E-BOOK

INNOVATIVE SKILL BASED ANIMAL HUSBANDRY & ALLIED PRACTICES FOR ENTREPRENEURSHIP

2024

EDITED BY:
DR.SUKANTA BISWAS
PROF ARUNASIS GOSWAMI
DR.SHAHAJI SAMBHAJI PHAND
DR. SUSHRIREKHA DAS

JOINTLY PUBLISHED BY
WEST BENGAL UNIVERSITY OF ANIMAL & FISHERY SCIENCES, KOLKATA
&
NATIONAL INSTITUTE OF AGRICULTURE EXTENSION MANAGEMENT(MANAGE)
HYDERABAD

Innovative Skill Based Animal Husbandry & Allied Practices for Entrepreneurship

Jointly Published

By

National Institute of Agricultural Extension Management

(MANAGE)

&

West Bengal University of Animal & Fishery Sciences

(WBUAFS)

INNOVATIVE SKILL BASED ANIMAL HUSBANDRY & ALLIED PRACTICES FOR ENTREPRENEURSHIP

Editors: Sukanta Biswas, Arunasis Goswami, Shahaji Sambhaji Phand & Sushrirekha Das

Edition: 2024

ISBN: 978-81-19663-66-8

Citation: Sukanta Biswas, A.Goswami, Shahaji Sambhaji Phand and Sushrirekha Das (2024). Innovative Skill Based Animal Husbandry & Allied Practices for Entrepreneurship [E-book] Hyderabad: West Bengal University of Animal & Fishery Sciences, Kolkata & National Institute of Agricultural Extension Management, Hyderabad, India

This e-book is a compilation of resource text obtained from various subject experts of W.B. University of Animal & Fishery Sciences, Kolkata & MANAGE, Hyderabad, on "Innovative Skill Based Animal Husbandry & Allied Practices for Entrepreneurship". This e-book is designed to educate extension workers, students, research scholars, academicians related to Veterinary & Animal Sciences, fishery science and other allied science about the Sustainable Development of entrepreneurship among the stakeholders. Neither the publisher nor the contributors, authors and editors assume any liability for any damage or injury to persons or property from any use of methods, instructions, or ideas contained in the e-book. No part of this publication may be reproduced or transmitted without prior permission of the publisher/editors/authors. Publisher and editors do not give warranty for any error or omissions regarding thematerialsinthise-book.

Published for Dr. Yogita Rana, IAS, Director General, National Institute of Agricultural Extension Management (MANAGE), Hyderabad, India by Dr. Srinivasacharyulu Attaluri, Deputy Director, MANAGE and printed at MANAGE, Hyderabad as e-publication.

FOREWARD

Animal Husbandry Plays a pivotal role in sustainable livelihood of rural stakeholders, which significantly contribute in the economy of rural India. It is considered a sustainable mechanism for all-round development of organization and stakeholders in general. However, in recent times, several challenges like- Innovative technological development, economic liberalization and globalization acting as prime bottleneck in the facets of development. Considering this challenges, adoption of various innovative skill based animal Husbandry& allied management strategies helps in effective development of entrepreneurship among stakeholders. These approaches also mediate economic progress for creation of rural skill based employment through holistic entrepreneurial ventures. Hence, developing sustainable entrepreneurship for upliftment of the younger generation is of paramount importance.

In view of this, promotion of Animal Husbandry and allied farming based self-employment assumes significance for boosting rural entrepreneurship and livelihood opportunities for better role performance in socio-economic development. Ultimately, this will reduce unemployment, increase efficiency in resource utilization and finally, enhance the empowerment and income of the rural employees and stakeholders of the Country.

In this context, I am gratified that the West Bengal University of Animal & Fishery Sciences (WBUAFS) Kolkata, and National Institute of Agricultural Extension Management (MANAGE), Hyderabad jointly publishing E-book on *"Innovative Skill Based Animal Husbandry & Allied Practices for Entrepreneurship"*. The e-book is designed to enable participants from different states to conceptualize various innovative animal Husbandry and management strategies as well as avenues for better role performance in their organization and society in general.

I compliment the authors and editorial team of WBUAFS, Kolkata and MANAGE, Hyderabad for publication of an E-book as visionary document for better sustainable application and adoption of the technological practices in holistic development of the state as well as Country.

Prof. Arunasis Goswami
Professor& Former Director
WBUAFS, Kolkata-37, WB

PREFACE

Animal Husbandry has emerged as a powerful force in driving economic growth, creating employment opportunities, and addressing societal needs since time immemorial. In India, a Country rich in natural heritage, animal Husbandry management strategies holds tremendous potential for fostering organization development, promoting sustainability and empowering entrepreneurial stakeholders.

This E-book explores the fascinating realm of Innovative; skill based animal Husbandry & allied sector management avenues in India. It delves into the convergence of traditional animal Husbandry practices with innovative and modern technological principles in relation to sustainable animal husbandry practices. The journey of this innovative strategical approach is not only about enhancing formal and non-formal organisation productivity, but also about transforming mind-sets and fostering a culture of innovation. By harnessing the potential of Extension professional, researchers and workers, India can unlock new avenues for rural development, sustainable livelihoods, and environmental stewardship. This e-book will explore the various dimensions of livestock, Poultry farming and allied management thoughts and procedures through innovative practices in India. By harnessing power of extension and entrepreneurship and adopting management practices, we can foster a more inclusive and sustainable future for India and beyond.

This e-book is an outcome of collaborative online training program on *'Innovative Skill Based Animal Husbandry & Allied Practices for Entrepreneurship'* conducted from 21-23rd August, 2024. This book will be highly useful to veterinary & allied science extension professional and functionaries as well as extension workers who are working at the ground level. A myriad of topics from Advances in Poultry farming, Strategic Nutritional Management of Livestock & Poultry, Integrated farming practices, AMR, Zoonosis, Sustainable Entrepreneurial process in Animal Husbandry & Fishery sectors, ICT & its application in Extension etc. has been covered for the benefit of the readers. The Editors' express sincere thanks to Dr. Yogita Rana, IAS, Director General; MANAGE for encouragement in publishing this e-book. The financial aid provided by MANAGE, Hyderabad for this training program is duly acknowledged. We hope and believe that the suggestions made in this e-book will help to improve the ability of all the stakeholders to enhance performance of Animal Husbandry & allied sector professionals in support of sustainable empowerment among stakeholders in the Country.

Dr. Sukanta Biswas
Dr. Shahaji S. Phand
Dr. Sushrirekha Das

Dated. 30th November, 2024

CONTENT

Chapter-1

Sustainable Poultry Farming: Advances in Holistic Entrepreneurship Development

Sanjeev Kumar[1] and Manjari Pandey[2]

Bihar Animal Sciences University, Patna, Bihar, India

[1]Registrar, Bihar Animal Sciences University, Patna, Bihar, India and corresponding author (Email: registrarbasu@gmail.com; skgicar@gmail.com)

[2]Assistant Professor, Animal Genetics and Breeding, College of Veterinary and Animal Sciences, Kishanganj, BASU, Patna, Bihar (Email: mnpandey155@gmail.com)

World Commission on Environment and Development introduced the concept of sustainability in 1987. The sustainable development is attained when the needs of current generation is met without compromising the needs of future generations. It is based on the principle of balancing economic, social, environmental and institutional interests (Valentin and Spangenberg, 2000). Sustainability may be seen as adding values to the ethically good practices that serve an agreed goal to the masses.

The concept of sustainability has been incorporated in almost all the areas of modern world. Poultry farming, an integral component of global agriculture too has incorporated major transformations in recent years prompted by the need of sustainability. This transformation mirrors a larger trend toward more ethical, environmentally friendly, and economically viable poultry rearing techniques. Sustainable poultry farming aims not just on maximizing production but also promote poultry welfare, economic stability of farmers. It highlights the importance of minimizing negative environmental effects.

"Poultry" includes all domesticated birds kept by humans for their eggs, meat, feathers and other by-products. These are reared under different types of rural and urban farming systems. The local production requires minimum transportation with minimum usage of fossil fuel. Among the terrestrial creatures, poultry has the best feed conversion rate and the smallest environmental footprint in terms of energy and water use per kg meat or eggs produced. This article explores the advancements in sustainable poultry farming through the lens of holistic entrepreneurship development.

Components of Sustainable Poultry Farming

Poultry farming is sustainable if it follows practices that maximize resource utilization, reduce waste, emphasize poultry care, and adhere to the ethical norms. Some of the key components are:

Environmental Stewardship: The concept of sustainable poultry farming depends to a large extent on its impact on environment. The overall impact of complete production or value chain can be examined through a Life Cycle Assessment (LCA) method. It traces the inputs back to natural resources and emissions produced along the way. In an experiment that conducted an

LCA for broiler production reported that it is the most resource efficient meat production in agriculture due to its genetics and nutritional efficiency (Williams *et al.*, 2009). There is a huge potential for improvement in overall lifetime feed conversion efficiency and reduced reliance on fossil fuel.

The poultry farming is sustainable if there is efficient utilization of water and energy, minimum possible pollution, and adoption of practices that tend to preserve biodiversity. The entire cycle of poultry rearing till its consumption results in production of hatchery wastes, litter material, poultry droppings and slaughter house wastes like offal, organs of slaughtered birds, processing waste water and bio solids, etc. (Williams, 2013). Out of these most of them are rich in organic and inorganic nutrients that may be very valuable if recycled in an efficient way. The litter is being utilized for centuries to enhance crop production. Researches have shown that properly treated and neutralized poultry waste by-products can be used as components of livestock and poultry diets (McCaskey, 1995). Even value-added feed ingredients are produced in some regions using advanced techniques of treating and processing feathers and offal.

Now a day, many processing techniques are also available that can convert the organic matter present in manure and litter into bioenergy. Water flushed manure after anaerobic digestion yields biogas with varying concentration of combustible methane (FAO/CMS, 1996). This renewable source of energy can be utilized on farm as a source of heat or as fuel for electricity generating engines. The furs and feathers of poultry species can be used in the making of trending designer outfits that fetch high prices in the global market.

