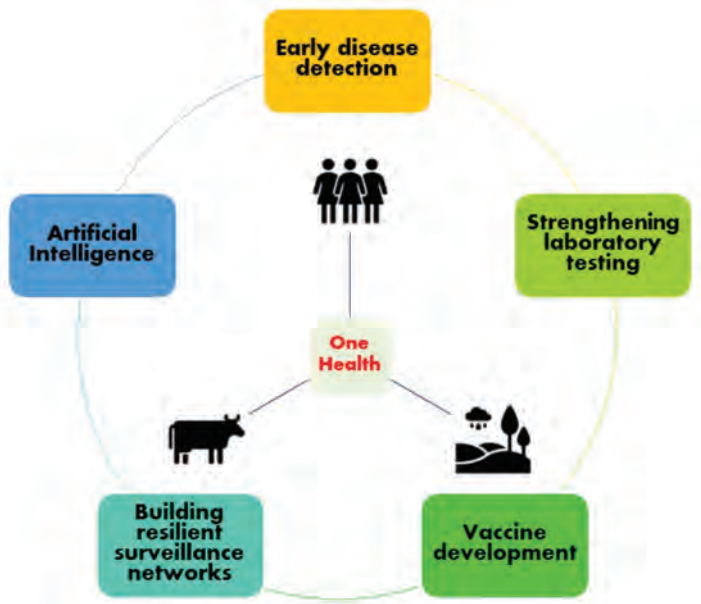


Figure 1: One Health components to tackle pandemics

Early disease detection

The extensive interactions among humans, animals, and pathogens across local and global level, may pose the establishment of a zoonotic pathogen having pandemic potential, thereby endangering the existence of millions of animals and humans. The initial identification of these threat may occur at the local level with the observation of sick individuals (people or animals) by either physician or veterinarian. But often, this initial observation is never reported beyond the local area because the disease is not recognised as unusual or does not spread, however in some cases, the recognition of initial cases may lead to the engagement of regional or national government authorities, as well as the possible involvement of international health responders. The early disease

detection programme can be risk-targeted monitoring, syndromic surveillance, or clinical diagnostic evaluation, at the same time the engagement of citizens, care providers, veterinarians, farmers, and others involved in collection of essential samples is critical to the success of such programs (Figure 2).

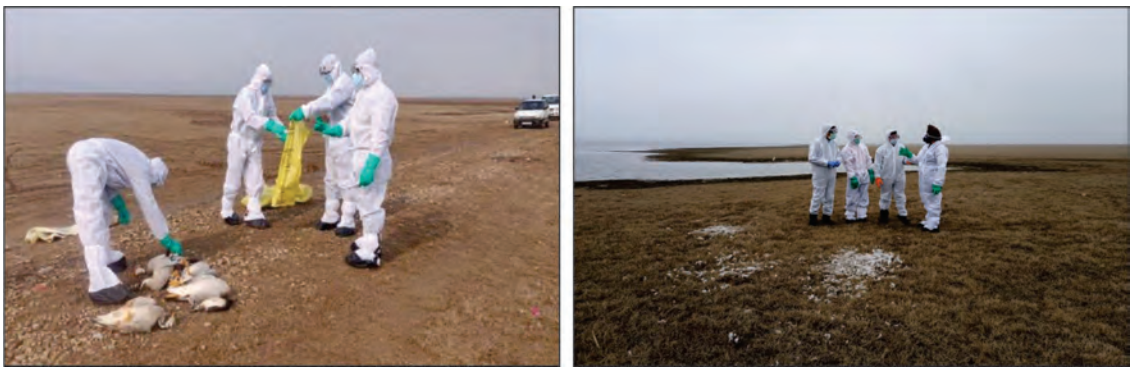


Figure 2: Collection of dead birds and site- inspection at the epicentre site of Bird flu outbreak

Further, the easy access to reference testing and verification is needed, particularly when symptoms are seen and a known causative agent can not immediately be identified. Establishing national and international networks between clinical laboratories, public health institutions and academia, and the ability to provide reference testing would be key to make this happen. Therefore, there is need to create centralised systems in which epidemiological and laboratory diagnostic tools along with the trained man power should be employed at national, state or local level especially at the high-risk human-animal interactions regions for the early detection of disease.

Strengthening laboratory testing

The advancement of diagnostics and the use of modern technologies has resulted in a significant rise in awareness of the microbial world and possible zoonotic infections that might harm human and animal health. The development of extremely sensitive and specific molecular tools based on nucleic acid amplification tests technologies, such as PCR, real-time quantitative PCR, and whole-genome sequencing has revolutionised pathogen discovery. An exciting area of diagnostics development in the past five years has been the growth of rapid diagnostics tests, or RDTs. RDTs used during COVID 19 pandemic has shown its effectiveness in surveillance and demonstrated its potential to alter the diagnostic possibilities. Despite the revolution and success of modern molecular and antibody detection techniques for identifying acute zoonotic pathogen infections, other techniques such as indirect fluorescent antibody assays, virus isolation and bacterial culture, histology, immunohistochemistry, and electron microscopy, remains extremely valuable and should not be overlooked.

In order to increase the diagnostic spectrum, the World Health Organisation (WHO) has developed a strategy named as 'Global Outbreak Alert and Response Network' (GOARN) which is a collaboration of integrated system of laboratories that provide guidance and assist local and national laboratories in disease diagnosis. Beyond the modern diagnostic equipment and collaboration, the growth and characterization of zoonotic pathogens necessitates well-equipped laboratories, higher biosafety and biosecurity infrastructure to protect investigators, specialised reagents, and highly trained laboratory staff to combat the upcoming disease threats and pandemics.

Vaccine development

The understanding of EIDs has developed during the past two decades. The SARS-CoV 2 pandemic shows that its high mortality and transmissibility has caused significant global disruption, thus, focused on urgent requirement of therapies like administration of vaccines. What makes COVID-19 pandemic more remarkable is the trails for checking vaccine effectiveness which were completed within 300 days rather than following a traditional approach which take around 5-10 years to develop a vaccine. Therefore, there is a need to develop new vaccine platform technologies that can shorten the cycle of chain of years and make it possible to rapidly develop, test and produce multiple vaccines on emergency basis. Another step that should be taken to circumvent a pandemic is the equal distribution of vaccination to all. The state and local health administrations should make decisions regarding how to distribute vaccines to the providers within their jurisdictions in an equitable and efficient manner, with the objective of initially reaching the priority groups.

In addition to other pandemic response and control strategies such as monitoring, communication planning, quarantine, and illness treatment, the deployment of effective vaccinations has the potential to save lives and prevent disease transmission. The development of effective vaccine is the key to control infectious disease outbreak and mitigating pandemic and epidemic risk (Excler *et al.,* 2021). To deal with the emergence of a pandemic, a pandemic preparation strategy that includes vaccine deployment and monitoring of adverse effects is required. The key to preventing a pandemic is to make vaccination a public good, available to everyone, everywhere, and everyone has a role to play in reaching the objective.

Building resilient surveillance networks

The primary objective of early disease detection is to build strong and resilient surveillance networks capable of identifying uncommon and isolated health events at the local level and connecting those observations with a highly qualified public health laboratory team. The human and animal health experts, as well as field ecology teams, must collaborate with the joint scientific and public health objective to detect the novel emerging infections as soon as possible from animal reservoirs and the human population.

Moreover, there is a need to collect standardised samples that reflect the human and animal microbiome (bacteriome and virome) at regular intervals and across nations in order to detect early threat from emerging and spreading in population.

Currently, at the global level, various agencies such as US Agency for International Development (USAID) Emerging Pandemic Threats Program funded "PREDICT" project and Global Early Warning System (GLEWS) are collaborating with communities and strengthening zoonotic disease surveillance activities and providing in-depth capacity building for human and animal health field and laboratory workers. Moreover, it also conducts regular active surveillance and laboratory detection for emerging novel zoonotic diseases in humans and animals. The PREDICT project's goal is to rapidly identify emerging novel viral threats to human and animal health by using techniques which detect new and unknown pathogens as well as capacity building to characterise and mitigate epidemic risk that could lead to pandemic. Furthermore, the GLEWS is primarily concerned with disease tracking, information sharing, disease analysis, risk assessment, and action. However, to be effective, these integrated techniques, surveillance programs need long-term, sustainable funding, investment in human resources, infrastructure, laboratory and communications equipment, as well as the establishment of local or regional monitoring centres.

Development of digital surveillance: Artificial Intelligence

Soon after the COVID-19 pandemic was proclaimed, the WHO signalled that artificial intelligence (AI) could be a significant tool for managing the pandemic's issue. AI is a non-medical intervention for overcoming the global health crisis and developing next-generation pandemic preparedness. AI-powered early warning systems can assist in the detection of epidemiological patterns by analysing current events, digital content, and other information channel to generate early warnings that can assist surveillance, healthcare networks and data flows (e.g. WHO Early Warning System, Bluedot). Currently, many countries are using population surveillance to track COVID-19 cases (for example, geolocation data, surveillance-camera videos and credit card records to trace coronavirus patients) and also established contact tracing systems to identify possible infection routes. Moreover, in hospitals, semi-autonomous robots and drones are being used to respond to the emergency demands such as delivering food and drugs, cleaning and sterilising, assisting physicians and nurses, and making equipment delivered. Furthermore, in several cases, AI systems have proved their ability to infer epidemiological data faster than traditional health data reporting.

Despite the fact that various studies on current COVID-19 pandemic have appeared, there is still a need of implementation of new innovative ideas to tackle disease threats and future pandemics. The continuous breakthroughs in modern technology have

benefitted the human and animal life, and there is a strong notion that established research plans incorporating AI would be extremely beneficial in supporting people in preventing future pandemics.

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FIELD VETERINARIAN-NEW CHALLENGES

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Veterinarians are often underestimated. Their work can be sweaty, smelly, physically challenging, and emotionally draining. The people who become veterinarians endure it all for the sheer love of the job and a deep rooted passion for helping animals.

The average veterinary hospital is open almost 6 hours a day. Most doctors and other veterinary staff work the entire time that the clinic is open. Even after closing, the staff must remain at clinic until each patient is stabilized for the evening. Just because the clinic is closed does not necessary mean you go home at closing time. Pets don't get hurt or sick by appointment. Vet clinics usually don't have dozens of support staff to handle a mad rush of patients. Vets and supporting staff work when the animals need them. Regardless of their responsibilities within the clinic, they serve the needs of animals with great care and compassion. In spite of all these efforts, following issues must be kept in mind while working as Field Veterinarian.

Cleint concerns: Animals were traditionally defined as property, but more owners now see their pet as a family member. It means they expect the best possible treatment for their companion. This can sometimes result in hostile clients who disagree with veterinarian approach and it can potentially lead to legal disputes. Even if a client is happy with the care, getting them to comply with your medical advice can be challenging. Make sure owners understand the importance of prevention in ensuring a pet has a long and healthy life. This can include maintaining a healthy weight, cleaning teeth, regular deworming and regular check-ups.

Knowledge update: It is increasingly important to promote and update your professional knowledge because vet services are no longer just offered in clinics. If your practice is clinic-based, you may begin to feel competitive pressure from local quacks and alternative care focused on more holistic and natural measures. Veterinary medicine is also becoming more specialized, with clients expecting their pet to be referred to a specialist for treatment or surgery. Also be aware some clients may turn to the Internet to make a diagnosis and treat their pet's conditions themselves.

Managing staff: Working at a veterinary clinic can be a physically taxing job. Vets and supporting staff are on their feet for most of their shifts and often end up working hours that span well beyond an eight-hour shift. They are also exposed to disease, the possibility of bites or other physical injury caused by animals, and heavy lifting. The job can be emotionally taxing when dealing with upset clients and sick or dying animals on a daily basis. Make sure your practice has protocols in place to ensure staff gets

proper breaks and are taking care of themselves mentally, physically and emotionally.

Proper record keeping: - Veterinarian is probably busier than most people you know. Instead of just accepting that you'll never have free time again, try to find ways to streamline you're working. May be you could convert to digital records instead of paper, or perhaps you should hire additional support staff so you can focus on the most important aspects of your working. There are likely numerous ways to make your life easier if you brainstorm a bit...

Wild animals treatment: While dealing with wild animals, following aspects must be considered.

- Minimize the animal's distress
- Utilize appropriate safety precautions
- If needed and not already done, contact the appropriate authorities with oversight of the species
- Ensure all records and documentation are accurate and complete

Zoonotic diseases: While working never forget the importance of zoonotic/ occupational diseases. Transmission may occur through various modes such as during veterinary procedures via urine, faeces, saliva, blood, tissue, airborne or droplets, through water or soil, digestion of food, or via direct contact such as animal bites or scratches. Significant zoonotic diseases include bacterial diseases such as anthrax, leptospirosis, brucellosis, tuberculosis, tetanus, cat-scratch disease, salmonellosis, campylobacteriosis, and yersiniosis; viral diseases such as Q fever, Crimean Congo haemorrhagic fever, and rabies; pyrogenic diseases such as toxoplasmosis, leishmaniosis, toxocariasis, cryptosporidiosis parasite; Creutzfeld- Jacob Disease (CJD), transmissible spongiform encephalopathy (TSE), bovine spongiform encephalopathy (BSE); or mycological infections such as aspergillosis. Taking precautions against zoonotic diseases is important in order to maintain working conditions and production and increase quality. The livestock owners should be informed about the pasteurization or proper cooking of milk and dairy products. Pet-owners must be provided with the necessary information when obtaining pets and should follow hygiene practices and vaccination calendars. Providing training on the care and hygiene conditions of pets and zoonotic diseases through awareness camps would be beneficial

Veterolegal cases: Veterinarians are the primary professionals investigating animal cruelty, conduct examinations, and become involved in legal investigations. Veterinarians are often responsible for the documentation of the physical findings of abuse, circumstantial evidences in case of poisoning, collection of associated physical evidence and provide expert opinions in a court of law. Forensic case not only involves domesticated animals

but also includes many other species. Specialised forensic investigations are likely to be the remit of the pathologist, the toxicologist and other specialists even though the preliminary examination of live or dead animals and instigation of supporting tests will probably long remain the province of the practising veterinarian. Veterinary forensics is a multidisciplinary approach that encompasses law enforcement, toxicology, veterinary medicine, entomology, anthropology, pathology, ballistics, botany, odontology, DNA analysis and other forensic analyses.

Remember following key points while dealing with vetero legal cases.

- The vetero-legal post-mortem examination is made in order to ascertain the cause of death and is done after receiving request report from police officials (FIR/ DDR).
- All descriptions should be concise and non-technical terminology used when possible because necropsy report ultimately may have to be understood by nonmedical people.
- All organ systems should be examined and all abnormalities described, even those usually regarded as incidental in a standard necropsy.
- Photo documentation is an important part of forensic necropsies. Throughout the entire necropsy, significant findings should be photographed. The photos could provide visual support to the identify the specimen and supportive during legal proceedings.

Other challenges: The biggest challenge for veterinary practitioner to keep themselves updated on the changing standards, emerging trends and new drugs, therapies and treatments in the field. Health challenges related to heartworm, diabetes and cancer continue to grow. Drug shortages and a lack of availability of human-label medications must also be considered and vets must be flexible both in how they administer drugs and which they use. It is also beneficial to maintain a community presence and address issues such as animal over-population and the importance of practicing an effective spay-and-neuter program.

Though working in a veterinary hospital has its challenges, but the rewards far outweigh the hard times. Our pets can't speak to us and tell us what hurts. Being able to connect with an animal to determine the nature of an illness or injury takes many skills. Using those skills to help restore a pet's health brings great joy that makes all of the stressful times worthwhile. Ultimately, for those who work in a vet clinic, happy and healthy pets are the greatest reward!

ENTREPRENEURIAL OPPORTUNITIES IN PROCESSING AND VALUE ADDITION OF MEAT

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Abstract:

Development of entrepreneurial attitude amongst youth and women is one of the integral approaches for holistic and sustainable economic growth of country. The role of animal husbandry is very prominent in this direction. The country has achieved self-sufficiency in terms of quality production and there have been attempts to widen the scope by introduction of easily adoptable processing technologies of livestock products, including meat. Novel value added products have been introduced which not only help in gaining consumer attention, but provides variety, convenience and helps in enhancement of shelf life. The role of GADVASU in popularization of these technologies through trainings, technology transfer and in-situ and ex-situ consultancy has helped promising entrepreneurs to establish their product line with multiple benefits. The scope of entrepreneurial ventures through meat processing and value addition is discussed in detail in this article.

Keywords*: Entrepreneurship, export, meat processing, technology transfer, value addition*

An excellent source of high quality protein, meat is considered as a vital part of human diet. In recent times, meat is gaining prominent position in Indian food basket (Mehta *et al.*, 2015). Apart from proteins, meat is also an important source of the vitamins, particularly B_1, niacin (nicotinic acid), B_2, B_6 and B_{12} and vitamin A. It is a major source of valuable minerals like iron, copper, zinc and selenium. Slaughtering the healthy animals and processing carcass in a safe, hygienic and wholesome manner is the prerequisite for the growth of this industry. Lot of efforts are being invested by both Central and state governments to give a strategic push to this sector. Although fresh meat provides key avenues to the producers and manufacturers, however, for boosting their income and profitability, processing and value addition has been looked upon as a promising solution.

In the fiscal year 2020, total meat production in India amounted to over 8 million metric tonnes (approx. 8.60 million metric tonnes) with per capita availability of approximately 6.45 kg/ year. According to APEDA, as far as export potential of meat is concerned, India has exported 774.11 MT of processed meat to the world for the worth of Rs. 11.92 Crores/ 1.62 USD Millions during the year 2020-21 (APEDA, 2021). The major export destinations include Hong Kong, Qatar, Bhutan, Myanmar etc. As evident, the sustained livestock production which ensures both food and financial

security to majority of Indian population is largely dependent on efficient utilization of livestock products. Processing and value addition has emerged as a promising tool to cater diverse concerns. Value addition of meat is referred to the enhancing nutritional value, economic and health benefits through the processing into designer and health oriented meat products by incorporating various functional ingredients and with use of other techniques such as tenderizing the tough meat, preparation of cut of parts and utilization of slaughter house byproducts to develop valuable products (Kausar *et al.*, 2019). Value addition and processing is instrumental in enhancing economic value of meat product by changing its current place, time, and form to characteristics that are more preferred in the marketplace. With rapid industrialization, urbanization, increase in disposable income, nuclear family, education and awareness, the market for value added products has seen an increasing trend. Meat processing industry has been continuously improving productivity and efficiency by applying various latest technologies. Producers have a challenge to be responsive to consumer demands by producing what is desired by the consumers and market response. Hence, the concept of value addition is not only improving the functionality of meat products for enhancing nutritional value but increasing profit margins of the producers with a great deal. As discussed earlier, India is a leading exporter of fresh bovine meat and most of the income (95%) is generated through the same. This can be visualized as a profitable venture with interventions of value addition methodologies. Processing of meat into various value added products for domestic consumption and export can really benefit economically. As per estimates, only 3% of total meat produced in our country is processed into value added meat products, thereby the scope for expansion seems to be immense.

The linkage of processing and value addition with entrepreneurship development, particularly amongst youth is getting well established. Development of entrepreneurship skills is directly related to the socio-economic development of the society. The growth of the modernization process i.e. industrialization, urbanization and migration further encourage it. First, they provide greater opportunities for productive employment and secondly, they function as an instrument of social change. The socio-economic development of the country is attained only when the society create a large number of entrepreneurs from strata of population. Coupled with motivational profile, there are certain personal qualities which are found in successful entrepreneurs. They take initiatives and are persistent in their approach. Further, they seek information and subsequently generate new one which bears an element of innovativeness. Processing and value addition of meat indeed provides a better platform as it increases convenience to consumer through reduced in preparation time and minimizing processing steps. Alongside it ensures sustainable demand for the products, improvement of safety and product attributes such as appearance and taste. Cost reduction, competitive pricing and byproducts utilization leading to sustainability

of meat industry and an overall increase in the value of product are the key features. But this needs capacity building in an integrated manner which is required to equip and improve human resources with necessary skills to handle the multifaceted needs of meat processing sector. Government's Skill Development initiative stresses on devising competence based trainings and course curriculums for budding entrepreneurs to help them in gaining insights on developing, marketing and merchandising their produce.

Guru Angad Dev Veterinary and Animal Sciences University (GADVASU) is committed to inculcate the entrepreneurial attitude and skills amongst youth and women. In this pursuit, various entrepreneurship development programs have been conducted in the field of meat processing and value addition. The department of Livestock Products Technology has designed a model to boost entrepreneurship by providing them hands on training in processing, preservation and marketing of meat. Technical know-how is shared with interested entrepreneurs by signing memorandum of understanding with them which indicates a firm hand holding to help them in dealing with the produce from farm to fork. On-site demonstrations and trainings are also imparted to them as per the need and demand. Various technologies of meat processing have been transferred to promising entrepreneurs like shelf stable pork pickle, ready to eat meat snacks, health oriented meat products etc.

Meat processing sector is a sunrise sector with immense potential. The target to have a spiking growth can be achieved with adequate interventions like value addition and processing. Financial and technical assistance from government and non-government agencies is equally important for the promotion of this sector. The roles of research and academic institutes is important to make the enterprise of meat production and processing economically viable through generation of ideas that can help them to make more profit, leading to expansion of interest by startups. It is equally important to make entrepreneurs aware of governmental policies and incentives from time to time. It's a need of an hour that we should help making our promising youth self-reliant so that they can strive for becoming job creators than job seekers.

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AN IN-DEPTH ANALYSIS OF INDIAN PIGGERY INDUSTRY

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Abstract

With an increase in global population, pressure on land has increased immensely for fulfilling the nutritional requirement of growing population. In this context, piggery industry offers many advantages for meeting future food demand due to certain inherent traits like high fecundity, better-feed conversion efficiency, early maturity and short generation interval. Though, Indian piggery industry has remarkably contributed to increase in farmers income yet it is in budding stage, owing to certain challenges such as absence of sufficient number of breeder farmers, lesser availability of quality pigs, lesser consumers preference and religious taboos etc. So, channelized efforts are required in all sectors including conjoint involvement of the state governments, the universities, the farmers, different industries concerned with pig and its product.

Keywords*: swine production, farmer income, pork industry,*

Introduction

Animal husbandry and livestock sectors are critical for rural livelihood and economic development of the country. India possesses one of the largest livestock wealth in the world and a quarter of the agricultural gross domestic product is contributed by the livestock sector. Among the livestock species, pig finds an important place as it being reared by socio-economically weaker sections of the society. Pig as compared to other livestock species has a great potential to contribute to faster economic return to the farmers, because of certain inherent traits like high fecundity, better-feed conversion efficiency, early maturity and short generation interval. Pig farming also requires small investment on buildings and equipments. It has immense potential to ensure nutritional and economic security for the weaker sections of the society.

Current scenario

In India, pig farming sector is highly un-organized and 70% of the pig population is reared under traditional small holder, low-input demand driven production system, except for limited number of semi-commercial pig farms in Kerala, Punjab and Goa (Annual report, 2019). The typical production system consists of a simple pigsty and feeding comprises locally available grains, vegetables and agricultural by-products

along with kitchen waste. Also, the distribution of pig population across the country is not uniform, for instance, majority of swine population is recorded in the eastern (2.8 million) and north-eastern (4.5 million) states; highest in Assam (2.10 million), followed by Jharkhand (1.28 million), Uttar Pradesh (0.41 million), West Bengal (0.65 million) and Nagaland (0.40 million)(20th Livestock census, 2019). Thereby, a large proportion of pig population is reared in the tribal belts of the country where the people are non-vegetarian. The genetic potential of Indian swine industry has not improved greatly in comparison to the exotic breeds since currently only 20% of the pigs kept in India are crossed with exotic breeds and in the remaining swine population inbreeding is practiced owing to nonsystematic breeding and selection strategies. In nutshell, the pig rearing is still unorganized venture that requires science and technology driven support to make it a vibrant enterprise.

Demographics

The total pigs in the country have decreased by 12.03% over the previous census and the total pigs in the country are 9.06 million as per 20th livestock census. The total Pigs contribute around 1.69% of the total livestock population. Out of the total population, number of males are 4.66 million (3.46 million indigenous and 1.20 million exotic) and 4.50 million are females (3.40 million indigenous and 1.10 million exotic). As per Census data, there is a change in population of indigenous and crossbred/exotic pigs in India. The majority of the pig population in India is of indigenous breeds (76 percent) though population of cross-bred and exotic pigs decreased by 22.78 percent from year 2012 to 2019) (19th Livestock census, 2012). The trends shows that the major share of the pig population is indigenous pigs, the level of population was almost steady from 1992 census. However crossbred pigs were 23.90% in 2012 and reached to 20.97% in 2019.

Pork Meat Scenario in India

Pork production in India is limited, representing only 4.82% of the country's animal protein sources. Production is concentrated mainly in the northeastern corner of the country and consists primarily of backyard and informal sector producers. According to 20th Livestock Census of India (2019), the total swine population, while small, has declined in comparison to the previous census. In the most recent decade, the population has declined to approximately 9.06 million head from a high of 14 million in 2003, as indicated by the 20th Livestock Census of India. The meat production in the country as per 2019-20 data was 8.6 million tons with a per capita availability of 5.2 kg. The Indian market for processed pork products is small, and the majority of this market is supplied through imports. Although there are some local companies which manufacture processed products such as sausages and bacon, quantities are limited and the industry is small. According to MoFPI, there are 3600 slaughter houses in India, although the majority of

these facilities do not export. There is a small number of abattoirs in India which meet international standards. However, these facilities do not process pork meat.

Pork consumption

In the next ten years, it is predicted that the total consumption of meat in India will double from its present numbers. As per capita income of individuals rises, they tend to spend on improving their lifestyle and food consumption habits. Pork consumption is negligible in India, with the exception of the north-east while it is a major item elsewhere. In the European Union, 42.6 kg pork is consumed per person every year, while in the US, 29.7 kgs are consumed (FAO report, 2019). Pork is a staple for Chinese, and so over 35 kg are consumed per person per year. Indian pork consumption can be divided into two segments:

1. The vast majority takes place in the informal sector in the form of locally raised fresh pork meat. This meat is not widely distributed in the organized retail sector. Given cultural perceptions and consumer perceptions about pork meat, consumption of fresh local meat is limited to north eastern India where pork consumption is more prevalent.
2. The second segment of the pork market deals with high-value imported products. These products include cured meats such as sausages, ham, bacon and canned meat products, as well as small quantities of frozen meat. They are typically found in most leading Indian hotels catering to international business travellers and tourists. Additionally, there is demand for imported pork products amongst well-travelled Indian consumers and foreigners residing in India. Processed products such as sliced meats, hams, bacon and sausage can be found in specialty shops and high-end restaurants.