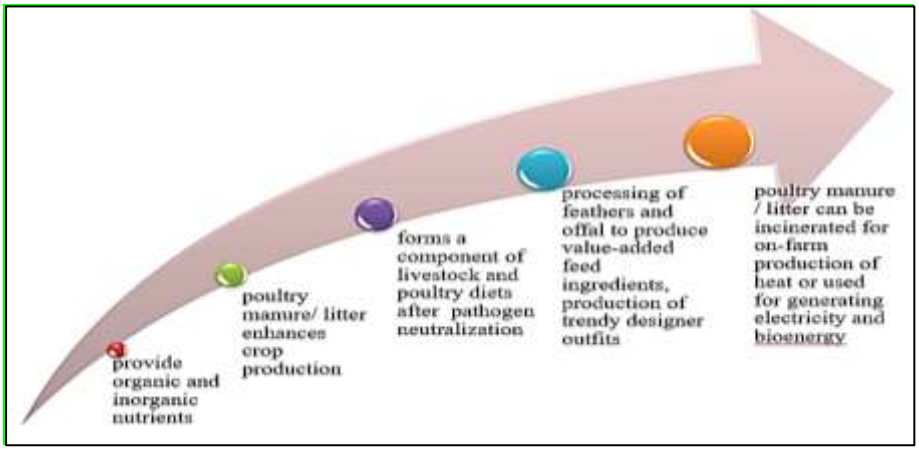


Fig. 1: Poultry waste management for efficient utilization of waste

Poultry Welfare: Another major component of sustainable poultry farming is providing humane conditions for poultry, including adequate space, proper nutrition, and proper environment to express their natural behaviours. Freedom of movement, whether raised on floor or raised in cage system, is one of the major concerns. Adequate space along with climate-controlled housing

is a necessity. Renewable sources of energy like solar heating and natural ventilation can reduce the need of fossil fuels.

Multi-tier cage systems are common for controlled-environment housing that provides ideal thermal environment for the birds (Glatz and Bolla, 2004). The water system should be designed in a way that keeps the water uncontaminated. In a welfare quality research project sponsored by EU, a list of certain criteria were established for defining welfare related aspects. It highlights the points that suggest that poultry should not suffer from prolonged hunger and thirst, have ample space to move around and be able to express normal non-harmful behaviour. It suggests that positive emotions need to be promoted and negative emotions like fear, distress, frustration, apathy must be avoided in poultry farming.

Certain systems do not fulfil these criteria and some rearing methods cause suffering to poultry e.g. foot pad dermatitis which may be associated with fast growth. The compromised

welfare may result in abnormal behaviour and stress. Irrespective of the applied animal welfare definition used, it is a fact that farm animals, including poultry, are living, sentient individuals which need to be protected and offered opportunities for living a life worth living.

Fig.2: Modern housing system for sustainable poultry farming

The human society need to secure practices for future that promotes poultry welfare, giving birds a life that is without sufferings which is desirable for sustainability and ethical point of view (Thompson, 2007)

Economic Viability: Implementing cost-effective measures that ensure profitability while reducing financial risks for farmers/ entrepreneurs.

Social Responsibility: Every entrepreneurial activity has some social responsibility that must be well defined and properly carved for the benefit of masses. Engaging with local communities, adhering to ethical labour practices, and contributing positively to rural economies are some of the social responsibilities associated with poultry farming. The sustainability of any farming system depends on its positive impacts on the society.

Studies regarding working conditions of farm workers in poultry farm deal with two categories of social aspects for humans i.e. working conditions and health of the workers and owners and fairness of employment contracts like health insurance, decent salaries etc. there are certain employment hazards associated with poultry farming e.g. the workers engaged in poultry farming are at a higher risk of getting infected with antibiotic resistant bacteria, allergies to antibiotics, dust exposure from litter and feathers (Le Bouquin, 2014).Disease risks, issues related to human rights and general working conditions are inter linked to each other. Gender balance is yet another crucial aspect. Greater proportion of women force is involved in small scale farm level or on family/individual level production systems (Dolberg, 2007). However the large-scale farms are dominated by male work force. This too needs to be equated. Each of these aspects needs to be dealt carefully for making the business and market of poultry farming sustainable.

Advances in Holistic Entrepreneurship Development

Holistic entrepreneurship in the context of sustainable poultry farming goes beyond traditional business practices. It integrates innovative strategies that balance economic success with environmental and social responsibilities. Here are key advances:

1. Technology Integration

Modern poultry farms are increasingly leveraging technology for precision farming. Automated feeding systems, climate control sensors, and data analytics optimize resource use and monitor animal health in real-time. This not only improves efficiency but also reduces environmental impact by minimizing resource wastage.

Technologies in housing management: Fully automated poultry house is the near future of poultry farming where most of the operations will be done by robots. Automated public control system will check the unwanted entries, safeguarding the entire flock. Air quality monitors installed in the poultry farms will display various air quality information like level of carbon dioxide/ ammonia, humidity, temperature etc. Newer technologies like livestock monitoring system, robotic system with artificial intelligence aided by computer vision capabilities will soon be incorporated in poultry farms as well.

Technology in Egg sexing and sex alteration

In layer farming, the sexing is usually carried out after hatching and several male chicks are killed. This can be avoided if the sex is identified before hatching. SELEGGT GmbH is an automated, scientific approach of endocrinological (hormone-based) technique in which a tiny drop of allantois fluid is extracted from fertilized egg and is placed in a patented marker in which

estrone sulphate (present only in female sex) reacts and changes colour thus differentiating the sex as early as 8th to 10th day of incubation.

eggXYT CRISPR Gene Editing Technology: In this technology, a bio-marker is inserted in DNA of male chicks at the parent stock level that creates an optical signature in embryos which helps in detecting male chicks during the breeding/ hatching operation. The male embryos are diverted to food production (Thornton, 2018).

RNAi technology: Modifying the activity of key sex-determining genes during embryonic stage can alter the sex of embryo. Modification in DMRT1, a Z-linked gene (needed for testes development) induces development of ovaries in chicken embryo thus producing genetic males (ZZ) with attributes of female (Smith *et al.,* 2009). Similarly, knocking down aromatase will produce only male chickens (Lambeth *et al.,* 2013).

Technology in nutritional domain

MAKEFEED POULTRY software is a window-based computer software developed by the scientists of ICAR- Central Avian Research Institute, Izatnagar, Bareilly. It formulates low cost, efficient balanced feed for layer and broiler chickens, quails, guinea fowls, turkeys etc. based on diversified agro-climatic conditions of India.

Resource management through augmentation of nutrient bio-availability in non-conventional feedstuffs: Various techniques including physical, chemical and biological treatments are in place to enhance the bio-availability of nutrients in non-conventional feed stuffs like wet processing, reconstitution with or without enzymes, autoclaving, alkali and acid treatments, fermentation etc. Addition of microbial phytase in diets of poultry significantly improves phosphorus utilization. Mineral chelates, prebiotics, probiotics etc. are found to enhance the immune response as well as production performance of poultry.

***In ovo* injection of nutrients**: *In ovo* feeding and *in ovo* vaccination result in better post-hatch growth and immunity in the birds. Certain nutrients that can modulate the genes related to growth and immunity have been identified and used to develop a package for *in ovo* intervention resulting in better post-hatch growth and increased immunity against common diseases.

Nutrigenomics: It is one of the most interesting areas which can address issues related to both resources as well as changing expectations. The use of Ecomomas E (Thiruvenkadan and Prabakaran, 2017) augments the same pattern of gene expression even if Vitamin E content in feed is reduced by as high as 80% which ultimately reduces the cost of feed. Programmed Nutrition (PN) is the emerging field where nutrigenomics is being used for delivering diets that significantly lower down the excretion of minerals and cost of diet, improves antioxidant status of birds and enhances the quality of egg and meat (Kumar and Pandey, 2019).

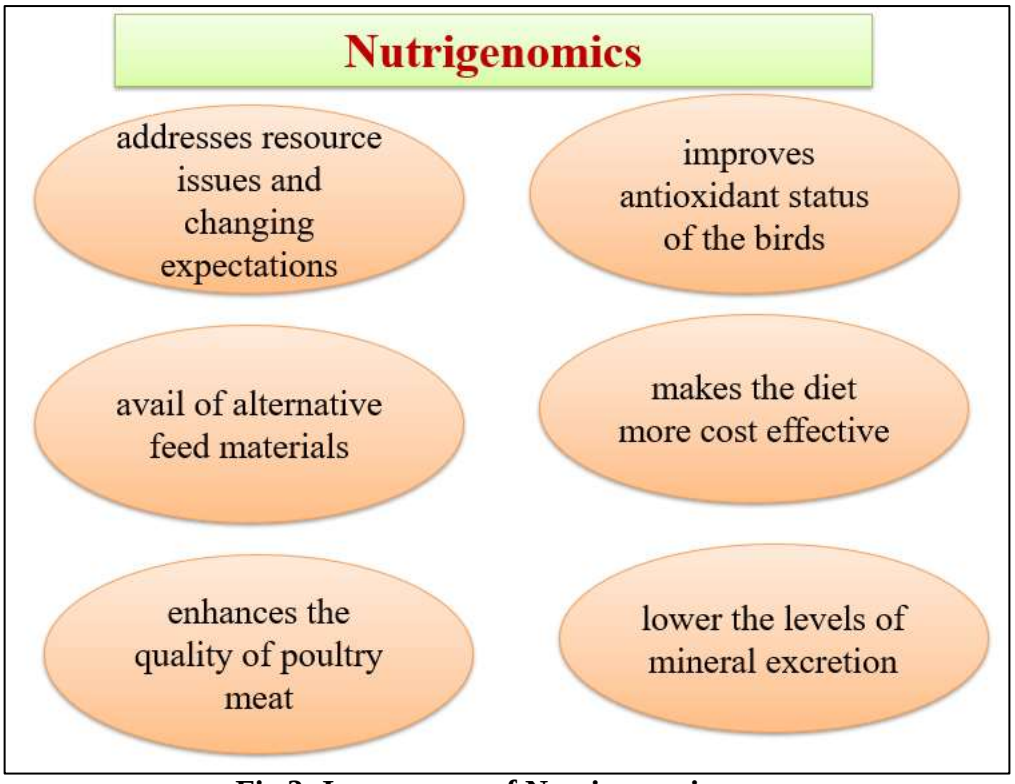


Fig.3: Importance of Nutrigenomics

2. Agro-ecological Practices

Agro-ecology principles emphasize natural synergies between crops and livestock, reducing dependence on external inputs like chemical fertilizers, fossil fuels and antibiotics. Integrated farming systems promote soil health and biodiversity conservation, contributing to sustainable agricultural landscapes.

For climate mitigation, it is important to reduce the use of fossil fuels in poultry farming. Depending on how poultry and their feed are raised, poultry production can be carbon neutral. Unlike grazing animals, poultry do not produce significant amounts of the greenhouse gas, methane, during digestion. Poultry has the least impact on ecology in terms of land size, water use, environmental stress and footprints both for poultry meat and eggs (De Vries and De Boer, 2010). Transport however is an environmentally burdening activity.

Manure from poultry can be used as fertilizer for crops. Also, poultry can be fed with by-products, such as cull crops or fruit pulp, to increase nutrient cycling. Insects raised on crop and food residues can also provide sustainable feeds for poultry. Integrated poultry farming is the emerging practice that will keep it sustainable.

3. Resource Management and Economy related Initiatives

Waste from poultry farming like manure, can be used as an organic fertilizer or through anaerobic digestion, can also be recycled into bioenergy. Circular economy model that closes the

nutrient loops within the farm, minimizes the cost on disposalof waste and reduces environmental pollution.