Gap Analysis in the swine industry

The per capita consumption of meat in developed/industrialized countries is much higher compared with developing countries. Consumption of meat in the USA is 124 kg per capita per year (340 g/day). The global average meat consumption is 38 kg per year (104 g/day). Countries whose population consumes the least amount of meat are located in Africa and Asia. The ten lowest-ranking countries in meat consumption consume 3–5 kg per capita per year. However, in case of India, it is much less in comparison to even African countries such as Ethiopia, where the average annual meat consumption per capita is estimated to be 8 kg/year as compared to India's per capita meat availability being only 5.2 kg per year (BAHS, 2019-20). Thus, it is apparent that there exists a huge gap of meat availability between India (5.2 kg per year) and the global average of 38 kg per year. Analyzed from the point of required nutrition, as per WHO standards, the daily requirement of protein is 63 gm per day. In average Indian diet conditions, 50.75 gm per

day per person (approx.) for the vegetarian population, and about 55.25 gm per day per person (approx.) for the non-vegetarian population is available. Notwithstanding this, the average deficit of protein requirement is approximately 12.25 gm for vegetarian and 7.75 gm for non-vegetarian. Moreover, by 2050, it is expected that the population in India would increase by 34% and to fulfill the dietary recommended levels of the livestock products by Indian Council for Medical Research (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. This means that the current level of production, the milk, meat and eggs would have to increase by 1.5, 3 and 4.7 times respectively. Fulfilling the feed demand of this huge livestock from same resource base of land and water is going to be a huge challenge.

Pig farming has the potential to fill this huge demand of animal protein in India in coming days. In comparison to other livestock rearing, the advantages of pig farming are extremely high. The growth rate of the pig farming business is very high. Within a short span of time, one can increase the quantity of livestock as pigs are the most prolific breeders with high fecundity and shorter generation interval. A sow can be bred as early as 8-9 months of age and can farrow twice a year. They have a very short gestation period of 114 days and able to produce 6-12 or even more piglets in each farrowing. Pig farming provides quick returns since the marketable weight (80-100 kg) of fatteners can be achieved at the age of 7-9 months. Among various livestock species, pig has the highest feed conversion efficiency (1.6) and dressing percentage (60 to 80%) after broiler, as they produce more live-weight. Pigs can utilize wide variety of feed stuffs viz. grains, forages, damaged feeds, vegetables and garbage and convert them into valuable nutritious meat.

Pork provides one of the most nutritious meat with high fat and low water content and has got better energy value than that of other meats. It is rich in vitamins like thiamine, niacin and riboflavin. Besides, piggery being an employment opportunity for farmers, it has also a commercial value as source of store fat/lard for which there is an increasing demand for poultry feed, soap, paints and other chemical industries. There is good demand from domestic as well as export market for pig products such as pork, bacon, ham, sausages, lard, bristles or hair etc. Pig's manure is widely used as fertilizer for agriculture farms and fish ponds. So, one can say every part of the pig's body is usable in various commercial industries that can be used by a farmer if he is well versed with the pig physiology. Another great advantage of pig farming business is that, one can start with a small amount of money which reduces the financial burden.

Challenges

According to the FAO, animal protein production will grow at least 3 times by

2050, and meats (poultry, swine, and beef) will double while fish production will be multiplied by almost 10 times. An increase in intensification is inevitable, because arable land cannot be increased in proportion. The key challenge will be to produce sustainable food and, of course, sustainable feed to raise our animals, with limited availability of resources and with the need to reduce pressure on the environment. The main Challenges of Swine Production in India are summarized as follows:

- Absence of sufficient number of breeder farmers throughout the country is a major constraint leading to lesser availability of quality pigs for fattener farmers and market.
- Tendency of the pig grower to raise pig to marketable age on zero to negligible inputs and lesser preference of the consumers for pork from the local pigs etc.
- Religious taboo attached with pork consumption is also a weakness for which marketing of pork has to be confined to a selective group.
- Over 20% of the pigs kept in India are crossed with exotic breeds, but with a large amount of inbreeding because of non-systematic breeding and selection.

In nutshell, the pig rearing is still unorganized venture that requires science and technology driven support to make it a vibrant enterprise. The various stakeholders require promotion at various levels such as technology, entrepreneurship development, and financial support to bring Indian pig farming at global level. Further, the shrinking resources in terms of land availability, water as well as threats from the changing environment being conducive for emergence of new diseases are gradually expected to limit the capacity for pork production optimization.

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STUD FARMING IN PUNJAB; REPRODUCTIVE ASPECTS

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Abstract

Marwari horses tradition is turning into a successful entrepreneurship in Punjab. According to the 20th Livestock census there are 3.4 lakhs horses and ponies in the country as compared to 6.2 lakhs in 2012 (19th livestock census). The total population of horses and ponies decreased by 45.6% in the last 7 years. Punjab ranks 7th among the states for horses and ponies population. The 56.66% decline in horses and ponies population directs to investigate the causes and timely management of the common reproductive disorders in equines such as anestrus, repeat breeding, cystic ovarian disease, ovarian tumors, abortions, dystocia, retention of placenta and uterine torsion. The selection of the future stallion can be done at birth of foal. It depends upon the foal pedigree, breed characteristics, body conformation and proper buildup of the foal. In Marwari breed the weight of foal (future stallion) must be > 45 kg at birth. Semen freezing is good idea for horse breeders of Punjab for maximum utilization of good pedigree stallions and it also helps in cryopreservation of genetics of top quality stallions and to avoid the spreading of contagious diseases among the equine population of the states.

Key words: *Marwari, stud farming, reproductive disorders, seasonal polyestrus, semen freezing*

Introduction

Horses have been a part of indian culture for centuries. India is home to some of the finest breeds of the world (Marwari and Kathiawari etc). Nowadays horse breeding turning to a successful business opportunity among the farmers. Every year different state and national level horse shows are been organized across the country. The prize money for the champion animals for different categories in different horse shows may varies from Rs. 31000 to 1 lakh. This plays vital role in upgrading the economics and management of horse result into improvement in quality of animals and rearing standards constantly. The covering fees of good pedigree Marwari stallion varies from Rs. 31000 to Rs. 125000 in Punjab. Nowadays the value of show quality Marwari colts and fillies (yearlings) is estimated between Rs. 10 - 25 lakhs. These factors are contributing in the conversion of traditional stud farm into successful entrepreneurship.

According to the 20th Livestock census there are 3.4 lakhs horses and ponies in the country as compared to 6.2 lakhs in 2014 (19th livestock census). The total population of horses and ponies decreased by 45.6% in the last 7 years. Punjab ranks 7th among the

states for horses and ponies population. Marked decrease in population of this species is also observed in Punjab from 32,860 (19th livestock census) to 14,656 (20th livestock census 2019). The 56.66% decline in horses and ponies population directs to investigate the causes and timely management of the common reproductive disorders in equines such as anestrus, repeat breeding, cystic ovarian disease, ovarian tumors, abortions, dystocia, retention of placenta and uterine torsion

Horses are said to be 'long day breeders' and seasonal polyestrus because their cyclicity depends upon the increase in photoperiod. Under tropical conditions mares starts their reproductive cyclicity as the day length reaches upto 10 hours a day (February - March) this is called transitional period of breeding of mares having variable estrous cycle length. Mostly the mares turn active to initial estrous cycles of the breeding year and their bean shaped ovaries starts gaining the size approximately 3-4cms with 2-3 waves of numerous large follicles (≥25mm). During this transition season mostly ovulations fails to occur and the end of this phase is marked by surge of luteinizing hormone that stimulates ovulation. When days length reaches upto >12 hours (April – August) mares completely turns to regular 21 day intraovulatory estrous cyclcity with estrus length of 4-5 days. Ovaries become large (4- 6cms) and soft and starts developing the ovulatory follicles at each estrous cycle of breeding season. As the day length starts decreasing again during (September- November) ovarian size starts reducing at the initial transition phase the only few mares having prolonged their estrus phase length and there percentage increases as the season progress towards winter months (Sertich 2020). During the peak winters (December – January) mares reproductive cyclicity temporarily suspended for a few months due short day length <8 hours. Ovaries become small (1.5-2cms), hard and smooth with no follicular development this phase termed as a anestrus period.

Common reproductive Disorders

1) Anestrus: Lack of estrus is most common in mares due to markedly shortening of day length and reduced size of ovaries which cannot support the follicular growth. Anestrus during transition and breeding seasons can be treated after proper clinical diagnosis. This condition may occur in lactating mares, clinical endometritis and barren mares. Anestrus can be treated by giving injection estradiol cypionate 0.5mg I/M or Buserelin acetate 40µg I/V or I/M.

2) Repeat breeding (RB): Animal fails to conceive after 3 or more consecutive breeding. The clinical and sub clinical endometritis developed during excessive (>2) coverings during the estrus phase resulted into post mating induced endometritis (PMIE). The incidence of PMIE increased by many folds 20-30% during off season due variable estrus length. Various techniques are available for diagnosis of this condition such as uterine cytobrush, uterine swab and uterine low volume lavage. These techniques are efficient for picking accurate

uterine endometrial samples which enhances the accuracy for the diagnosis of RB. The treatment regimen includes uterine flushing with normal saline (500ml) alone or in combination with Antibiotics (e.g. gentamicin 40 ml or cephalexin 4 g etc) and disinfectant (0.5% solution of Povidine iodine) intrauterine during estrus followed by injection oxytocin 20-25 I.U. intravenously is quite helpful in clearing the uterine mucous. Modern approaches for curing the endometritis by using mucolytic agents such as N-acetyl cysteine (NAC) 5% (3g in 60ml normal saline), Hydrogen peroxide (H_2O_2) 3% in 100ml normal saline and Dimethyl sulphoxide (18 g DMSO) 30% solution

Immunomodulators can also be used such as E.coli LPS (100 µg), Mycobacterium cell wall extract (MCWE) 1500 µg and Glucocorticoids (50mg Dexamethasone) with or without antibiotics based upon culture sensitivity test.

3) Cystic ovarian diseases (CoDs): There are commonly two types of ovarian cysts.

   a) Follicular cyst: This condition occurs when increase in size of follicular >45mm. and follicle persist for many days without ovulation. The common signs are nymphomania, cheesey uterine mucous, estrus length is about 8-10 days and split estruses etc. This condition can be managed after proper diagnosis based upon ultrasonography and clinical signs. It can be treated by administration of injection human chorionic gonadotrophin (HCG) chorulon 2500- 3000 I.U. intravenously or buserelin acetate 20µg I/M or I/V. ovulation is seen within 36-48 hours after treatment regimen.

   b) Luteal cyst: Anestrus is most common signs in this condition due to prolonged diestrus. Sometimes animal takes months to return into normal cyclicity. This condition can be diagnosed by ultrasonography on two successive examinations on 10 days interval for persistant corpus luteum. The early diagnosis of this condition is necessary to save the time and cost of rearing of the farmer and also to achieve desired fertility rate of farm. This condition can be managed by giving injection cloprostenol sodium 500 mcg I/M and same dose can be repeated on 14^{th} days of 1^{st} injection if animal is not returned to estrus.

4) Ovarian Tumors: The granulosa cell tumor is the most common in the mares. A clinical diagnosis can be made based on the ultrasonography and presence of enlarged one or both ovaries. Endocrine testing may be beneficial to confirm a diagnosis. Surgical removal of the tumor eliminates the adverse effect on pituitary function and results in resumption of follicular development and ovulation in the opposite ovary overtime.

5) Abortions: The normal gestation length in mares varies between 320-360 days

but due to any of the circumstances gestation length less than the normal is considered as abortion. There are many causes of abortion in equine such as uterine infections (bacterial, fungal and virus), twinning, low level of pregnancy hormone. In a retrospective survey of Punjab for last 5 years the incidence of early gestational pregnancy losses between day1- 90 is very much high (14-15%) followed by mid gestational from day 90-210 (7-8%) and late term abortions >210days is (4%) (Mahal *et al.*, 2021).

6) Dystocia: The fetal position is mainly responsible for dystocia in equines due to very long extremities. About 60% of equine dystocia occurs due to wry neck condition with displacement of head and neck towards lateral side, 20% due to breech presentation, 10 % dystocia due to monster fetuses and remaining due to other postural defects. It is difficult to handle equine dystocia due to strong uterine expulsive forces and therefore, sometimes mare needs mild sedation and proper epidural anesthesia for proceding the dystocia cases. The incidence of dystocia of mares in Punjab is 4-5% (Mahal *et al.*, 2021).

7) Retention of placenta (RoP): In equines normal timing of placenta expulsion is 15-20 minutes but if placenta is not expelled within 3 hours of parturition then it is termed as RoP. This condition mostly occurs in dystocia cases and it increases the incidence of ascending placentitis which further causes sub clinical and clinical endometritis in mares. The incidence of occurrence of ROP cases is 4-5%. Retention of placenta can be easily managed by using various ecbolic (e.g. inj. oxytocin 20- 25 I.U. or inj. Methylergometrine maleate 2-5 mg etc) followed by parentral administration of antibiotic therapy at least for 4-5 days along with manual removal of the remaining placenta within the uterus to eliminate bacterial infection. Inject tetanus toxoid 3ml I/M as additional therapy to equines while handling any ROP case.

8) Uterine Torsion: This is uncommon condition in equine reproduction. But it is life threatening to dam as well as foal. The incidence of uterine torsion in Punjab is 2-3 % (Mahal *et al* 2021). The condition causes colic. It mostly occurs during mid to late gestation and needs early diagnosis and surgical intervention (caesarean section under general anaesthesia).

Stallion Selection and Management

- The selection of the future stallion can be done at birth of foal. It depends upon the foal pedigree, breed characteristics, body conformation and proper buildup of the foal. In Marwari breed the weight of foal (future stallion) must be > 45 kgs at birth and minimum six months weaning period is necessary to achieve healthy BCS (3-3.5/5). The creep ration for the foal can be started at the age of 2-2.5 months with

250g initially with addition of 300- 400g every month upto six months of age. The basic formulation of creep ration is having protein 18%, Fat %, Energy 14%, Fibre 8% and 2% mineral mixture. Proper deworming schedule followed initially at day 15 (syrup Piperazine citrate 30ml orally), day 30 (syrup albendazole 30ml orally) followed by 3-4 times deworming annually with calculated dose rate. The recommended vaccination schedule is given in table 1.

- The feed formulation for yearling and stallion contains protein 15%, fat 6%, energy 18%, 10 % fiber and 2% mineral mixture. The balanced feed should be provided to horse @ 1-1.5 kg/100 kgs body weight.
- The stallion should be examined with various semen fertility tests and venereal diseases (contagious equine metritis CEM etc) before the start of breeding season. Minimum 1-2 coverings/ mare/ estrus allowed to reduce chances of PMIE. To avoid over utilization of stallion two coverings/ day twice a week pattern must be followed to achieve maximum fertility rates. The tradition of excessive utility of stallion by horse breeders' which results in increasing the incidence of repeat breeding in Punjab and percentage of barren mares is increasing every year. A stallion can easily cover 45-50 mares/ breeding season (Bredford 2016).
- Covering area should be grassy and dust free to prevent environment contamination during crossing of the mares.
- A horse with poor body conformation (carpus valgus, club foot, long back, sickle hock etc) and inherited diseases (wobbler syndrome etc) is never be used for breeding purpose.
- Semen freezing is good idea for horse breeders of Punjab for maximum utilization of good pedigree stallions and it also helps in cryopreservation of genetics of top quality stallions and to avoid the spreading of contagious diseases among the equine population of the states.
- The ejaculate volume of stallion varies from 30-250 ml with average sperm concentration of 120million/ml and the total ejaculate concentration lies between 7-10 billion with average 60% normal morphology and progressive motility.
- The 15-20 doses of semen (straws) can be developed from single ejaculate of stallion with minimum concentration of 500 million sperms/dose. Acceptable post thaw motility of equine semen is ≥35% (Charles 2012).

Table 1: Vaccination schedule against important diseases of horses

Horse age	Vaccination	Booster dose
3 months	Tetanus toxoid	Every 6 months
6 moths	Equine herpesvirus	Yearly
4-6 months	Rodococcus equi (rattles)	Yearly
6-9 months	Equine influenza (intranasal)	Every 6 months
6-9 months	Rabies	Yearly

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EQUINE COLIC: AN APPROACH TO DIAGNOSIS AND MANAGEMENT

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Abstract:

Colic is one of the leading causes of mortality in horses. There are many gastrointestinal causes responsible for equine colic. Understanding of the pathophysiology is important to elucidate the underlying cause of the problem. Knowledge of the predisposing factors along with thorough history, clinical examination and laboratory evaluation are important steps to reach at confirmatory diagnosis of the most probable cause. Early and accurate diagnosis forms the pillar for correct treatment and management of colic patients.

Keywords*: Equine colic, pathophysiology, diagnosis, treatment*

Colic or abdominal pain is frequently observed clinical manifestation seen in horses suffering from a number of gastrointestinal and non-gastrointestinal abdominal disorders. The colic episode may be acute or chronic and recurrent in nature. Four basic causes of pain are distension of gut with gas, fluid or ingesta, stretching on the root of mesentery, ischemia or infarction, and deep ulcers in stomach or bowel. A careful consideration of the history, presenting signs and a systematic clinical examination along with suitable laboratory data will help the veterinarian to elucidate the cause of the colic. Affected horses may be anorectic, depressed, restless, frequently lay down or get up, roll, grunt, sweat and kick at the abdomen. In severe cases, there may be cardiovascular complications including increased heart rate (HR), prolonged capillary refill time (CRT), cold extremities, and bright red mucous membrane (MM) initially followed by dark MM in later stages. Low grade recurrent pain may occur due to presence of foreign bodies such as sand or enteroliths in large colon. Acute visceral pain may be observed when fecolith is present in the transverse colon causing complete obstruction (Ihler *et al.*, 2004; Smith 2015). Parietal pain associated with peritonitis is usually observed on external palpation and animals are usually reluctant to move whereas in visceral pain, animal will show active signs of colic.

Pathophysiology of equine colic

1. Anatomic and functional factors predisposing horses to develop colic

- Horses being hind gut fermenters so indigestible fiber has to pass through a simple stomach and small intestine
- Inability of the horse to vomit
- The unfixed position of left colon
- The long mesentery of small intestine
- Upward movement of ingesta and narrowing of lumen at the pelvic flexure
- The cecum is a blind sac
- Termination of the right dorsal colon into much narrower transverse colon

Primary disturbance in all colic cases is distension of the stomach or intestines. It may be static due to accumulation of ingesta, gas or fluid (physical colics) or transient due to periodic distensions as a result of a spasm and increased peristalsis of intestinal segments (functional colics). A secondary cause of abdominal pain is stretching of peritoneum because of entrapment of viscus and stretching of its mesentery. Abdominal pain though exhausting does not kill the animal. In fatal colic like acute intestinal obstruction, dehydration (due to sequestration of fluid and electrolytes) and/or shock (due to infarction and occlusion of blood supply) that kills the animal. Hyponatremia and acidosis are the other two life threatening accompaniments. The ultimate rupture of stomach or intestine resulting in deposition of toxic ingesta or fecal contents into the peritoneal cavity causes profound shock and death within few hours. In impaction, if not treated well in time, the cause of death is assumed to be combination of exhaustion due to pain, autointoxication, and deprivation of food and reflex effects of continuous distension of intestines on the cardiovascular system (Smith 2015)

2. Non-strangulating simple obstructions

Simple obstructions result from luminal obstruction without concurrent vascular strangulation. Common causes are ascarid impactions, food or foreign body impactions, hypertrophy of the ileum, pedunculated lipomas, abdominal abscesses, adhesions and neoplasia. Though morphological damage in these cases is usually minimal but continued pressure at the obstruction site or development of strangulation may cause significant intestinal damage. In the partial obstruction, there may be mild pain until there is complete obstruction in which fluid and electrolytes accumulate in the lumen leading to dehydration and hypovolemia. In proximal intestinal obstructions, acidic gastric fluids are sequestered or lost and continued absorption of alkaline pancreatic secretions leads to metabolic alkalosis. However, due to prolonged duration and development of hypovolemic shock, horses often develop metabolic acidosis (Smith 2015). In contrast,

in distal i.e., jejunal or ileal obstructions, initially acid-base status remain within normal limits until fluid fill the intestine proximal to the obstruction and reach the stomach. So, metabolic acidosis develops secondary to hypovolemia in the late phase. Rectal palpation reveals distended loops of small intestine. Peritoneal fluid examination finding is usually unremarkable.

3. Strangulating obstructions

These include volvulus, internal (epiploic foramen entrapment, omental and mesenteric defects) and external (inguinal, umbilical and abdominal wall and hernias) obstructions. Obstruction of intestinal lumen is often accompanied by interruption of the intestinal blood flow. Depending on the degree of vascular occlusion, intestinal mucosa may develop mild to severe hypoxic and ischemic injuries. Loss of mucosal barrier leads to systemic and/or peritoneal absorption of bacteria and endotoxins. Sufficient amounts of fluid and electrolytes accumulate proximal to the obstruction and combined with endotoxin mediated shock led to metabolic acidosis and severe alterations in cardiovascular function. Peripheral perfusion at this stage is significantly reduced leading to further tissue hypoxia, anoxia leading to anaerobic glycolysis and lactate formation.

4. Non-strangulating infarctions

One cause for intestinal infarction is migration of *S. vulgaris* larva from the intestinal lumen to the cranial mesenteric artery causing thrombus formation leading to reduced intestinal perfusion. Other cause for infarction is hypovolemic shock which may lead to systemic hypotension and reduced intestinal tissue perfusion. Pathogenesis in these conditions is usually ascribed to a thromboembolic event leading to obstruction of vascular supply. These emboli break off from the thrombus formed in the cranial mesenteric artery or ileocecocolic artery leading to vascular obstruction and intestinal ischemia (Smith 2015). In some cases, intestinal infraction may be seen without the presence of emboli. It is assumed that vasoactive substances such as thromboxane liberated from activated platelets could have caused potent vasoconstriction, leading to low flow and tissue infarction.

5. Large intestinal disorders

Disorders of the large colon usually include colonic impaction with ingesta, sand impactions, enteroliths, foreign body obstructions, left and right dorsal displacement of ascending colon, colonic volvulus and colonic intussceptions. Impactions with the undigested fiber or infarction due to verminous arteritis are the two major pathologies of colic of large intestine. Colic in this case is usually subacute and has a protracted course amenable to medical treatment in case of impactions or incurable in case of infarctions. Dehydration and shock are two major pathopysiological events in most displacements, foreign body obstruction and volvulus cases though in most of these conditions,

pathogenesis is not clearly understood. The distension of large bowel is mainly due to gas entrapment rather than fluid accumulation. Acute intestinal accidents like that of small intestine involvement do occur when small colon is involved. Simple luminal obstructions in small colon may result from primary impaction, foreign bodies, fecoliths, phytobezoars and trichobezoars. Meconium retention in foals, intramural hematomas and strangulating obstructions are the other pathologies of the small colon though the latter two are rare in equines.

Disorders of cecum include cecal tymapnitis, cecal impaction and cecal intussception. Cecal tympanitis usually occurs secondary to other problems such as large colon obstruction. Rectal examination is helpful in diagnosis of large distended cecum on the right side of the abdomen. Cecal impaction could be a primary condition attributed to poor nutrition and dentition, dietary changes or previous colic or a secondary condition as a post operative complication. Cecal intussception may involve intussception of either apex of cecum (cecocecal) or the cecum into right ventral colon (cecocolic). The factors implicated are verminous arteritis, *Anoplocephala perfoliata* infestation and intramural masses which could be palpated on rectal examination. Cecal volvulus usually occur secondary to large colon volvulus and may result in systemic shock (Smith 2015).

6. Peritonitis

Contamination from a single point source can spread bacterial infection throughout the entire peritoneal cavity within 3 to 6 hours with normal contractions of the intestines, the abdominal wall, and the diaphragm. The release of histamine and serotonin from resident peritoneal macrophages and mast cells by this insult leads to an increase in vascular permeability and leakage of proteins and fluid into the peritoneal cavity. With the host's successful immune response, bacterial and foreign debris is cleared, inflammation resolves, and the mesothelial lining is restored, and the fibrin is eventually removed by fibrinolysis. If the inflammation continues, abdominal abscesses and adhesions result. The horse shows varying degrees of lethargy, depression, colic, ileus, fever, weight loss, tachycardia, and diarrhoea. If the infection is generalized, the large shift of fluid and electrolytes from the vascular space to the peritoneal cavity can lead to severe dehydration and hypovolemic shock (Davis, 2003).

Approach to diagnosis

1. History taking

Taking history about the feeding, deworming and behavoiur of the animal is very important and helpful in diagnosis of colic. Mild to moderate degrees of abdominal pain are often responded to symptomatic treatment with analgesic and laxatives. Severe pain or pain that is unresponsive to analgesics may require major diagnostic efforts. Recurrent mild to moderate colic may serve as an indication of more serious problem such as internal

abscess, thromboembolism, enterolith, sand or other foreign bodies, tumor, gastric ulcer, abdominal adhesions, strictured bowel or urinary tract disease.

2. Physical examination

Physical examination helps to differentiate intestinal causes of colic from extra intestinal causes such as abdominal abscesses, tumors and genitourinary tract diseases which are not so common in horses. Presence or absence of borborygmi or whether feces are passed or not, help in ascertaining extra intestinal causes. Rectal examination is useful to determine the anatomic location within the gut or extra intestinal causes such as tumors, abscesses and masses. Most cases of severe constant colic indicate gut involvement often with anatomic displacement.

Assessment of degree of pain and recording of temperature, respiratory rate, HR, MM colour and CRT are important for predicting cause and clinical outcome in colic cases.

Pain: Intense continuous pain is usually associated with the most severe lesions with vascular compromise. Ischemia produces intense pain due to anoxic changes in tissues in early stages but later on when gut become severely compromised and nonviable, pain usually subsides and depression occurs due to endotoxic shock (Ihler *et al.*, 2004). Obstruction of the bowel due to gas or fluids leads to intense pain and shock in small intestine as there is limited capacity for distension as compared to large intestine.

Pulse rate and strength along with HR indicate the severity of cardiovascular dysfunction and are related to pain, vascular volume and response to endotoxemia. In severe pain, HR increases to more than 80 beats per minute (strangulating obstructions: HR 50 to 100 bpm; anterior enteritis: HR increase up to 90 bpm) where as in large intestinal obstruction, HR is usually 40 to 65 bpm. Normal systolic blood pressure in the adult horse is 100 to 125 mm Hg. Horses with systolic blood pressure of less than 80 mm Hg generally have poor prognosis.

Peripheral perfusion is best assessed from the gingival mucosa which is normally pale pink in color and have CRT that is normally 1 to 2 seconds. Prolongation of CRT and alteration of color of the gingival mucosa indicate altered perfusion and cardiovascular dysfunction.

Gut sounds are generally 'gurgling' associated with mixing of fluid and gas and should be taken frequently in a horse with continuing abdominal pain. Auscultate dorsal and ventral abdomen on both sides. Alteration in sounds indicates the severity of problem. Ileocecocolic sounds can be heard as 'water down a drain pipe' one to three per minute in the right paralumber fossa. Spasmodic colic causes increased intensity/rate of sounds where as obstructions cause decreased peristalsis (Ihler *et al.*, 2004). If no feces

passed, a more serious condition could be there especially if intestinal sounds are absent.

Nasogastric intubation is a useful tool for diagnosis of gastric impaction or dilatation and proximal enteritis though it reduces pain associated with distension and prevents gastric rupture by decompression of the stomach and anterior gut. As horse cannot vomit so in cases with severe pain, it should be done at the initiation of the examination.