Even slaughtering and processing of meat and eggs consumes a lot of energy and water. Therefore, it is important that the processing units must focus on utilizing renewable sources of energy thereby reducing the impact on the environment. Poultry litter or feathers too can be integrated in sustainable production systems by composting them for organic matter.

A study conducted in Brazil, China, Netherlands and the United States on modelling water footprint in poultry production was determined by FCR, feed composition and ingredient origin (Gerbens-Leenes *et al.*, 2013) and it was reported that roughage has lower water footprint and lower FCR than concentrate. The research emphasised that for sustainable poultry farming the status of local water availability is very important. Production that requires more water is not sustainable in areas that have scarcity of water.

Another very relevant aspect of resource management is related to protein sources that are shared by poultry and human beings. Nutrigenomics, *in ovo* injection of nutrients, and augmentation of nutrient bio-availability in non-conventional feed stuffs as discussed above are some of the alternatives that can be used for sustainable poultry farming without competing with the food availability for humans.

Inappropriate and growing use of antibiotics in poultry farming is yet another aspect which needs to be handled very seriously. Any type of production that relies on the use of medicine, which imposes a risk of developing resistant bacteria over time, or whose residuals pollute the surrounding environment, cannot be classified as ‘sustainable’, especially when the medication is used for preventive purposes or as growth promoters and/or as mass medication.

Breed Diversity

More than 30 species of animals are domesticated till date worldwide. In India, the total registered breeds are 220 out of which total 20 poultry breeds have been recognised by NBAGR, Karnal, Haryana although more than 8000 registered breeds of different species including hundreds of poultry breeds are recognized worldwide. Most of these breeds are reared by small farmers, who are also playing an important role in their conservation. Most of the breeds are indigenous, locally adapted and multi-purpose that suit to various farming enterprises. Not all breeds are economically viable but we cannot risk to lose those breeds as it is not just the loss of natural capital or genetic wealth but also loss of a possibility of adapting to different situations and changing environmental conditions (FAO, 2015). Sustainability in the future depends on presence and maintenance of genetic variability.

4. Market Diversification

Holistic entrepreneurship encourages diversifying product offerings beyond conventional poultry meat and eggs. Specialty products such as organic, free-range, and heritage bred poultry, appeal to niche markets willing to pay premiums for quality and sustainability.

Poultry Products technology

With the advancement in biotechnology genetic and nutritional manipulation in the egg composition has become a reality.

Designer eggs can be produced having lower cholesterol (Hargis, 1988; Elkin *et al.*, 2003; Kim *et al.*, 2004; Elkin, 2007) and fatty acid levels, higher concentration of vitamin A and E, increased micro mineral contents like selenium, iodine, zinc, copper and chromium in albumin and yolk. Iodine deficiency is one of the major deficiency problems in India and eggs could be a good source for its supplementation (Kaufmann *et al.*, 1998). Alteration in the diet of poultry can change the fatty acid profile of eggs. The omega-3 fatty acid content in the egg yolk can be increased by adding safflower oil, marine algae, fish oil, fish meal and vegetable oil in poultry feed (Holman *et al.*, 1982; Bjerve, 1991). Genetically modified chickens can produce eggs containing pharmaceutical compounds like insulin which can be used for treatment of diabetic patients (Verma*et al.*, 2012).

The worldwide researchers are focusing on production of designer meat that will have higher levels of antioxidants like Vitamin-E, selenium, carotenoid pigments, flavonoid compounds, lecithin and phosvitin and also rich in herbal active principles like, Allicin, Betaine, Eugenol, Lumiflavin, Lutein, Sulforaphane, Taurine Eugenol, Lumichrome, Lycopene, Curcumin, Carnosine, Quercetin (Sireesha and Prasanna, 2019). The designer meat has more shelf life as it is less susceptible to lipid peroxidation which prevents fishy taint to the product and prevents destruction of fat-soluble vitamins and natural fat-soluble pigments.

Value-added poultry products:

Various value-added products are now available in the market. Value addition not only increases the taste but also the variety and shelf life of the products. Some such value added products include cured and smoked chicken, chicken patties, chicken nuggets, intermediate moisture chicken meat, chicken chunkalona, chicken meat spread, marinated chicken breast fillets, vinegar based chicken gizzard pickle, cooked chicken stock (One-minute curried chicken), mixed chicken loaf, cooked chicken roll, pickled eggs, albumen rings, salted egg, egg strips, egg waffles, egg pancake, egg roll, egg crepe etc.

By- products from poultry slaughter have also been used to prepare pet food. Pet food biscuits can be prepared by using damaged egg liquid, bakery waste, mixed cereal flour, soyabean oil and permitted food additives with a shelf life of about 4 months at room temperature.

Marketing strategies

The human beings are excessively engaged in the world of digitalization. Proper channelizing, marketing and reaching the customers have become easy. Proper marketing is the key to earn profit. Developing branded unique products from indigenous poultry is the much-needed demand. The quality of poultry product is of much concern in respect to the globalization of market and economic integration. Developing an online platform for sale of the product is a necessity. eNAM under Ministry of Agriculture and Farmers' Welfare, Government of India is one such electronic trading portal that promote uniformity in agriculture marketing by streamlining of procedures across the integrated markets, removing information asymmetry between buyers and sellers and promoting real time price discovery based on actual demand and supply. It provides better price discovery through transparent auction process based on quality of produce along with timely online payment. Most of the products of animal/ poultry origin are yet to get place in it.

Building the trust of consumers

Now a day, various products are available in the market. What product to choose depends on the trust of consumers on the quality of the product. Various technologies can be incorporated to increase the transparency.

Augmented reality is one such technology where consumers can receive information regarding the source of food and the processes through which it has undergone. Virtual reality is another budding technology which can help in keeping an eye on the birds and walking through the entire farm without disturbing them (Pandey, 2021). This can be used to give virtual tour to the consumers without breaching the biosecurity measures.

Complete transparency in food supply chain is now possible through a transformative technology i.e. Block chain. It gives complete information about the origin, distribution and supply of food. In poultry industry, it can be used to fetch complete details about where the bird came from, how it was fed and raised and how it was processed. Virtual invoice accessible to all the parties in real time can make accounting more transparent. It is already in place in China and U.S. Soon it will form a massive part of the food industry's future, driving quick changes (Alonzo, 2018)

Another technology, Internet of Things (IoT) can simplify the sharing and analysis of data. It allows one to have as much information as possible with easy accessibility (Alonzo, 2018). An informed consumer is always an asset that helps in the growth and sustainability of poultry farming

5. Educational and Training Programs:

The emerging technologies and methods are new to the farmers. Most of the farmers are reluctant to adopt new technologies until and unless they are educated about the sustainable practices and their benefits. Technical trainings and demonstrations are necessary to enhance their trust on adoption of new technologies and methods. Such trainings empower farmers and educate them to make right decisions that are beneficial both their business, economy and the environment. The stakeholders need to know about the holistic approach that focuses on how the health of poultry birds is integrated with the health of the natural environment and humans.

Challenges and Opportunities

While sustainable poultry farming presents numerous benefits, challenges persist. There are many sustainability aspects that need to be addressed in poultry farming. Poultry sector is a complex system and it will remain unsustainable if any of its subsystems faces unsustainable challenges *e.g.* feed production in environmentally and socially critical conditions. There are potential conflicts between long-term consequences and short-term costs or benefits (Williams *et al.*, 2009). Then initial investment costs for technology adoption is very high. The regulatory compliances are hard and educating consumers about the value of sustainably produced poultry products is not a cakewalk (Vaarst *et al.*, 2015). However, these challenges also bring opportunities for innovation, collaboration among stakeholders, and market differentiation.

Conclusion

Sustainable poultry farming is not merely a trend but a necessity in ensuring food security, environmental health, and economic stability. Advances in holistic entrepreneurship development are pivotal in driving this transformation, fostering a new generation of poultry farmers who are stewards of the land, guardians of animal welfare, and contributors to thriving rural communities. By embracing sustainability in poultry farming, we can build a resilient agricultural sector that meets present needs without compromising the ability to meet needs of future generations.

References

Alonzo, A. (2018). Disruptive technologies coming to the poultry industry. WATTPoultry.com, retrieved on 24/2/2021. (https://www.wattagnet.com /articles / 334 36 - disruptive-technologies-coming-to-the-poultry-industry)

Bjerve, K.S. (1991). Omega-3 fatty acid deficiency in man: Implications for requirement of α-linolenic acid and long chain omega-3 fatty acids. *World Review of Nutrition and Dietetics*. (65): 133-142.

De Vries, M. and De Boer, I.J.M. (2010). Comparing environmental impacts for livestock products: A review of life cycle assessments. *Livestock Science*. 128: 1-11.

Dolberg, F. (2007). Poultry production for livelihood improvement and poverty alleviation. FAO publication: Poultry in the 21st century. Pp. 26. (http://www.fao.org/ag/againfo /home/events/bangkok2007/docs/part3/3_1.pdf.)

Elkin, R.G. (2007). Reducing shell egg cholesterol content. II. Review of approaches utilizing non-nutritive dietary factors or pharmacological agents and an examination of emerging strategies. *World's Poulry Science Journal.* 63: 5-31.

Elkin, R.G., Furumoto, E.J. and Thomas, C.R. (2003). Assessment of egg nutrient compositional changes and residue in eggs, tissues, and excreta following oral administration of atorvastatin to laying hens. *Journal of Agriculture and Food Chemistry*. 51: 3473-3481.

FAO. (2015). Coping with Climate Change – the roles of genetic resources for food and agriculture. Commision on genetic resources for food and agriculture. Pp. 110. (http:// www.fao.org/3/a-i3866e.pdf)

FAO/CMS. (1996). Biogas technology: a training manual for extension. (www.betuco.be/biogaz/biogas%20fao.pdf on 19/11/2019)

Gerbens-Leenes, P.W., Mekonnen, M.M. and Hoekstra, A.Y. (2013). The water footprint of poultry, pork and beef: A comparative study in different countries and production systems. *Water Resources and Industry*. 1-2: 25-36.

Glatz, P.C. and Bolla, G. (2004). Production systems, poultry. In Encyclopaedia of meat sciences, Oxford, UK, Elsevier. 1085 – 1092.

Hargis, P.S. (1988). Modifying egg cholesterol in the domestic fowl: A review. *World's Poultry Science Journal.* 44: 17-29.

Holman, R.T., Johnson, S.B. and Hatch, T.F. (1982). A case of human linolenic acid deficiency involving neurological abnormalities. *American Journal of Clinical Nutrition.* 35: 617-623.

Kaufmann, S., Wolfram, G., Delange, F. and Rambeck, W.A. (1998). Iodine supplementation of laying hen feed: a supplementary measure to eliminate iodine deficiency in humans*? Z Ernahrungswiss*. 37: 288-293.

Kim, J.H., Hong, S.T., Lee, H.S. and Kimt, H.J. (2004). Oral administration of pravastatin reduces egg cholesterol but not plasma cholesterol in laying hens. *Poultry Science*. 83: 1539-1543.

Kumar, S. and Pandey, M. (2019).Advancements in Biotechnology for Safer Poultry Production in India, *In* Compendium of XXXVI Annual Conference of Indian Poultry Science Association and National Seminar on "Conceptual understanding and future strategies for welfare friendly poultry production in India" at CGKV, Durg, during Dec., 11-13, 2019, LP-5: 26-33.

Lambeth, L.S., Cummins, D.M., Doran, T.J., Sinclair, A.H. and Smith, C.A. (2013). Over expression of aromatase alone is sufficient for ovarian development in genetically male chicken embryos. *PLoS One*. 8: e68362. (doi:10.1371/ journal.pone.0068362)

Le Bouquin, S. (2014) Air quality in poultry hatcheries. *Proceedings of the XIVth European Poultry Conference*, Stavanger, abstract.

McCaskey, T. (1995). Feeding poultry litter as an alternative waste management strategy. In K. Steele, ed. Animal waste and the land water interface, New York, Lewis-CRD. 475–484.

Pandey, M. (2021). Modern technologies shaping the poultry industry. *epashupalan*. 3(2): 25-30. (https://wp.me/pbYZMt-2qg)

Sireesha, P. and Prasanna, S. (2019). Designer eggs and poultry meat as functional foods – An overview. *The Pharma Innovation Journal*. 8(4): 829-831.

Smith, C.A., Roeszler, K.N., Ohnesorg, T., Cummins, D.M., Farlie, P.G., Doran, T.J. and Sinclair, A.H. (2009). The avian Z-linked gene DMRT1 is required for male sex determination in the chicken. *Nature*. 461: 267–271.

Thiruvenkadan, A.K. and Prabakaran, R. (2017). Recent Approaches in Poultry Breeding. *Approaches in Poultry, Dairy & Veterinary Sciences*. DOI: 10.31031/APDV.2018.02. 000533

Thompson, P.B. (2007). Agricultural sustainability: what it is and what it is not. *International Journal of Agricultural Sustainability*. 5 (1): 5-16.

Thornton, G. (2018). 16 innovations to change poultry production. WATTAgNet.com. https://www.wattagnet.com/articles/36187-innovations-to-change-poultry-production.

Vaarst, M., Steenfeldt, S. and Horsted, K. (2015). Sustainable development perspectives of poultry production. *World's Poultry Science Journal*. 71 (4): 609 – 620. DOI: https:// doi.org/ 10.1017 /S0043933915002433

Valentin, A. and Spangenberg, J. (2000). A guide to community sustainability indicator. *Environmental Impact Assessment Reviews*. 20: 381-392.

Verma, M., Kumar, A.K., Kumar, A., Rahal, V.A. (2012). Designer Eggs: A Future Prospective. *Asian Journal of Poultry Science*. 6 (3): 97-100.

Williams, A.G., Audsley, E. and Sandars, D.L. (2009). A Lifecycle Approach to Reducing the Environmental Impacts of Poultry Production. *Proceedings and Abstracts, 17th European Symposium on Poultry Nutrition. S4.1*, pp. 7.

Williams, C.M. (2013). Poultry waste management in developing countries. Poultry Development Review. FAO. ISBN 978-92-5-108067-2. (http://www.fao.org/3/a-i3531e.pdf#page=102 on 21/11/2019)

Chapter-2

Technological Interventions in Animal Feed and Nutrition for Augmenting Livestock Productivity

Prof. A. K. Samanta
Department of Animal Nutrition,
College of Veterinary Sciences & Animal Husbandry
CAU (I), Selesih, Aizawl, Mizoram,796015

Animal Husbandry is an integral component of agricultural system. India is endowed with huge livestock population and sustains about 15% of the world's livestock population and 17% of the world human population from 2.3% of the world geographical area. The animal productivity is, however, far below the world average. The inadequate feed resource is the major constraint in the productivity of livestock. Feed affects livestock productivity, profitability, environmental impact, human food and nutrition security, animal welfare and ethics, and animal and human health (Makkar, 2016). Feed is the main input factor for the milk and meat production from livestock, constituting 60-70% of the total recurring expenditure of livestock rearing. Poor-quality fibrous crop residues are the major roughage source. Crop residues provide only moderate amount of energy and other nutrients are deficient particularly nitrogen. The increase in demand for livestock feed has led to introduction of several technological solutions that ensure increase production of quality feed with limited resources. Major focus for small holder livestock research for many years has been therefore, on developing the technologies for improving the nutritive quality of crop residue and to provide optimum nutrients to the dairy animals.

Feed & fodder resources

There is tremendous pressure of livestock on available feed & fodder, as land available for fodder production has been decreasing. It is obvious that deficit in green and dry fodder is increasing every year, while for the concentrate gap is almost static. But this gap is very critical and is going to determine the type of animal and husbandry practices to be followed.

At present, India has a net deficit in concentrated feed ingredients (28.9%), dry crop residue (23.4%) and green fodder (11.24%) (Roy *et al*., 2019). The existing feed resources that are fed to the livestock can be broadly classified into four major categories- crop residues, pasture & grazing resources, forage crops and concentrates.

i) **Crop residues**: Crop residues are the most important feed resources for the livestock in India. These form the basic bulk of available feed resources with the farmer. The extent and

effectiveness of the utilization of the crop residues by the farmers depends on the traditional practices of the village or the farm and also on the total feed resources availability. Most of these are poor quality roughages of low digestibility i.e. generally lower than 50% digestible and are low in protein and Non protein nitrogen (often less than 6% Crude protein) and variably deficient in minerals.

ii) **Pasture and grazing resources**: Under extensive grazing systems and with small and marginal farmers especially under village conditions the contribution of greens from the native pastures and other grazing resources become quite important. The availability of the green from the native pasture is declining over the years. These feed components have poor nutritive value. With certain interventions like proper management of native pasture, introduction of suitable legume species etc. the nutritive value from these resources could be improved considerably.

iii) **Forage crops**: Forages for feeding of livestock can be produced on crop land as well as on un-cropped farm or non-farm areas. The primary purpose of forage crops viz. cultivated fodder, shrubs and fodder trees is to bridge the nutrient gaps specific to the farming system. Animals are fed fodder crops in the form of hay (dehydrated green aerobically), silage (anaerobically fermented forage conditions) and forage (cut green and provided fresh).In the agro forestry system the magnitude of deficit occurrence is comparatively less due to the presence of trees and shrubs integrated with production of crops, which can ensure year –round supply of forage.

iv) **Concentrates**: These are normally used as high value supplements to obtain gain in livestock production. However, the quantum of response to these supplements would depend on several factors like the condition of the animal, the type of supplement used-either protein or energy or a combination of the two, the basal roughage materials and stage of lactation. Coarse cereal grains like corn, barley, sorghum and bajra- play a significant part in the supply of animal feed and account for almost 44% of the total amount of cereals. Maize makes up about three-fourths of all coarse grains, whereas barley makes up 15% (Agrawal *et al*., 2008).

Nutritional technologies: Technological solutions that promise to increase production of quality animal feed, can be categorized into five groups (Balehgn et al., 2020) namely:

1. **Technologies for feed productivity/availability improvement**: Following technologies aimed at improving biomass production or availability of feed
    - Improved forage plants
    - Silvi-pastures/Agroforestry
    - Protected grazing
    - Food-feed crop integration

- Protected Agriculture e.g hydroponics, green house forage production
- Agronomic intervention on cultivated pastures

2. **Technologies for feed quality enhancement**: Following technologies are focused on improving nutritional value, palatability, feed intake and digestibility of low-quality feeds
    - Chemical treatment of crop residues
    - Biological treatment of crop residues
    - Reduction of particle size of crop residues
    - Fertilization of crops
    - Forage crop breeding
3. **Technologies for feed quality maintenance or preservation**: Following technologies aimed at preserving the nutritional quality of feeds during storage for off-season feeding.
    - Silage making
    - Hay making

Technologies for enhancement of the nutritional status of animals: Through supplementation of animal diets with highly nutritious ingredients that supply critical nutrients or enhance digestion and assimilation of feed.

- Balanced and or phased rationing or ration formulation
- Supplementation with concentrates
- Supplementation with multi nutrient blocks
- Supplementation with feed additives

4. **Analytical and operational technologies:**
    - Near Infrared Reflectance Spectroscopy (NIRS)
    - Use friendly ration formulation tools
    - Livestock/feed management applications

Some of the most commonly applied feed and fodder technologies related to qualitative enhancement of available feed resources are discussed below in brief.

Urea Ammoniation technique: Crop residues play an important role in the feeding of livestock. Unfortunately, the lignification of the cell wall and negligible amount of nitrogen, minerals and vitamins present in the crop residues make them poor quality roughages. Efforts have been made to improve their nutritive value by treating them with chemicals. Various chemicals have been used for the treatment of poor-quality roughages. Ammoniation through urea appears to be promising for improvement of nutritive values of crop residues in developing

countries (Mehra et al, 1989). Here the various conditions required for the urea ammoniation of straw are discussed in brief.

Urea level: The basic principle in releasing ammonia from urea is its breakdown to its components that is ammonia and carbon dioxide by Urease enzyme. Different workers have tried different urea levels for this technique. ICAR (1985) has advocated the use of 4% Urea for Ammoniation of Straw to be optimum.

Moisture level: The efficiency of hydrolysis of urea to ammonia depends upon the moisture level of straw. The basic function of water is to dissolve and hydrolyze the urea. Water also acts as a vehicle to move ammonia in the straw. Upadhayay (1989) observed best result with 40% moisture level with different levels of urea for the treatment of wheat straw. ICAR has recommended the use of 65 litres water per 100kg of straw.

Temperature: The effect of Ammonia is accelerated by increasing the temperature. Therefore, urea ammoniation is feasible where the environmental temperature is high, i.e. in tropical climate.

Period of treatment: Results of studies conducted in India indicated that duration of treatment of urea ammoniation range from 3days to 3weeks in hot climate in India. A period of 3-6 weeks would probably be adequate under Indian condition (Rai et al, 1993).

Urea molasses mineral block (UMMB): The unique ability of ruminants to synthesize microbial protein by the use of urea as NPN sources provided ready source of energy should be available. This UMMB will provide additional nutrition and enhance utilization of roughages. The urea molasses and mineral liquid mix is to be solidified into the form of a block which is both acceptable and manageable without having deleterious effects on animals. Development of UMMB technology is cost effective. Here, utmost care needs to be exercised that these blocks are meant only to serve as licks. It should release urea nitrogen more slowly so as to minimize the urea toxicity. UMMB facilitate the supply of minerals and vitamins. UMMB also helps in overcoming the under nutrition of our livestock and generates better returns at the village levels on farm produce.