Rectal examination is done to detect three abnormalities. Firm enlargement of intestine as large columns caused by impaction of feces in large colon or ingesta in the terminal ileum at ileocecal valve is the first thing to note down. Second important finding is distension with fluid and some gas if small intestine is affected or just gas if large bowel is affected. The third finding is very tight stretching of mesentery. Always try to examine the pelvic flexure which is a frequent site of impaction and may reside in number of positions. Locate the base of cecum for the presence of tympany or impactions. Practically large fecoliths in the transverse colon could be palpated easily. Empty feel to abdomen is suggestive of a ruptured viscus. In cecal dilation, the tight bands may be palpated on the distended cecum. Medial displacement of the caudal edge of the spleen and large intestine in the nephrosplenic space indicate displacement of large colon laterally and dorsally over the nephrosplenic ligament

3. Ultrasound and radiography

Ultrasound can be particularly useful in locating masses, adhesions or enlarged liver in foals. Radiography can be useful to detect enteroliths and sand infection in some horses.

4. Laboratory analysis

Packed cell volume (PCV) and total proteins (TP) are of immediate benefit in diagnosis and management because they help in assessing hydration and vascular integrity. A TLC and DLC may be valuable when peritonitis is suspected. A high count with left shift is usually expected in acute local peritonitis and a marked leucopenia is expected in acute diffuse peritonitis. The critical parameters are TP (7.5 g/dl or less), PCV (45 % or less), blood pH within the normal range of 7.25-7.3, plasma sodium not less than 132 mmol/l and plasma bicarbonate not less than 24 mmol/l.

Blood lactate level is considered to be of excellent prognostic value in terms of outcome and deciding about the surgery. In normal horses, the blood lactate level is 6.13-7.30 mg/dl (0.68-0.81 mmol/l). Levels greater than 75 mg/dl (8.3 mmol/l) indicate a poor prognosis (White II, 2006). The other valuables of prognostic and diagnostic relevance are low blood chloride levels (acute gastric dilatation), metabolic alkalosis (acute gastric dilatation and impactions of large bowel), and metabolic acidosis (small

intestinal obstructions).

Abdominocentasis is indicated in all cases of severe, persistent or recurrent colic. Normally peritoneal fluid is present from a few drops to 50 ml and clear and odorless to yellow with a TP below 2.5 g/dL, specific gravity <1.015, little or no fibrinogen (<100 mg/dl) and WBC <10000/µl. The elevated levels of these parameters or increased number of neutrophils in peritoneal fluid indicate peritonitis. Grossly, fluid changes to cloudy-yellow, then to serosanguinous with fibrin clots and then to black with bowel necrosis and hemolysis of extravasated RBCs. Elevated levels of proteins in the peritoneal fluid are usually present in anterior enteritis (duodenitis or proximal jejunitis). In peritonitis, elevated proteins are also accompanied by elevated number of neutrophils in peritoneal fluid contaminated with feed material in case of rupture. In case of possibility of bowel penetration, peritoneal tap should be undertaken at a different location. Analysis of lactate in blood and/or peritoneal fluid has been recommended as an aid in prognosis and assessing severity of tissue damage (Rose and Hodgson, 2000).

Presence of sand can be detected by mixing feces in water in a bucket and looking for sediment after pouring off water.

5. Check response to treatment

If pain cannot be alleviated, surgical intervention and specific diagnosis of displacements, internal hernias, masses and adhesions are the next step. Findings of physical examination including per rectal examination and evaluation of degree of pain decide about further laboratory tests. Standard treatment includes parenteral administration of an analgesic agent and oral administration of a mild laxative such as Dioctyl sodium sulfosuccinate (1mL/kg of 5% DSS) or mineral oil (4 litres). Check the stomach for reflux after passing nasogastric tube. Acidic pH of gastric reflux may indicate primary gastric dilation whereas alkaline pH may point towards small intestinal blockage. Foul smelling and dark brown reflux is often found in anterior enteritis (duodenitis-proximal jejunitis). Withheld oral medication if significant amount of reflux is present. If cardiovascular function is impaired, sodium containing fluids should be given IV @ 3 to 10 L /hour for a 450 kg horse. Trocar using 14 to 16 gauze 6 inch needle inserted through aseptically prepared skin if large amounts of painful gas is auscultable in right flank.

Management of colic

1. **Decompression:** The first step to alleviate abdominal pain is decompression of the distended stomach or intestine by nasogastric intubation. The tube can be left in place if repeated decompression is required. Decompression or enterocentasis can also resolve cecal tympany. Once gas is removed, saline or an antibiotic solution should be infused through the needle as it is pulled out of the cecum to avoid leaving contaminated material in the peritoneum or body wall (White II,

2006). Decompression of colon can be used as a lifesaving protocol in horses with massive colon tympany though it can be avoided because of increased risk of inadvertent tearing due to movement of the colon and laceration of blood vessels.

2. **Pain management:** Pain management is one of the most important aspects of colic treatment. Though analgesic drugs are useful to relieve physical signs of pain but they may mask signs of progression of the disorder. Drugs like flunixin meglumine and ketoprofen appear to be most potent NSAIDs for the control of visceral pain with effects lasting up to 8 hours. But their duration of action may mask the progression of clinical signs associated with devastating GI lesions so frequent reassessment of the horse's condition is necessary. Alpha-2 agonists like xylazine and detomidine induced analgesia through suppression of CNS neurotransmission and producing muscle relaxation. Xylazine is a potent drug for control of visceral pain with effects lasting for 45 minutes if administered @ 1.1 mg/kg IV or IM though in less severe pain effective analgesia can be produced at lower doses. The short duration of action is good for repeated assessment of patient however they are having side effects like hypotension, decreased cardiac output, ileus and decreased intestinal blood flow. Detomidine is comparatively more potent than xylazine with fewer detrimental effects on CV function and GI motility. Narcotic analgesics like butorphanol is most frequently used for analgesic and sedative effects. Other than potentiating the effects of alpha-2 agonists on GI motility, it has no significant adverse effect (White II, 2006). The combination of butorphanol (0.01-0.1 mg/kg IV) with low doses of xylazine (up to 0.2-0.4 mg/kg IV) is being used by many clinicians for good analgesia that lasts for 10 to 90 minutes.

Equine analgesics commonly used for visceral pain	
Drug	**Recommended dose**
Flunixin meglumine	0.25–1.1 mg/kg IV every 8–24 hours
Ketoprofen	2.2–3.63 mg/kg IV or IM every 24 hours
Xylazine	0.23–1.1 mg/kg IV 2.2 mg/kg IM
Xylazine plus butorphanol	1.1 mg/kg xylazine IV plus 0.1 mg/kg butorphanol IV
Detomidine	0.005–0.04 mg/kg IV
Butorphanol	0.1–0.4 mg/kg IV of IM
Detomidine plus butorphanol	0.01 mg/kg detomidine IV plus 0.05 mg/kg butorphanol IV
Lidocaine infusion	1.3 mg/kg by bolus IV plus 0.05 mg/kg/min by infusion IV

3. **Treatment of impactions:** Softening and lubrication is usually required in case of impactions of large colon but limited to mild obstructions. Care should be taken not to administer oral fluids to horses with gastric reflux. Mineral oil such as liquid paraffin is a surface lubricant that facilitates the passage of ingesta by direct lubricant effects and reduction of intestinal water absorption. Recommended dose rate is usually 5-10 ml/kg every 12-24 hourly. Pouring of 3- 4 litres of luke warm water through nasogastric tube helps to further soften or hydrate the intraluminal contents. Psyllium, a hydrophilic mucilloid laxative which acts by increasing the water content and bulk of fecal mass, is used in management of sand colic. Recommended dose rate is 1 g/kg PO q24 hour for several weeks to encourage expulsion of sand from the large colon. Dioctyl sodium sulfosuccinate (DSS) is a detergent which decreases surface tension of the impacted mass and increases penetration of water, can be used @ 10-20 mg/kg orally every 48 hours as a 5% solution. However, higher concentrations and frequent dosing can result in diarrhea.

4. **Stimulating intestinal motility:** Cholinergic agonists which promote the parasympathetic tone and proposed to increase gastrointestinal motility, include bethanechol and neostigmine. Bethanechol has no apparent therapeutic benefit but neostigmine clinically appears to promote large intestinal motility and induce defecation, can be used @ 0.02 mg/kg q 30 min. Neostigmine is shown to delay gastric emptying and has minimal effect on small intestinal motility. Benzamides such as metoclopramide and cisapride can also be used but their effect is not clearly understood. Metoclopramide @ 0.25 mg/kg diluted in 1 litre saline delivered by infusion over 1 hour q6h has been shown to promote gastrointestinal transit but experimentally. Common side effect reported is centrally mediated excitement. Repeated doses of cisapride (0.1 mg/kg IM, PO or per rectum q8h) have been shown to promote gastrointestinal motility in ileus experimentally and reduce the prevalence of postoperative motility disorders clinically. Erythromycin lactobionate, a macrolide antimicrobial acts as a motilin receptor agonist, has been used for the treatment of motility disorders @ 0.5-2.2 mg/kg IM or IV q6h though higher doses may cause downregulation of motilin receptors. Lidocaine hydrochloride, a local anaesthetic delivered as IV injection as a bolus @1.3 mg/kg followed by a continuous infusion @ 0.05 mg/kg/min IV for 24 hours has also been suggested effective in treating motility disorders (White II, 2006)..

5. **Treatment of endotoxemia:** Flunixin meglumine at low doses (0.25 mg/kg q6-8h IV) results in reduction of many untoward cardiovascular effects of endotoxemia without risk of masking of the signs of deterioration in colic horses Dimethyl

sulfoxide (DMSO) due to its anti-inflammatory effect has been shown to improve chances of survival in horses with endotoxemia and subsequent to bowel ischemia when used @0.1-1.0 g/kg q 24h slowly IV as a 10 % -20 % solution.

6. **Correction of dehydration:** Hydration of acute abdominal patient is valuable when treating intraluminal obstructions particularly impactions of the large colon. In these cases, it is designed to augment cardiovascular function and assist in increasing the volume of fluid in the GI tract which assists to hydrate and macerate the impacted mass. Large volumes of fluid must be considered in horses with severe abdominal pain or GI disease showing evidence of cardiovascular compromise. Hydration is usually accomplished by administration of balanced electrolyte solutions such as Ringer's and lactated Ringer's. The volume required is calculated by estimating water loss as percentage of the body weight or the percent of blood or ECF change. A rough estimate can be calculated from the PCV and TP in the following formula: Percent change in PCV or TP = (measured PCV or TP) – (normal PCV or TP) x 100/(normal PCV or TP). This percent change represents the change in the blood or the ECF volume from normal. The calculated percentage multiplied times the blood volume (7 % of the body weight in kg equals liters of blood) is the estimated amount of fluid which needs to be replaced immediately to provide adequate circulatory volume. Because PCV vary widely in horses during colic, calculations using TP may give a better estimate. The over-hydration technique can be used as a primary treatment for pelvic flexure and cecal impactions and should be used rather than repeated administration of oral laxatives in refractory patients. The fluid can be administered IV over a 24-hour period or as a bolus. The replacement fluid should be balanced supplying sodium and chloride with adequate potassium and calcium. In severe dehydration and horses with endotoxic shock, a 7.5 % hypertonic saline can be used a emergency measure as it rapidly draws water from the extracellular and intracellular space into the circulation. But it must be followed with adequate replacement fluids to restore hydration. Oral supplementation with magnesium oxide @ 20-30 mg/kg/day may also be considered in horses with hypomagnesemia which usually occur in horses that are off feed without electrolyte supplementation. In partial obstructions evident by passage of small amounts of feces and no gastric reflux, fluid administered by nasogastric intubation may be helpful in providing fluid support. An adult horse can tolerate 6 to 8 L of isotonic fluid administered via nasogastric tube every hour. On the other hand, if complete obstruction or >2 L of gastric reflux is present, fluids should not be administered by nasogastric tube or nasogastric fluid administration should be stopped if there are signs of abdominal pain during or immediately after administration.

7. **Treating hypercoagulation or DIC:** Disseminated intravascular coagulation (DIC) is the most common hemostatic disorder in horses with inflammatory and ischemic GI tract disorders. This syndrome is characterized by marked activation of the intravascular coagulation system leading to massive thrombin activation, fibrin formation, and consequently widespread microvascular clot deposition resulting in ischemia and multiorgan failure. DIC can be easily diagnosed through lab analysis of any three parameters such as thrombocytopenia, decreased mean platelet component (MPC), prolonged clotting times (prothrombin time and activated partial thromboplastin time), decreased fibrinogen concentration, decreased coagulation inhibitor activity (antithrombin, protein C) and increased fibrinolytic product concentration (D-dimers). Administration of heparin is considered the most effective and safe treatment for reducing severe intravascular hypercoagulation in horses with DIC (White II, 2006). Heparin in horses has not only anticoagulant properties but also antiplatelet aggregation effects which make it highly effective in reducing hypercoagulation and DIC in horses. Low-molecular-weight heparin (Dalteparin 50 IU/kg SC q24h; Enoxaparin 0.5 mg/kg SC q24h) is highly effective in reducing thrombus generation and fibrin deposition and is safer than unfractionated heparin. Moreover, this heparin has no reported detrimental effects (e.g., agglutination, anemia, hemolysis) on erythrocytes although thrombocytopenia may occur.

8. **Treating verminous arteritis:** The following may be effectively used against larval stages of *S. vulgaris* in the cranial mesenteric artery:

Dewormers	
Drug	**Recommended dose**
Fenbendazole	10 mg/kg Once daily for five consecutive days
Ivermectin	200 mg/kg Once
Moxidectin	400 mg/kg Once

9. **Decision about surgery:** In making decision about surgery, it will valuable to separate impending enteritis and peritonitis from bowel disease requiring surgery (White II, 2006). Fever or decreased WBCs count and neutropenia may be indicative of impending or ongoing enteritis in which case surgery is contraindicated.

Surgical exploration is indicated when:

- Severe and intractable pain
- HR >75/min, pulse weak, CRT >2 sec, injected mm, cold extremities, shock, normal/slightly increased temperature

- Complete absence of gut sounds
- Bowel is markedly distended/displaced
- More than 5 litres of yellowish alkaline gastric reflux ± rapid accumulation of fluid
- Peritoneal fluid indicates damaged bowel (blood tinged)

Surgery is contraindicated when there is fever, neutropenia or marked neutrophilia, severe jaundice or marked enzyme abnormalities indicative of liver diseases, foul smelling, brownish-red gastric reflux characteristic of proximal enteritis (duodenitis-jejunitis), extra intestinal cause not amenable to surgical correction or colitis is there.

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PRECISION DAIRY FARMING

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Abstract

Precision dairy farming (PDF) is adoption and use of technologies for recording behavioural, physiological and production indicators of animals in order to determine health and reproductive status of animals accurately and timely, and to monitor and assist in farm management to improve profitability. Various PDF technologies include wearable devices (ear tags, halters, neck collars based devises, reticulo - rumen bolus, pedometers, tail ring accelerometers, tail head injectable transponder, vaginal bolus) and non-wearable devices (automated milking system, milk flow-meters, milk conductivity meters, 3D imaging of body condition score, infra-red spectrometry milk composition analyzers, online somatic cell count, automated feed-dropping control units, remote sensing, feed troughs with measuring capabilities, automated calf feeder systems, infrared udder surface temperature etc). Most of the commercially available wearable PDF technologies measure one or the other parameters in real time such as animal activity, rumination and eating etc. and reliably tell the dairy farmers about animal's estrus, insemination time, health status etc on multiple electronic devises like PC, tablet or smartphones anywhere and all the time. The PDF technologies monitoring heat stress and GPS are also commercially available.

Keywords: *Precision dairy farming, wearable devices, non-wearable devices, estrus detection, herd health*

Introduction

Profitable dairy farming demands regular monitoring of the herd and timely decision making. Management of large herd size dairy farms involves extensive monitoring of wide range of activities including focus on individual animal apart from group management. Therefore, farm automation and use of advance techniques (IoT) has become imperative for intensive dairy farming. With the development of robotic knowledge, the idea of monitoring animals in dairy herds has transformed from a few minutes of human attention to the use of robust practices, referred to as precision dairy farming. Precision dairy farming (PDF) can be defined as "The adoption and use of technologies for recording the behavioural, physiological and production indicators of animals in order to accurately and timely determine health and reproductive status (viz. identification of sick animals and estrous) for timely interventions to improve farm performance, sustainability and profitability" (Stone 2017)

For profitable dairy farming, it is very important that animals in estrous are identified at appropriate time, and sick or poor performer are detected at the early stage so that required actions can be undertaken. The detection of estrous in cattle typically relies upon human observations and / or use of teasers. Similarly, in a big dairy herd identification of sick animals, animals approaching calving, or exhibiting abnormal behaviour or routine is a difficult task that usually requires keen observations by herdsman and labour. However, in such herds, animals in estrous or sick animals are often missed due to poor monitoring or sometimes physiological / behavioural changes are undetectable to human senses, thus usually it is too late to act effectively resulting in reproductive impairment or loss of animals. Precision dairy farming technologies can fill this gap and provides a tool to detect estrous, health status and other signals of animals at appropriate time for better decision making. The PDF technologies are not just an instrument or equipment that solely automates laborious processes like automated shed cleaner. These are smart technologies that monitor and record various signals from the animals, and translate the monitoring results in useful information for the dairy farmers. These technologies are the future of modern dairy farming, which will be automated, computer based, and less labor-intensive.

Precision Dairy Farming Technologies

Several PDF technologies are commercially available and used worldwide, and some technologies are under development stage and commercially not available. There are certain features common to all the types of PDF technologies, such as recording real-time data from individual animals and representing the information in the tabular, numerical and graphical form, which can be easily understood by dairy farmers / herders. The PDF technologies can be applied to the animal itself or at milking parlors, feeding alleys, and inserted within the animal's body. The technologies available can be broadly classified as (1) Wearable devices and (2) Non-wearable devices (Caja *et al.*, 2016). Wearable devices are those which are applied to the animal itself or within the body of the animal. Non-wearable devices include technologies applied in the milking parlor, or at a place where monitoring of animals is possible.

Common wearable devices (Fig. 1) includes,

i. Ear Tags – heat detection / monitors health status / heat stress
ii. Halters - heat and health status
iii. Neck collars based devises - heat detection / monitors health status / heat stress
iv. Reticulo-Rumen bolus – rumen pH and temperature (Commercially not available)
v. Pedometers - heat detection / monitors health status
vi. Tail ring accelerometers - calving alert

vii. Tail head injectable transponder - estrus detection by measuring mounting behavior

viii. Vaginal bolus- Measures vaginal temperature giving parturition alert

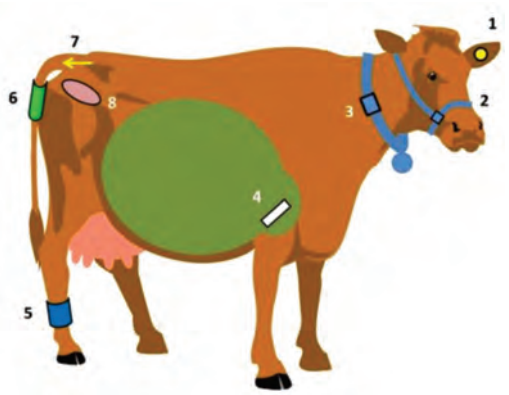


Fig. 1. Schematic diagram sharing sites of various wearable devices

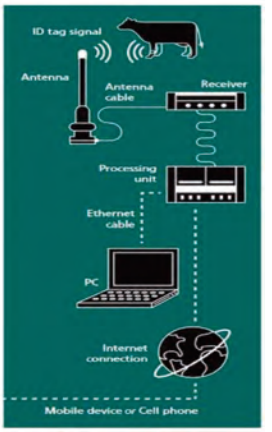


Fig. 2. Data communication system

In most of these PDF technologies, devices (having various sensors) are applied on animal. These sensors continuously record various parameters of the animals and send information to the receivers trough antenna and then to the system control / processing unit through wired or wireless networks. The control unit sends information, alerts to the user on multiple devises viz. PC, tablets, smartphones etc (Fig. 2). If internet connection is available, a user can check information of his farm from anywhere anytime.

Components of a usual Herd Health Management System

Most of the commercially available PDF technologies measure one or the other parameters such as eating time, rumination time, lying behaviour, jaw movements, activity, vaginal electrical resistance, vaginal temperature etc and based on these signals / indicators provide information on estrus detection, insemination time, calving prediction, health status of the animals etc. Although all the indicators may not be available in all the technologies, however following are the important parameters / indicators recorded in many of the PDF technologies commercially available,

(a) Periods of activity / inactivity

Pedometers are used to monitor walking activity and even milk production in dairy animals (Fig. 3). Recent ear tag and neck collar based sensors / devices also monitors animal activities (Fig. 4). Monitoring and analysis of daily walking activity and behavioural patterns such as activity/ inactivity by automated monitoring devices is used to detect estrus in animals. There is an increase in activity and restlessness during estrus. This increase in activity is more during late night to early morning hours from 2.00 am to 8.00 am on the day of estrus (Dolecheck *et al.*, 2015). The use of automated

activity monitoring devices and pedometers has raised estrus detection rates to 80% to 100% (Roelofs *et al.*, 2010). Lying behaviour is the highest priority of dairy cows with approximately 10 to 13 hours a day. The lying periods of the cow increases when they are provided with ample space/ loose pens. Further, cows lie more during dry periods than milking cows. The periods of lying are affected by stocking density in the stall, type of bedding used, stage of lactation, transition period, signs of pain such as lameness, and metabolic disease such as sub-clinical ketosis. There is an increase in lying behaviour in dairy cows in lameness. In a study, it has been found that pedometer predicted lameness earlier than the appearance of clinical signs. It has been recorded that the pattern of activity measured by a pedometer was different in cows diagnosed with a displacement of the abomasum and ketosis from the activity pattern of healthy cows (Edwards and Tozer 2004). Therefore, monitoring of walking activity of an animal can provide useful information for analysis health and reproductive status of animals. Generally, commercially available pedometers determine the ideal time for insemination and optimize husbandry conditions: Such systems continually monitor cow's daily behaviours including standing time, lying time, walking time, stand-up count and step count. If the cow displays increased or decreased activity, the system sends an alert to the dairy farmer. This enables the farmer to treat any health problems quickly – before it impacts cow's health and production.



Fig. 3: Pedometers
(source: https://www.alamy.com)

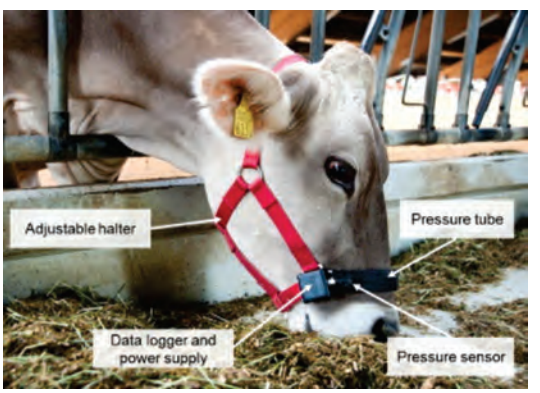


Fig. 4. Halter based device
(Zehner *et al.*, 2017)

(b) Eating time, rumination and feeding behaviour

On an average, lactating dairy cows spend about 4.5 hours per day for eating and 7 hr per day for rumination, with a maximum total chewing time of 16 h/d (Beauchemin, 2018). The rumination time of around 8:46 hours a day was calculated using rumination loggers in cows. Rumination is a diurnal behaviour, with 63% of total rumination occurring during night time. The eating time refers to the time for prehending the feed, chewing, and swallowing. The eating time in cows comprises meals with a meal bout of

37-57 min of eating an average of 5-10 meals/day separated by periods of non-eating. A mean eating time of 284 min/d, ranging from 141 to 507 min/d has been recorded in cattle (White *et al.,* 2017). The happening of animal health disorders has also been found to affect the behavioural signs of cows. For example, a considerable decline in diverse clinical condition. Several devises are available that records, analyse and provide information (real time as well as hourly / daily basis) about eating time and rumination of the animals. The devises that are commercially available are applied on neck (neck collars based) (Fig. 5) or ears (ear tags based) (Fig. 6). Different devises uses different technologies however, commonly available PDF technologies like ear tags, neck collars, and halters use RF 3axial accelerometers to measure rumination time, eating time, activity etc in dairy cows.



Fig. 5. Cow with Neck based collar



Fig. 6: Cow with ear tag based sensors

Monitoring of feeding behaviour of the animals at feeder by using electronic feed monitoring system is another tool available to identify the animals with abnormal behaviour occurs mostly due to ill-health. Healthy animals spend more time at feed bunk than the sick animals. Moreover, healthy animals visit the feed bunk immediately following the feed delivery.

(c) Heat stress monitoring

The PDF technologies are commercially available that can tell when cows are feeling the heat by monitoring how frequently and heavily they are breathing and alerts the dairy farmers if the herd is suffering from heat stress. Usually, specific devises to monitor heat stress in cattle are incorporated in the same ear tags / neck collars based devise that are used for monitoring eating patterns, rumination and activity.

(d) GPS

The GPS collars is a PDF technology that records detailed position of the animals, thus allowing understanding of animal behaviour and farm management. Commercially

available systems keep an eye on entire dairy farms and know 24/7 where the cows are. It transmits the exact position of single or multiple cows in real time. Knowing position of cows in big dairy farms may simplifies daily work and saves time.

Integrated heat detection, health monitoring, cow positioning, heat stress detection systems and herd management software

These systems reliably tell the dairy farmers when their cows are ready for insemination. Alerts are sent to the farmers on multiple electronic devises like PC, tablet or smartphones etc. A sensor monitors the cow‘s movement at all times. Such systems shows periods of high activity for each individual animal and, even its live location. This gives an excellent basis for quick reactions and successful fertility and health management. Changes in eating and rumination behavior as well as measurements of activity / inactivity, may indicate potential health problems. The alert function tells immediately if the cow is exhibiting feeding or health problems so that one can react quickly and appropriately. In addition to providing health and reproduction alerts, and basic data about eating and rumination behaviour and activity status of the animals, several commercially available systems also analyse data and generate various reports viz. Heat Report, Anestrous Cows Report, Irregular Heat Report, Pregnancy Probability Report, Health Report, Distress Report, Distress Alerts, Fresh and Pre-Fresh Cows Reports, Heat Stress Graph, Daily Group Consistency Graph, Group Routine Graph etc that is helpful in analysing farm performance. In most of the available systems, report of individual animals as well as groups / herds (viz. lactating, dry, pregnant, heifers etc) is provided. Further integration of these systems with milking parlours and herd management software provides mechanisms to farmers to store and analyse farm animal, production and reproduction data and accordingly undertake management interventions and decisions.

Non-wearable devices

Non-wearable devices include technologies applied in the milking parlor, or at a place where monitoring animals is possible. These include automated milking system, milk flow-meters, milk conductivity meters, 3D imaging of body condition score of the animal, infra-red spectrometry milk composition analyzers, Online somatic cell count, and navigators for analysis of milk biomarkers for mastitis detection, progesterone assays, Automated feed-dropping control units, remote sensing, Feed troughs with measuring capabilities, Automated calf feeder systems, infrared udder surface temperature etc.

Therefore, precision dairy farming technologies empowers the dairy farmers / herdsman to monitor their herds more effectively with minimal labour thereby improves farm profitability. Specifically for veterinary clinicians / researchers, the PDF

technologies is a tool that add in disease diagnosis, provides valuable information for monitoring treatment response, and understanding behaviour of animals during different physiological stages, seasons, management practices, and disease conditions.