Mineral supplementation: Under farming system, where straws or stovers form the major source of roughages, the role of minerals become more pertinent as these roughages are deficient in minerals. Minerals deficiency can have marked effect on productivity, health and reproductive performance. Providing region- specific mineral mixture based on the mineral mapping of the area is a cost-effective approach. Supplementation of the diet with mineral mixture is a effective way of overcoming most reproductive problems such as repeat breeding,

low fertility, infertility, delayed post-partum oestrus, and silent heat(Singh and Prasad,2002 ; Tiwari *et al*. 2012).

Strategic supplementation: Strategic supplementation with concentrates or greens is an important area for improving the nutritive value of poor quality roughages. These can be effectively used for improving the feeding of animals and their productivity from the available feed resources. The prerequisite for its effective implementation is the availability of information on the feeding practices, availability of feed resources and their composition and the production capacity of the animals in different region of hilly area. The beneficial effect of strategic supplementation has been successfully demonstrated well under field condition (Sharma et al., 2002)

Densified complete feed block technology: This is an innovative feed technology by which animal can get all the required nutrients as a balanced ration for 24 hours. The dry roughage and the concentrate are the two major components and micro nutrient supplement form the minor component. The technology allows all the ingredients to get sufficiently blended so that concentrate particulate matter sticks to fibre particles with the help of binder or molasses. This helps in preventing the separation of ingredients, making it as much as homogenous feed and leaving little scope for the selectivity by the animal. Being a complete balance diet, it meets all the nutritional requirements and thereby improving the productive and reproductive performance of the animals. There is also more persistency in the lactation curve in animals fed densified feed block or total mixed ration.

Bypass protein supplementation: The ruminant animals derive their amino acids supply jointly from dietary protein which escapes rumen degradation and microbial protein synthesized in the rumen. The amount of protein and amino acids that escapes rumen degradation vary greatly among different feeds, depending on their solubility and the rate of passage to the small intestine. Microbial protein synthesis, however, is regulated by the quantity of plant organic matter fermented in the rumen, provided that ammonia concentration and mineral elements are not limiting (Kaufman and Lupping, 1982). It is often the case in some situation that animal's requirements for amino acids not fully met from the normal sources of dietary protein. Rapid and extensive degradation of valuable proteins in the rumen lead research to develop the concept of protein protection from ruminal degradation with the principal objective of enhancing the supply of essential amino acids to the productive animal and reduction of nitrogen losses as urea in the urine (Annison, 1981).

Conservation of Fodders: Seasonal feed deficit can be reduced considerably or overcome through conservation and preservation of feed resources during the surplus seasons for use in

lean periods. The conservation and proper utilization of conserved grasses and fodders may be achieved through popularizing the adoptions of improved techniques of conservation and processing. The most economic and simplest method of preserving forage crops in the form of hay. The grasses and legumes should be conserved during their period of luxurious growth and availability in abundance. They should be harvested at the flowering stage and dried and stored as 85-90% DM. the hay should be conserved properly without allowing it to sun bleach as good hay should retain green colour. Silage can be prepared from the green fodder when the weather does not permit for hay making. Surplus green fodder available in rainy seasons can be preserved as silage for feeding during lean season. Practically any crops having sufficient soluble carbohydrate and moisture to produce the desired quantities of acids may be made into silage. The fodders like maize, sorghum, bajra, jower and seasonal grasses should be chaffed before filling into the silo. The leguminous forages alone are not suitable for silage making but after some treatments to provide soluble carbohydrate, they may also be converted into silage. The crop for silage making is generally harvested at flowering stage when it has the maximum amount of nutrients after bringing the dry matter percentage to 30-35 by wilting. Thorough pressing the packing of the fodders and proper sealing of the silo is equally important. Similarly, tree leaves lopped during the period of abundance availability can be conserved as hay or silage. The fodder, grasses and tree leaves having poor nutritive value may be converted into silage by adding supplements like urea, molasses and mineral mixture to improve their nutritive value.

Challenges and solutions in adopting technologies

Challenges

A number of technologies that are technically feasible under experimental conditions do not find wide acceptance by the small and marginal farmers because of the high cost of technology and lack of awareness or understanding of the benefits of these innovations. Lack of technical support and training on how to effectively implement and manage new systems also poses a significant hurdle. The use of urea treatment of straw, an effective technology in experimental stations, is rarely sustained beyond the life of funded projects, partly because economic and sociocultural issues are not sufficiently addressed (Owen et al., 2012). Labour is a further constraint as farmers are not interested to invest in labour-demanding feed technologies with uncertain returns. Weak extension systems also limit adoption of feed technologies and this may be considered among the main constraints. (Kebebe, 2019)

Solutions

To overcome these challenges, various strategies need to be employed across the country. Government initiatives and subsidies play a crucial role in making technology more accessible

to farmers. The technology which is generated at research station should be subsequently assessed and refined by conducting experimentation at the unorganized scattered small farm units in collaboration with farmers. Success in adoption of technologies has resulted from adoption of a combination of technologies (package-approach) that result in synergistic improvements in profits such as providing improved quality feeds to high genetic merit livestock breeds with high genetic merits (Redjal, 2005) The successful adoption of livestock technologies and subsequent practices is also dependent on the education and training of farmers. There is a critical need for capacity building of the farmers to understand and implement new technologies, manage their operations sustainably, and adapt to changing market demands and environmental conditions. Extension services, vocational training programs, and digital platforms can play important role in disseminating knowledge and skills to farmers across the country.

Refrences:

Dass, R.S. (2003) .In. Proceedings of short course entitled 'Recent Advances in Animal Nutrition research' at CAS, Division of Animal Nutrition, IVRI, 5-25 March,2003

ICAR (1985). Final report (1967-85),All India Coordinated Research project "Utilization of agricultural by products and industrial waste material for evolving economic ratios for livestock" ICAR,NDRI, Karnal.

Mehra, U.R., Pathak, N.N., Singh U.B. and Dass, R.S.(1989). Biol. Waste. 29:6770

Rai, S.N.,Singh, M., Amri Kumar,M.N., Walli, T.K and Pradhan, P,K (1993). In: Feeding of Ruminants on Fibrous crop residues. Kiran Singh and J.B Schiere (Eds).

Sharma, K., Narayan Dutta and Pattanaik, A.K. (2002). Animal Nutrition and Feed Technology. 2 (2):139-150.

Walli, T.K. (2008a).In. Proceedings of XXXVI Dairy Industry Conference, BHO, Page 74-79.

Makkar, H.P.S. (2016). Anim. Prod. Sci. 56, 519–534.

Balehegn, M et al. (2020). Global Food Security. 26:1-11.

Chapter-3

Socio-Spatial Analysis for Animal Husbandry Entrepreneurship: Integrating GIS & Statistical Software for Data-Driven Insights

Dr. Asif Mohammad, Senior Scientist
ICAR-National Dairy Research Institute, E.R.S., Kalyani-741235
West Bengal, India
e-mail: Asif.Mohammad@icar.gov.in

Abstract

Socio-spatial analysis is an important method for analysing the interaction of social phenomena and spatial structures, especially in the setting of animal husbandry (A.H.) entrepreneurship. This 'Socio-spatial analysis' utilizes Geographic Information Systems (GIS) and statistical software to examine issues such as resource allocation, market access, and policy implications. Recent research on ecosystems for entrepreneurship has mostly focused on geographical clusters, but there is still a lack in comprehension of the everyday socio-spatial environments in which entrepreneurs work. To create a customized geographic map using QGIS, shapefiles may be downloaded from the Survey of India's online portal, after that, they may be imported into a new QGIS project, and the data may be manipulated by selecting and exporting specific features, such as states or regions. This process includes adding map elements like grids, titles, and legends, and exporting the final map as an image file for further editing and use in decision-making, such as identifying strategic locations for business initiatives. Statistical analysis helps entrepreneurs in animal husbandry to understand socio-spatial variations, enabling them to tailor products and marketing strategies to different consumer segments based on age, economic background, and cultural factors. By using tests like Chi-square tests, ANOVA, cluster analysis, and regression analysis, they can identify consumer preferences and market trends, optimizing product lines and resource allocation for maximum profitability. This integration makes decision-making and strategic planning easier by identifying the best locations for operations, assessing infrastructure and logistics networks, and assuring regulatory compliance. This approach not only improves the sector's economic viability, but it also integrates entrepreneurial operations with larger socioeconomic development and environmental objectives.

1. Introduction

Socio-spatial analysis examines the relationship between social phenomena and spatial structures, particularly within the context of Animal Husbandry (A.H.) entrepreneurship, where

Geographic Information Systems (GIS) and statistical software provide valuable insights into factors such as resource allocation, market access, and policy impacts. A complex systems approach conceptualizes spatial systems from the bottom-up to understand how local spatial interactions generate emergent system-level behaviour and spatial patterns (Anderson, 2019). Theoretical frameworks and normative models like entrepreneurial ecosystems often fall short in observing, explaining, and informing policies at the communal level in rural contexts, where a socio-spatial lens proves more effective in understanding rural entrepreneurship holistically (Muñoz and Kimmitt, 2019). Hypotheses suggesting that socio-spatial inequalities strongly influence economic performance and foster political instability have been extensively investigated empirically (Lelo and Tomassi, 2019). Entrepreneurship is increasingly recognized as a crucial factor in uneven economic geographies, with spatial patterns of entrepreneurship linked to local cultural dynamics (Huggins and Thompson, 2016). The rapid growth of literature on entrepreneurial ecosystems (EEs) over the past five years has leveraged this concept to understand regional clusters of entrepreneurship (Hartman and Kear, 2024). However, the socio-spatial contexts in which entrepreneurs operate daily remain underexplored, prompting a need for intensified research into the linkage between entrepreneurial activities and localities to better understand the everydayness of entrepreneurship (Trettin and Welter, 2011). Multivariate spatial analysis of data from Great Britain indicates that community culture significantly influences entrepreneurship rates and that a bidirectional relationship exists between entrepreneurship and economic and social development outcomes (Huggins and Thompson, 2014). By harnessing GIS, small and medium-sized enterprises can unlock growth opportunities, drive innovation, and contribute to a sustainable future (Vincent and Tolulope, 2024). Contemporary GIS tools applied to e-entrepreneurship facilitate spatial inventory of diverse resources, integrated geospatial intelligence, predictive simulation ensuring safety and compliance, and reservation of investment areas, supporting investment documentation for public authorities (Jelonek et al., 2015). Socio-spatial analysis, utilizing GIS data and statistical tools, enhances understanding of A.H. entrepreneurship by examining local resources and interactions, cultural aspect, and their impact on socio-economic development. This approach reveals the significance of social and cultural factors in shaping entrepreneurship rates and highlights the potential of GIS data driven innovation and sustainable growth.