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MATRIX ASSISTED LASER DESORPTION IONIZATION BIOTYPER: A QUICK METHOD FOR BACTERIAL IDENTIFICATION

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Abstract

Matrix Assisted Laser Desorption Ionization Time of Flight (MALDI-TOF) biotyper is a very powerful system to identify a bacteria upto its genus and species level. The introduction of this system or its similar types, can help in quick and precise identification of bacteria in a microbiology laboratory. This technique is simple and can be easily adopted at the multi-speciality veterinary clinics for the ultimate benefit of the farmers practicing animal husbandry as well as pet owners.

Keywords: *MALDI-TOF, Bacteria, Diagnosis, Matrix*

Diagnosis is very important part of treating a disease in both medical as well as in veterinary practice as it not only helps in treating a patient rationally but also reducing the treatment cost. Disease diagnosis of bacterial origin relies on standard method of identification by culturing the bacteria on a suitable medium for a time period. Once the growth is achieved the next task is to identify the bacteria. The standard method of identification is to subject the isolated bacteria to various biochemical tests to deduce the results. This standard method is time tested and being followed in most of the microbiological laboratories. Despite it being good but this method of identification has some problems one being very cumbersome as it requires preparation of different media, requires technical expertise and requires a lot of time in getting up to the results i.e. identification of the genus and species of the bacteria.

Since, the clinicians are partially dependent on the microbiological results, so as to start treatment, thus, time required to deliver results becomes one major issue that needs attention particularly during the outbreak situations. To address the clinician's concern, scientists have brought in many innovations/inventions to reduce the time lag in the identification of the causative agent by using different strategies such as roping in of some immunological and/or molecular based tests. Though, these tests are good and have been used in various laboratories across the globe but they have certain limitations in terms of technical expertise as well as the cost associate with each test. Immunological based diagnostic tests have reached to the clinical settings to an extent, but, molecular

tests have not reached to the grass root diagnostic laboratories because of cost as well as technical expertise in performing these tests. Hence these molecular tests are not adopted commonly in routine diagnostic laboratory and being limited to research institutes or specialized laboratories only.

Recently with the introduction of Matrix assisted laser desorption ionization-Time of Flight (MALDI-TOF) bacterial identification system (Fig. 1), a lot has changed especially in the identification of bacteria. Using this technology we could identify bacteria and fungus (mould and yeast) very quickly.



Fig. 1. MALDI TOF

MALDI is based on mass spectrometry where mass-to-charge ratio (m/z) of an analyte, providing spectra within minutes is detected. This provides a unique mass spectral fingerprint of the microorganisms which upon comparison from the database provides us the identity of the bacteria isolated in the laboratory. In mass spectrometry biopolymer molecules present in the condensed phase are converted into intact, isolated ionized molecules in the gaseous phase. Then, these ions are separated as per their molecular weight after migration in an electric field. Each molecule detected is characterized by: the molecular mass (m), the charge (z), the ratio mass/charge (m/z), and the relative intensity of the signal. This leads to accurate analysis of peptides and its determination.

In the initial phase of development only molecules of low molecular masses were analyzed and the limit size of these varied from 1 kilodalton (KDa) for biopolymers to 9.0 KDa plus the laser was very harsh on the biomolecules leading to inaccurate identification. Later with the invention of soft ionization techniques such as MALDI-TOF and electrospray ionization (ESI), introduced in the late 1980, have largely overcome the problem of harsh ionization. Of these two, MALDI-TOF proved to be most effective for bacterial identification as it allows the detection of macromolecules in complex mixtures without prior purification of samples. One of the difficulties that arise when identifying organisms based on traditional or molecular methods is that it can be difficult to discriminate among species that are phenotypically, biochemically, or even genetically very similar. MALDI-TOF, on the other hand, relies on measuring microbial proteins that are typically well conserved within a species. Thus, it provides a more reliable means of discriminating one species from another. Using MALDI-TOF we can not only identify bacteria up to its genus but can in most of the cases identify it up to species level.

One of the major components used in MALDI-TOF, besides equipment is the matrix. Matrix serves two major functions viz., absorption of energy from the laser and isolation of the biopolymer molecules from each other. Many matrices are available

commercially but they all require almost same physical and chemical properties i.e. an efficient absorbance at the laser wavelength, efficient ionization and important stability not to interfere with the mass spectrum of the sample. Some examples of matrix include: 2, 5-dihydroxybenzoic acid (Gentisic acid), (for studying oligosaccharides, glycopeptides, and glycoproteins), 3, 5-dimethoxy-4-hydroxycinnamic acid (Sinapinic acid), α-cyano-4-hydroxycinnamic acid (α-CHCA) and Ferulic acid.

As of current knowledge there are two important platforms (commercially available). One Vitek MS (bioMerieux, France) and the other is MALDI biotyper (Bruker Germany). Each of the commercially available platforms has a unique set of organisms in its database, Vitek MS has been FDA cleared for the identification of 332 bacteria and yeasts, 50 mold, and 19 mycobacteria species or species groups representing a total of 1316 species. The MALDI Biotyper has been FDA cleared for the identification of 294 bacteria and 40 yeast species or species groups covering 425 species. Both the platforms are equally accurate, specific and reproducible. They are both capable of identifying the vast majority of organisms commonly encountered in the clinical laboratory

Some of the advantages of MALDI compared with other identification methods includes:

1. With MALDI-TOF we can identify wide variety of bacteria as well as fungus (yeast as well as mould) with good accuracy.
2. The method is also more reliable than traditional and molecular methods for identification.
3. It requires very small biomass to perform the experiment thus, we can identify a bacteria using a single colony and even after primary culturing.
4. It does not require much expertise thus with minimal knowledge of the microbiology we can perform this test.
5. It is very fast and accurate thus leading to reduction in time of diagnosis.

For the success of MALDI-TOF based identification method there should be a very good and reliable data base that should include a number of isolates for each species (to overcome geographical variation), grown under a variety of conditions (to overcome growth related variations) such that the spectral library for the organism is sufficiently robust to account for the inherent variability expected for any organism.

Recently the Department of Veterinary Microbiology, College of Veterinary Science, GADVASU, Ludhiana has set up MALDI-TOF facility for the benefit of farmers and till date we have tested more than 3000 samples and will continue to test and provide results quickly and accurately.

Thus, it is recommended that MALDI-TOF should be included in the

microbiological laboratories at the District level so that identification is done even at the district level as the identification using MALDI-TOF is very easy, quick, reliable and cost effective (if we omit cost of the equipment).

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AZOLLA: A PROSPECTIVE NON-CONVENTIONAL FEED RESOURCE

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Abstract

Azolla (Azolla pinnata X Anabaena azollae) is an easy to adopt non-conventional feed resource for livestock. Azolla is a branched free-floating aquatic fern that rapidly grows on the surface of the water. The fern Azolla, hosts a symbiotic blue green algae Anabaena azolla, which is responsible for the fixation and assimilation of atmospheric nitrogen. Due to this property azolla is a very nutritive and cheap conventional feed substitute for livestock. Azolla contains very high proteins, amino acids, vitamins (vitamin A, vitamin B12, Beta-carotene) and minerals. Azolla can be fed to cattle, sheep, goat, pig, rabbit, poultry and fish. Fresh azolla can be mixed with commercial feed or given directly to livestock. It has been reported that feeding azolla to livestock improves their productivity. It can also be used as biofertilizer, for weed control, for mosquito control and as carbon sequestration agent. azolla can be easily cultivated in artificially prepared small ponds.16 m^2 area can produce 2 kg azolla daily that can support one cattle/ 80 hens/50 kg fish.

Keywords: *Azola, non-conventional feed, fern, ruminants, animal nutrition*

Introduction

Feeding of livestock is a costly affair and accounts for 60-70% expenses incurred on livestock production. Various non-conventional feeding resources are being promoted to curtail the cost of production and improve the productivity. Azolla ***(****Azolla pinnata* × *Anabaena azollae)* is one such easy to adopt option. It belongs to the family of *Azollaceae*. Azolla is a branched free-floating aquatic fern that rapidly grows on the surface of the water. *Azolla* floats on the surface of water by means of numerous small, closely overlapping scale-like leaves, with their roots hanging in the water. The plant can readily colonise areas of freshwater, and grow at great speed thereby doubling its biomass every two to three days. The typical limiting factor on its growth is phosphorus. An abundance of phosphorus that makes azolla bloom. The fern Azolla, hosts a symbiotic blue green algae Anabaena azolla, which is responsible for the fixation and assimilation of atmospheric nitrogen. Due to this property azolla is utilized as bio- fertilizer for wetland paddy. Along with, azolla has been found to be a very nutritive and cheap conventional feed substitute for livestock. Azolla cultivation is popular in countries like China, Vietnam, and the Philippines, etc.

Due to Limited resources many farmers often struggle to procure sufficient feed for their animals. Due to nitrogen fixing property it is an excellent source of nitrogen accounting for its high protein value and hence azolla is an ideal sustainable feed for cattle, fish, pig, and poultry. Azolla cultivation needs meagre investment hence it is a low-cost alternative for good feed and good biofertilizer.

A. Use as feed for livestock

Azolla contains very high proteins, amino acids, vitamins (vitamin A, vitamin B_{12}, beta carotene) and minerals, so it is the excellent nutrient feed for livestock. Also, Azolla has low lignin content, hence easily digestible. The nutritive characteristics of Azolla (Dhawan & Ansal, 2021) are as under:

Nutrient		**Essential amino acids**		**Minerals**	
Name	**Percent**	**Amino acid**	**% of Protein**	**Name**	**Percent**
Protein	13-30	Leucine	9.1-9.4	Calcium	8.2-11.0
Fat	4-6	Isoleucine	4.1-4.8	Phosphorus	2.6-4.3
Fibre	9-13	Arginine	6.0-6.1	Magnesium	3.3-6.5
Carbohydrates	34	Valine	5.9-6.2	Potassium	20.4-25.2
Minerals	9-23	Tryptophan	1.5	Sodium	1.5-4.6
Moisture	93-95	Histidine	2.1-2.6	Chloride	1.7-5.2
		Methionine	1.1-1.7	Sulphur	1.2-5.4
		Threonine	5.3		

The above-mentioned bio-chemical constitution along with the rapid multiplication rate makes azolla an ideal organic feed substitute for livestock.

Rate of feeding

Azolla can be fed to cattle, sheep, goat, pig, rabbit, poultry and fish. Fresh azolla can be mixed with commercial feed or given directly to livestock. It has been reported that feeding azolla to poultry birds improves the weight of broiler chicken and increases the egg production of layers birds. Henry *et al* 2017 reported that supplementing azolla @ 30g/bird/day improved feed efficiency in turkey without affecting their production performance. In animals, Azolla-fed group showed a significant increase of 11.85% in milk production in cattle under 2nd to 4th lactation fed azolla @ @ 1:1 (1.5 kg Azolla + 1.5 kg concentrate) (Rawat *et al.* 2015). When broilers supplemented with dried Azolla meal @ 5.0% commercial feed the average body weight per broiler bird was 1880.0 g against 3184.6 g total feed consumed in Azolla supplemented group compared to 1780.2 g body weight against 3176.5 g feed consumption in control group (Rawat *et al.* 2015). The rate of feeding of azolla per day for Cattle, Pigs and Poultry is recommended @ 2.0 kg, 1.2 kg and 20-30 gm respectively

B. Use as biofertilizer

Azolla has been used for at least one thousand years in rice paddies as a companion plant to fix nitrogen and to block out light to prevent competition from other plants. Azolla fixes atmospheric nitrogen and store in leaves, Therefore, acting as a green manure. Azolla incorporation significantly increased residual soil phosphorus, grain weight, % grain filling and grain yield (5-42%; Oyange *et al.* 2019).

C. Use for weed control

Azolla plant can form a thick layer on water surfaces, so it uses for weed control in land farming paddy farm, Azolla forms a thick layer and cover all farm area and work as organic mulching which doesn't allow to produce weed. Use of Azolla slows down water evaporation rate and maintain soil moisture for a longer time.

D. Use for mosquito control

Azolla has another ability to restrict mosquito breeding process, and thus Azolla is also called as "mosquito fern."

E. Use in climate change

Azolla has been proposed as a carbon sequestration modality. The proposal draws upon the hypothesized Azolla event that asserts that Azolla once covered the Arctic and then sank, permanently sequestering tera tons of carbon and ending a warming event that reached 12-15 °C (54-59 °F) degrees warmer twenty-first century averages.

CULTIVATION OF AZOLLA

At a pH of 5.5-7.0 and temperature 20-25 ^{o}C azolla (Dhawan and Ansal, 2021) grows vigorously and doubles its biomass within 2-5 days (Sadeghi *et al.* 2013). Rex (2019) reported that during summer season cultivation of azolla in artificial pools gave good biomass between 22.81- 33.74^{o}C air temperature. Keeping this in view in Punjab azolla cultivation can be easily carried out for 9-10 months in a year. A layer of azolla can fix 1.0-2.6 Kg nitrogen per hectare. If fortified with nitrates and phosphorus one hectare water area can produce 300–600-ton azolla annually (20-25 ton on DM basis).

Steps for azolla cultivation:

1. An artificial pond of 16-40 m^2 area is created for cultivation of Azolla. For creating Azolla cultivation pond, select partially shaded area because Azolla needs 30% sunlight and too much sunlight will destroy the plant. The area under the tree is preferable. For creating the area artificially shade net can be used.
2. Dig out the soil for preparation of 0.3 m deep pond and level the soil. After that spread the plastic sheet around the ground to prevent water loss.
3. Spread 2-3 cm soil uniformly on the plastic sheet in the pond.

4. Azolla needs fertilizers for its growth. A slurry of cow dung @1kg/m²+8g/m² single Super Phosphate is spread over the soil layer. This improves the availability of nutrients for propagation of azolla.
5. Fill the pond with water to a level of about 10 cm then leave the pond for 5 days so that the ingredients may settle down. Water facilitates the fern to float freely
6. After 2-3 days add Azolla culture (120-150gm/m²) in the pond by gently rubbing Azolla in hands. It helps break Azolla into smaller pieces for faster multiplication.
7. After two-week start harvesting from pond of 2M × 2M size, you can harvest 1kgAzolla each day.
8. Replace 25-30% water every week and add cow dung and single super phosphate every week
9. Azolla can also be cultivated in waste water from animal shed that is rich in nutrients. This will help in regaining these nutrients through azolla (Phytoremediation) and will also reduce the pollution occurring due to waste water.