2. Utilisation of Socio-Spatial Analysis in Animal Husbandry Entrepreneurship

2.1 Optimum utilisation of resources: The identification of suitable places for animal husbandry-based entrepreneurship can be considerably improved by utilizing GIS data, which allows for a complete assessment of natural assets such as water accessibility, pasture quality,

and climate conditions. This spatial analysis allows entrepreneurs to identify the most appropriate places for their operations, while guaranteeing they have access to the resources required for sustainable and effective farming. Furthermore, socio-spatial analysis aids in the efficient allocation of these resources by offering insights into their geographical distribution and relationships within the region, reducing waste and increasing productivity. This holistic approach not only helps with decision-making and strategic planning, but it also encourages sustainable practices and improved financial results in the animal husbandry sector.

2.2 Market Accessibility: Using GIS data to examine proximity to markets, infrastructure for transportation, and logistic networks is critical for creating successful entrepreneurship in animal husbandry. This complete research enables entrepreneurs to strategically situate their operations in areas that maximize market access, ensure timely product delivery, and reduce transportation expenses. Businesses may reduce delays and improve the quality and freshness of their products once they arrive on the market by finding places with strong infrastructure and effective logistic networks. This method not only increases market reach and consumer satisfaction, but it also helps to reduce costs and increase profitability. Furthermore, the capacity to see and analyze spatial data facilitates improved planning and decision-making, allowing entrepreneurs to react to changing marketplace circumstances and logistical obstacles, ultimately promoting the animal husbandry sector.

2.3 Policy and Regulation Compliance: Mapping locations with unique zoning rules, environmental laws, and incentives using GIS data can greatly assist businesses in making professional decisions in the livestock husbandry sector. Providing a detailed picture of legal landscapes allows entrepreneurs to ensure that they comply with local legislation and prevent potential legal complications. Furthermore, locating places with advantageous zoning laws and regulations regarding the environment might assist in selecting the best locations for their business. Access to knowledge on government incentives and subsidies enables entrepreneurs to make the most on financial assistance, so increasing the viability and profit of their ventures. This strategic use of GIS data not only simplifies the planning process, but also increases chances for sustained success and growth in the animal husbandry business.

2.4 Social and Economic Impact: Examining different regions' socioeconomic factors, such as financial situations, labour force participation, and levels of education, might help animal husbandry entrepreneurs make better business decisions. This assessment assists businesses in understanding the economic landscape, identifying possible markets, and tailoring their operations to fit local demands. Furthermore, evaluating how animal husbandry enterprises might benefit local communities while contributing to economic growth provides useful

information and guidance. This method guarantees that business strategies are in line with community development objectives, promoting beneficial economic and social outcomes while increasing the long-term viability and earnings of animal husbandry businesses.

3. Integrating GIS and Statistical Software

3.1 Geographic Information Systems (GIS): GIS tools like as ArcGIS, QGIS, and Google Earth Engine can view and analyze spatial data on the availability of specific cattle breeds, feed, and fodder seeds. These technologies' primary functions involve illustrating land utilization patterns, analyzing terrain, monitoring changes in the environment, and determining the availability of various breeds of cattle and types of fodder. GIS tools aid in strategic planning by allowing the overlay of diverse data layers—such as demographic data, conditions in the environment, availability of resources, and marketing opportunities—and identifying patterns and connections. This complete spatial analysis facilitates informed decision-making, optimises resource allocation, and improves the effectiveness and long-term viability of animal husbandry ventures.

3.2 Statistical Software: Software such as R, SAS, and SPSS are required for statistical analysis of diverse datasets related to animal husbandry business. These technologies can handle large datasets, run sophisticated statistical tests, and produce credible findings, enabling entrepreneurs to draw significant inferences from their data. When paired with GIS data, statistical evaluation improves understanding of spatial patterns and allows for data-driven decision-making. The combined strategy provides a comprehensive picture of the aspects that influence animal husbandry, such as availability of resources, market dynamics, and socioeconomic situations, resulting in better informed and effective sector entrepreneurship initiatives.

4. Methodology for Socio-Spatial Analysis

The shape file data can be accessed from the Survey of India's online maps portal (Fig. 1) at https://onlinemaps.surveyofindia.gov.in. The site provides an administrative boundary database that can be readily downloaded. Once obtained, the shape file should be saved in a designated folder at a preferred location on the user's computer for further use.

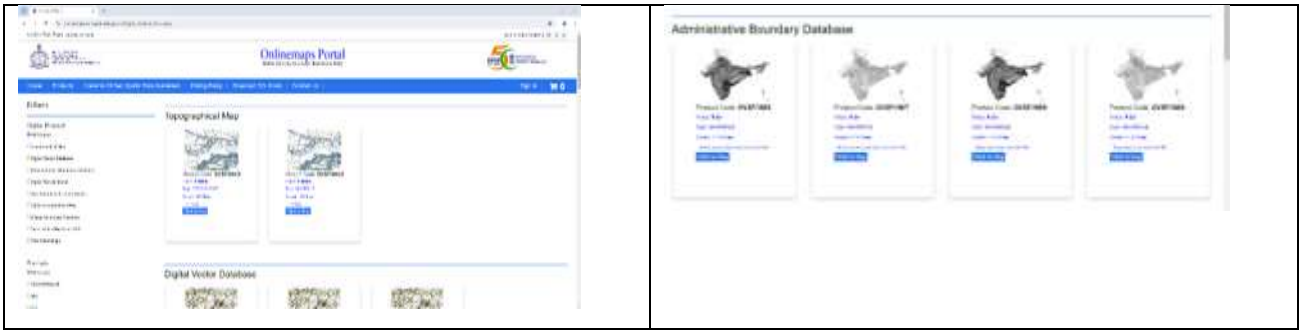


Fig. 1: Downloading shape files

In the subsequent stage, the open-source software QGIS can be utilized for creating spatial maps. To begin, launch QGIS and navigate to the 'Project' option in the menu bar, then select 'New' to initiate a new project for map creation using GIS shape files. After creating the new project, access the 'Layer' menu and choose 'Add Layer.' From the dropdown options, select 'Add Vector Layer.' Next, navigate to the folder where the previously downloaded shape files are stored. Select and import the desired shape file into the QGIS project (Fig. 2). This approach incorporates geographical information into the project, allowing for additional evaluation and visualization of geographical aspects. QGIS's vector data handling capabilities are critical for extensive geographical analysis, as they enable users to precisely handle, modify, and display geographic information. This setup is the first phase in the GIS workflow, allowing for following operations such as analysing data, map creation, and geographical data management.

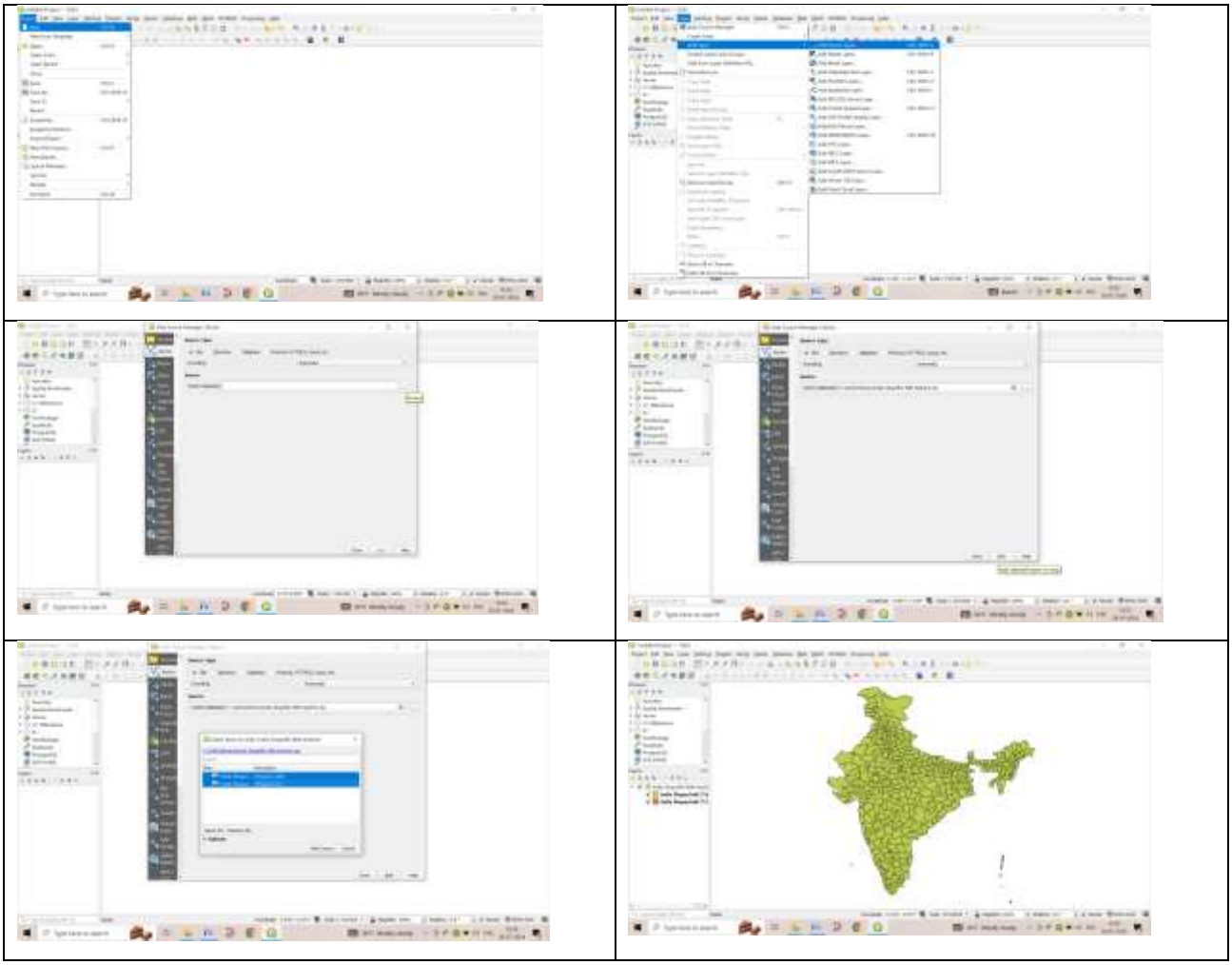


Fig. 2: Creating new 'QGIS project'

To work with specific data within a layer in QGIS, right-click on the desired layer and select 'Open Attribute Table' to access the attribute data associated with the layer. In the attribute table, identify and select all entries corresponding to the desired geographical entity, such as a state—

in this example, "West Bengal" (Fig. 3). Ensure that all relevant entries are selected, as this will highlight the chosen state on the map. With the state selected, right-click on the same layer again, selects 'Export,' and choose 'Save Feature As' from the dropdown menu. A dialog box will appear, allowing you to specify the desired file name and save location. To export only the highlighted portion of the map, make sure to select the 'Save only selected features' option. This process will generate a new shape file containing only the map data for the selected state, effectively isolating it from the rest of the layer's content. This phase is critical for narrowing the emphasis of the study or presentation to a specific location, allowing for additional spatial analysis or bespoke map development for the chosen area.

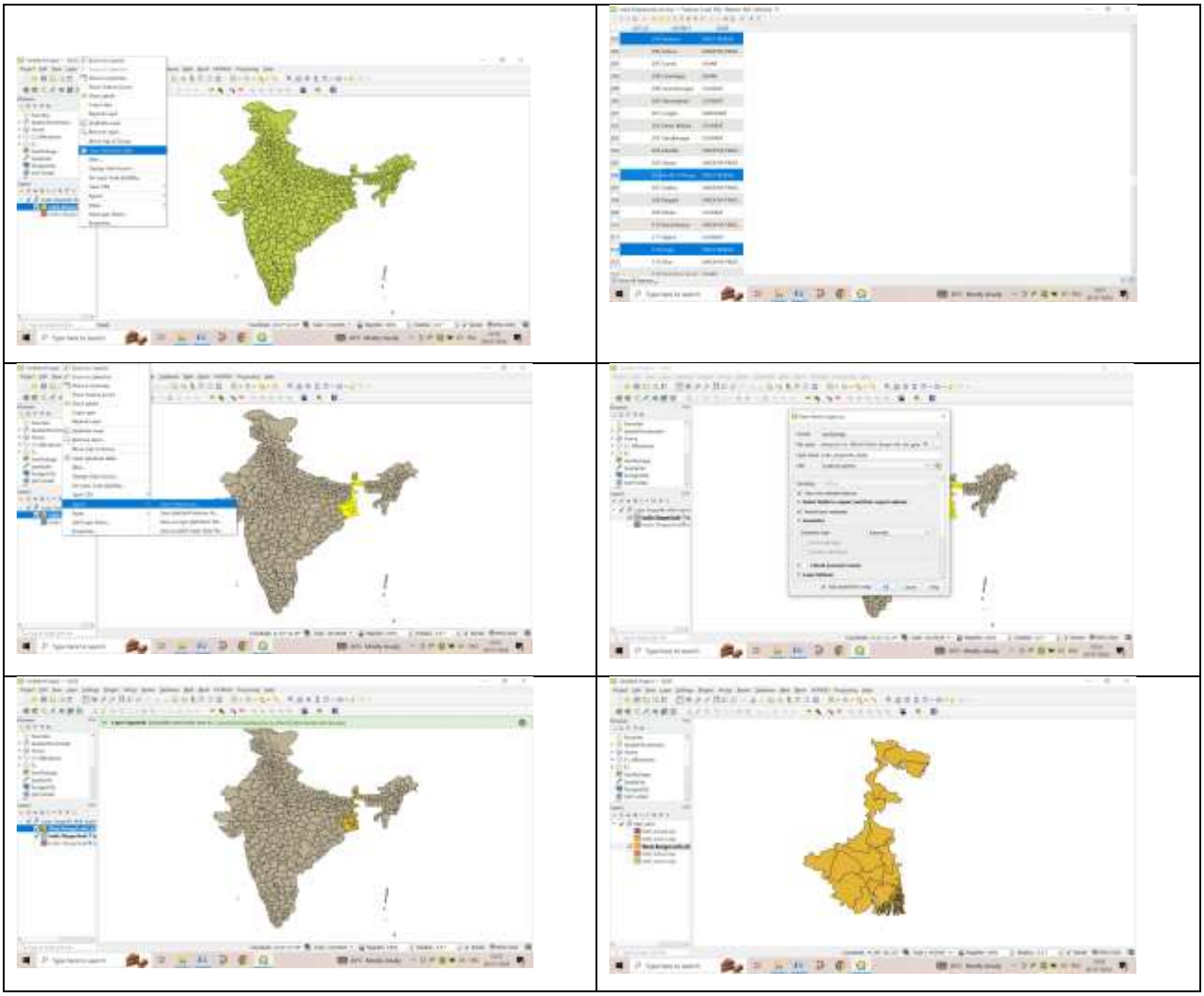
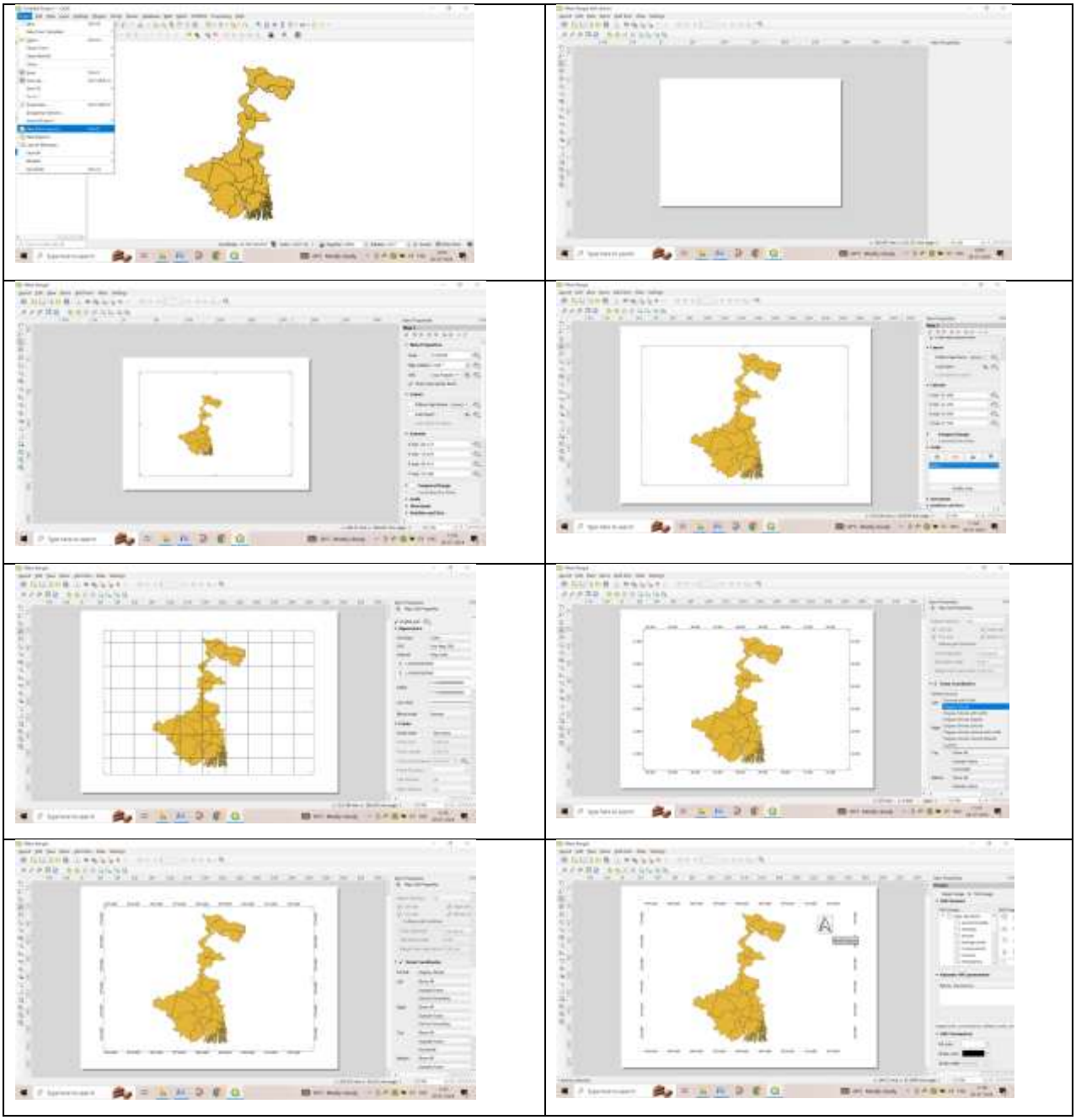


Fig. 3: Creating new layer in QGIS

To proceed with map visualization, select the newly created layer (e.g., West Bengal) and navigate to the 'Project' menu. From there, select 'New Print Layout,' which will open a new window dedicated to layout design. In this layout view, the map of the selected state can be added by inserting the corresponding map item. To enhance the map's presentation, you can

begin adding a grid by accessing the 'Grid' menu. This allows for the customization of grid lines and the addition of coordinates, providing geographical context (Fig. 4). Further refinement can be made by incorporating various map elements, such as a title, legend, scale bar, and north arrow, which can be added through their respective options in the layout window. These aspects are critical to making the map useful and user-friendly. The layout window also includes options for altering the size, status, and appearance of different components, ensuring that the end output adheres to the desired cartography standards. This extensive preparation process allows you to create a professionally designed map that is ready for export or printing and is personalized to properly represent specific geographic information.



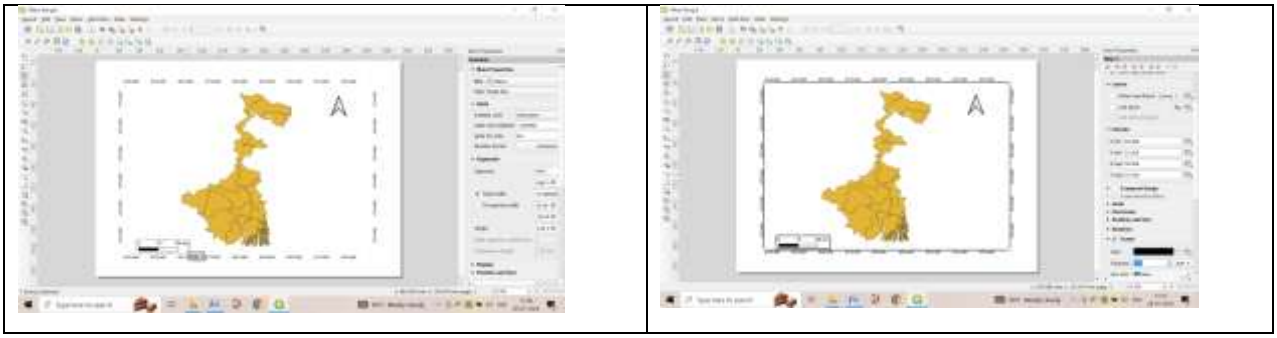


Fig. 4: Creation of Map using QGIS

In the following step, the created map can be saved as an image file. To do this, export the map from the layout window by selecting the appropriate export option, such as PNG, JPEG, or TIFF, ensuring it is saved in the desired location on your computer (Fig. 5). Once saved, the map image can be opened using suitable software for viewing and further editing, such as image editing programs or presentation software. This image can be used to identify and mark specific locations on the map, which can be useful for decision-making and planning purposes, particularly for entrepreneurs and stakeholders. Using various tools and menus inside the selected software, one can mark the map with more details, such as symbols, labels, or additional markers that emphasize specific regions of interest. These improvements can provide useful insights into spatial relationships and patterns, assisting with strategic analysis and planning. Entrepreneurs, for example, might use the map to determine the best places for growth of businesses, resource allocation, and infrastructure investment. The capacity to visually depict data on a map allows for more informed decisions, which improves the efficiency and effectiveness of planning and implementation.