Azolla production

A 16 m² area can produce 2Kg azolla daily that can support one cattle/ 80 hens/50 Kg fish. Depending upon the daily requirement of farm size of pit/ area under azolla cultivation can be increased.

How to procure Azolla

Azolla can be procured from fellow farmers, Krishi Vigyan Kendras, College of Fisheries Sciences, GADVASU, Ludhiana and different Agricultural Research organizations (free of cost/at nominal price).

Important tips

1. Azolla rapidly grows so as to maintain its biomass 300- 350 g /sq. meter, hence harvest daily to avoid overcrowding.
2. Add once in 5 days mixture of Super Phosphate, and cow dung also admixture containing magnesium, iron, copper, sulphur etc. at weekly intervals to enhance the mineral content of Azolla.
3. Replace 25 to 30% old water with fresh water, once in 10 days; it helps to prevent nitrogen build up in the pond.
4. Replace complete water and soil, at least once in six months and then add fresh azolla seeds.
5. Maintain the water level of at least 10 cm, so Azolla root doesn't grow in the soil and it remains easy to harvest.

6. Wash the harvested Azolla thoroughly, so as to remove dirt and smell of cow dung and then feed to the animals.

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INSTITUTIONAL DEVELOPMENT PLAN PROJECT AT GADVASU: TRANSFORMING EDUCATION WITH A MODERNISTIC APPROACH

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Abstract

In this era of global competitiveness, higher education needs a vibrant metamorphosis. As market-driven approaches being given due recognition in the agricultural sector, the education in same has to undergo a responsive shift. The increasing role of information technology and industrial interventions has called for reform in the agricultural education sector, wherein the graduating students should have up to date know-how of the current scenario with a tinge of innovation. In order to meet the national and international demands of high quality and skilled professionals, GADVASU is constantly making targeted efforts for the development of sustainable animal husbandry. With assistance under IDP, GADVASU aims at filling existing gaps through capacity building and training of both students and faculty at various international platforms, updating of existing infrastructure, networking with industries and universities of national and international repute, promotion of skill development, seeding innovation amongst young minds, increasing employability and entrepreneurial outlook and adopting a revenue generation model for sustainability in long run. This will specifically target exclusive development of soft-skills and entrepreneurship potential beyond regular academics. This will enable in generating a human resource for industries and will boost entrepreneurship amongst youths.

Keywords: *higher education, skill development, infrastructure, capacity building, innovation*

Project Background:

Indian Council of Agricultural Research (ICAR), Government of India (GoI) is implementing the World Bank supported National Agricultural Higher Education Project (NAHEP). The project was formulated with a total cost of US$ 165 million (Rupees 1100 crore at the exchange rate of Rs. 67.49 = 1US$) starting from 2017- 18. The project was proposed on 50:50 cost sharing basis between the World Bank and the GoI, implemented at the Education Division, ICAR, New Delhi. The project has been formulated with a focus to improve and sustain quality of higher agricultural education. It aims to produce a globally competitive agricultural human resource capable of developing newer technologies and skills for scale up and transfer of new technologies to improve the production system and value addition. Overall, the project aims to develop resources and mechanism for supporting infrastructure, faculty and student advancement, and

providing means for better governance and management of agricultural universities, so that a holistic model can be developed to raise the standard of current agricultural education system that provides more jobs and is entrepreneurship oriented and on par with the global agricultural education standards. The project is being implemented through following three components.

Component 1: Support to Agricultural Universities

Aims to strengthen Agricultural Universities to improve learning outcomes and employability of graduates and scale up postgraduate education, research & development and innovation and establishing centres of excellence.

Sub-component 1A [Institutional Development Plan (IDP)]: To enhance institutional and system management effectiveness, improve learning outcomes, employability and entrepreneurship of agricultural students, and ensure student and faculty development.

Sub-component 1B [Investments in Centres for Advanced Agricultural Science and Technology (CAAST)]: To support interdisciplinary advanced centres for innovative approaches to teaching, research, extension and integrating agricultural education with employment and entrepreneurship.

Sub-component1C [ICAR innovation grants to AUs (IG)]: To guide and support SAUs in developing and strengthening linkages with industry in agricultural education and research.

Component 2: Investments in ICAR for Leadership in Agricultural Higher Education

To enhance ICAR's effectiveness in (a) coordinating, guiding and managing agricultural higher education across the ICAR-AU System; and (b) its interactions with AUs and key stakeholders through interventions.

Component 3: Project Management and Learning

To administer, supervise, monitor and evaluate overall project implementation.

IDP-GADVASU

The IDP project entitled "Institutional Development Plan for Improved Learning Outcome, Skill and Entrepreneurship at GADVASU" was approved for implementation under NAHEP with total cost of Rs. 2447.48 Lakh. The project was initially sanctioned for a period of 24 months starting August 2019 ending July 2021 and was later extended till July 2022. The objectives of the project are:

- Strengthening academic programmes for producing industry and market-ready professionals and improving learning outcomes
- Harnessing on faculty and student development programmes for enhancing competence and diversity

- To develop innovative and sustainable revenue generation models

Infrastructure development under IDP:

Modernization of the UG-classrooms: Strengthening and modernization of existing class rooms (13) facilities of constituent colleges of GADVASU was done by installation of Smart class room units including interactive panels and LCD projectors with digital podium to enable interactive teaching for better understanding of the content through effective teaching.

Simultaneously, the undergraduate laboratories for various colleges were upgraded by installation of modern Laboratory modules and UPS facility for uninterrupted power supply.





Strengthening of students' amenities: Automatic washing machines were installed in the boys and girls hostels to provide better facilities to students. Three sets of Gym equipment's have been installed in all constituent colleges for work out and health maintenance. Further, Lockers have been provided to all departments for individual students with an aim to provide personal space for storage for their belongings in the college. For better personal hygiene of female students Sanitary napkins vending machines along with incinerator have been installed at all major locations in the university campus.

Green campus: Under the Green initiatives through strengthening disposal system two Animal Incinerators were installed at the Post Mortem Hall, Department of Veterinary Pathology for safe disposal of waste materials. Plantation drive was undertaken with an aim to increase the green coverage of the campus and protect the environment and a total of 1456 plants were planted. Further, in an attempt to reduce power usage and energy conservation LED lights were procured to replace the existing non-efficient light.





Improving educational standards:

Soft Skill Development: Thirty seven lectures (webinars and seminars) were conducted under soft skill programme on topics such as effective communication, scientific temper, emotional intelligence and personality development. A national training on Personality development was also conducted for students under IDP. Total number of beneficiaries till date was 3167.

Technical skills: Forty one lectures (webinars and seminars) with 7036 beneficiaries were conducted in all constituent colleges of GADVASU under technical skills on various topics including antibiotic resistance, food and animal borne disease, COVID-19, ornamental fisheries and dairy economics. A total number of 10 technical trainings on poultry, equine health and artificial intelligence were also conducted.

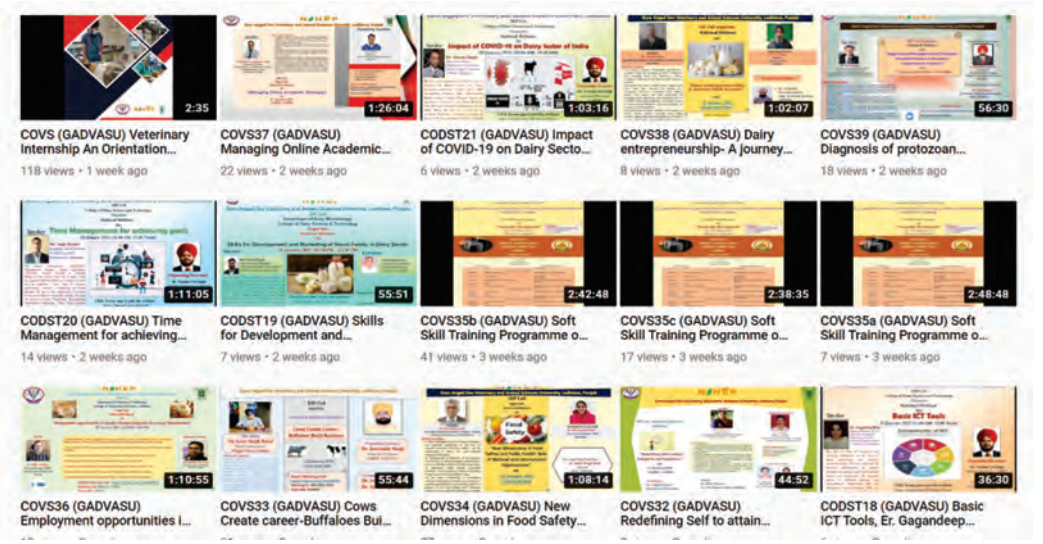
Entrepreneurial skills: Thirty four lectures (webinars and seminars) were conducted under entrepreneurial skills on topics such as entrepreneurial skills in dairy sector, fisheries, meat and egg processing, and goat farming with 4787 beneficiaries.

Industry -Academia Interface: Seven lectures were conducted under Industry- Academia interface on topics such as ornamental fisheries, buffaloes build business and Indian poultry process during COVID-19 etc.

Artificial Intelligence Training: Four training on Artificial Intelligence was conducted by College of Animal Biotechnology under IDP. Four modules *viz*. Basics of Artificial Intelligence: from Scratch to Conceptualization, Statistical Perspectives of Machine Learning, Diving Deep into the Concept of Machine Learning, and Intelligent Systems: Adding New Dimensions to Animal Sciences were conducted with a total of 70 participants from various constituent colleges of GADVASU.

Video Tutorials for UG Students: To cope up with the unprecedented situation of COVID-19 epidemic when the student missed classrooms teaching and physical learning, various initiatives were taken to minimize the loss and maintain the standards of teaching. In the process, a total of 40 Video tutorials (09) have been developed by all the constituent colleges and uploaded on GADVASU YouTube channel for online learning of students. These tutorials were developed to cover the practical aspects of the curriculum

and have proved highly beneficial to the students. Further, the YouTube channel also contains different playlist of Veterinary, Dairy and Fisheries webinar conducted on the online platform.



Remedial courses for weaker section students: Remedial classes were designed and organized to improve the academic skills and raise the level of comprehension of basic subjects to provide a stronger foundation for further academic work. Further, emphasis was laid on strengthening the knowledge, skills and attitudes in such subjects, where quantitative and qualitative techniques and laboratory activities are involved, so that, the necessary guidance and training provided under the programme may enable the students to come up to the level necessary for pursuing studies efficiently and to reduce their failure and dropout rate. These remedial classes were organized in College of Fisheries (06 courses), College of Dairy Science & Technology (06 courses) and College of Veterinary Science (06 courses) with a total of 415 beneficiary. The motivated teachers of the university were engaged to teach the identified poor performers and dropouts during the evenings of the working days, or on holidays, or in vacations, depending upon the mutual convenience. A significant increase in the students' performance has been recorded upon the implementation of these classes.

Visiting Professors teaching students at GADVASU

The College of Veterinary Science invited International Visiting Professors to pursue undergraduate teaching in B.V.Sc. & A.H. programme under the project to enable productive international cooperation and exposure of our students for academic improvement and enhanced skill development. Professor Eduardo Bastianetto, Preventive Veterinary Medicine, Minas Gerais State University, Brazil and Dr. Jaswant Singh, Professor, Department of Veterinary Biomedical Sciences, University of Saskatchewan,

Canada delivered several lectures in Veterinary Parasitology and Veterinary Gynaecology and Obstetrics, respectively. Practical classes with demonstration on various advance diagnostic laboratory techniques for sensitive and specific diagnosis of parasitic diseases in livestock were conducted in Parasitology. Dr. Singh, demonstrated the procedures to undergraduate students in the area of bovine follicular dynamics, reproductive ultra-sonography, embryo transfer technology and basic histology of reproductive system. The interaction with these distinct Professors enabled our students to get acquainted with the global contents and curriculum of Veterinary Science.

Further, several eminent scientists from premier institutes were invited as National/Guest faculty by all the constituent colleges for delivering lectures in their field of expertise to the undergraduate students.





Exposure Visit of Students to Industries and Plants:

Various exposure visits to Feed Mills and Fish farm were organized for the student of College of Fisheries (03) whereas, the students of College of Dairy Science & Technology (03) visited several milk plants of Punjab for exposure. The students of College of Veterinary Science (21) visited Punjab Home Guards Canine Breeding and Training Institute, Mohali; Punjab Police Academy, Phillaur; Livestock Farms; Feed Plants; Frozen Semen Station and Nanital Zoo under the project.

International training for faculty and students:

The project enables productive academic international cooperation, faculty international training, students' international internships/exposure by supporting visits by Indian students and faculty for training and experimentation in premier laboratories worldwide and consolidation of bilateral cooperation through academic and research partnerships. Under the faculty international training programme, till date 05 faculty members have been granted approval for training period ranging 03-06 months at various reputed laboratories abroad. Further, case for approval of second batch of faculty members under International training is under consideration. Also, a batch of 26 undergraduate students from College of Fisheries has been selected for International training after approval from ICAR.

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Dear authors, 'Vet Alumnus' - the official organ of the Alumni Association, College of Veterinary Science (Ludhiana), Guru Angad Dev Veterinary and Animal Sciences University, Punjab-141004, India is a registered journal with ISSN 2319-5762 and is being published biannually in the months of June and December every year. Recently published issues of the 'Vet Alumnus' are available as OPEN ACCESS on https://www.gadvasu.in/page/vet-alumnus

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