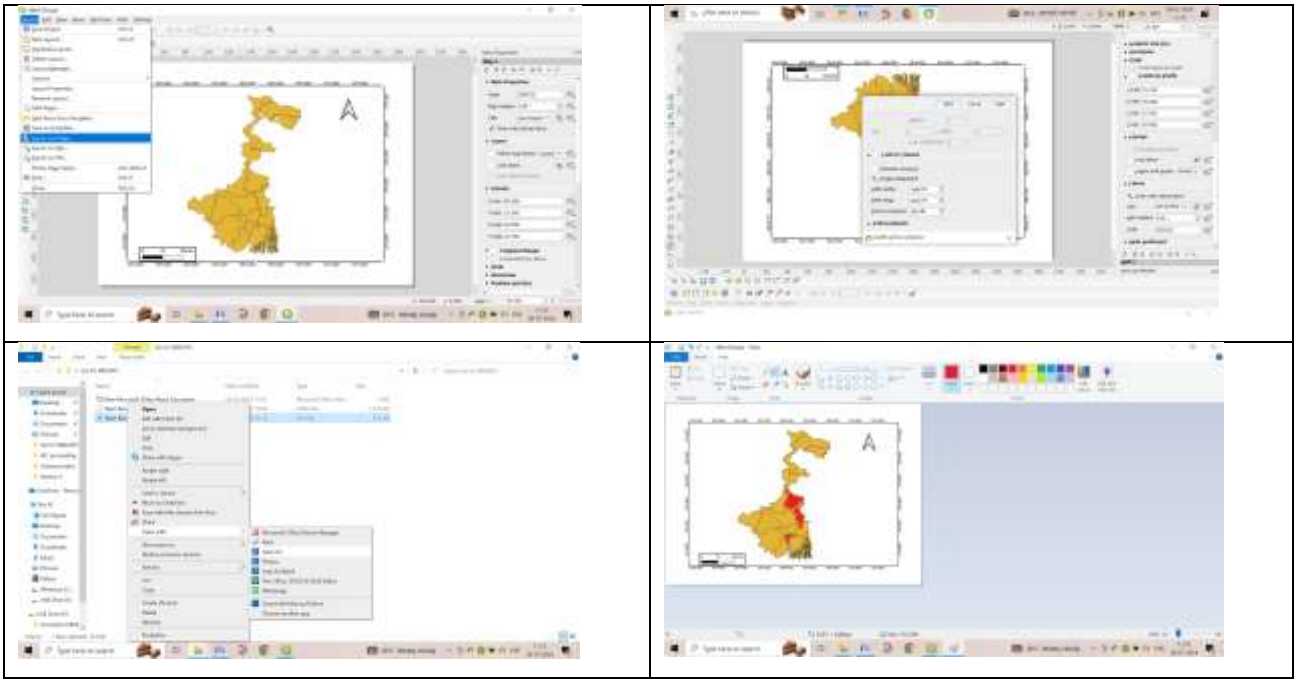
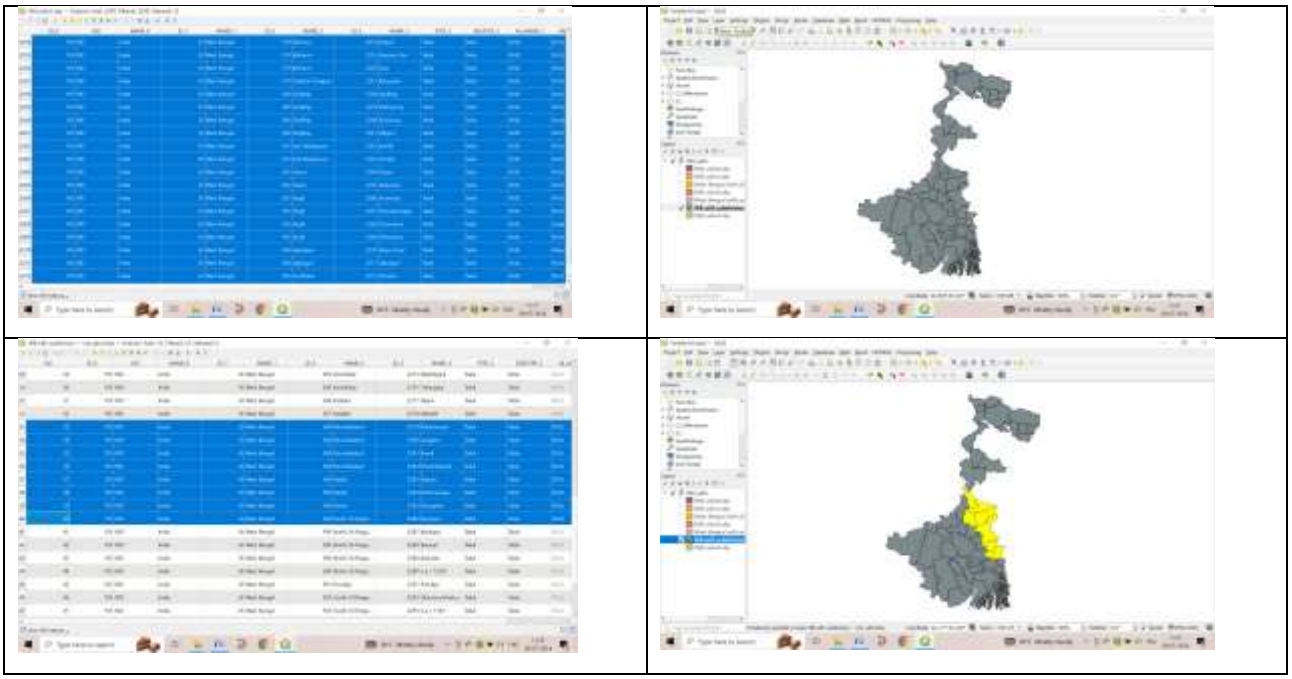


Fig. 5: Saving the map in print layout

Consider an entrepreneur preparing a project report on establishing a goat farming unit specializing in the Black Bengal breed. After researching and determining that the availability of pure Black Bengal goats is highest in Murshidabad, Nadia, and parts of North S. 24 Parganas districts in West Bengal, the next step involves creating a location map to delineate the prospective catchment area for sourcing these goats. The following procedure outlines the development of such a map. First, obtain accurate geographic and demographic data for the specified districts, ensuring they are represented in the mapping software being used, such as QGIS. Import the relevant shape files, focusing on administrative boundaries that highlight the specific regions of interest. Using tools within the software, outline and highlight Murshidabad, Nadia, and North S. 24 Parganas, emphasizing areas where Black Bengal goats are most prevalent (Fig. 6). To increase the map's usefulness, incorporate other aspects such as geographic characteristics, water supplies, and current agricultural infrastructure that are relevant for goat farming operations. By including these characteristics, the map will provide a thorough overview of the catchment region, allowing for more strategic decisions about farm setting, goat collecting routes, and allocation of resources. The completed map can then be downloaded and attached to the project report, providing a visual depiction of the potential catchment region that is critical for stakeholder comprehension and decision-making.



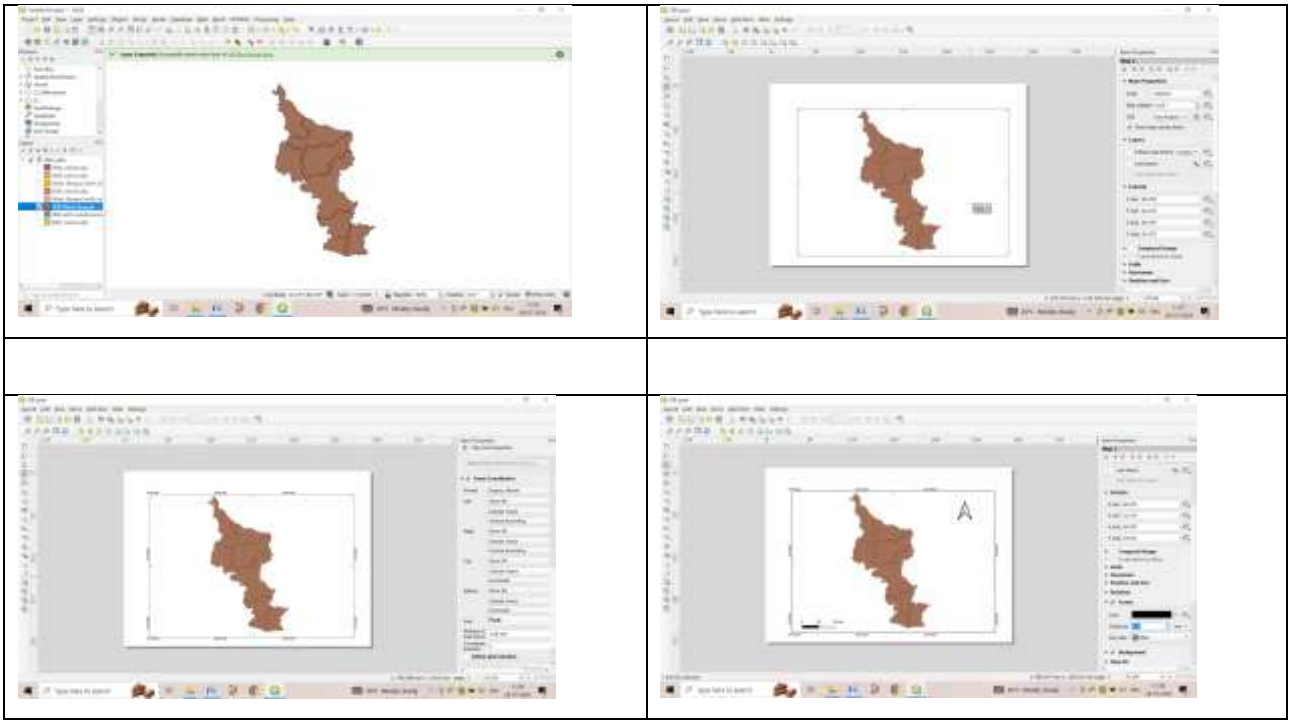


Fig. 6: Creation of map for entrepreneurship on Black Bengal goat

5. Socio-Spatial variation for Animal Husbandry Entrepreneurship

Statistical analysis is critical in studying socio-spatial variations, which can have an important effect on animal husbandry business. Animal husbandry entails keeping and raising livestock for milk, meat, fibers such as wool and various other goods. Recognizing socio-spatial variations—differences in social as well as geographic factors—allows entrepreneurs to tailor their products and services to various consumer demands and preferences.

5.1 Socio-Spatial Variation and Consumer Categorization: Socio-spatial variability refers to the variances that exist between different social groupings and geographical regions. These discrepancies can be attributed to factors such as age demographics, income levels, social norms, and geographical preferences. Consumer preferences for specific animal husbandry products, for example, may differ depending on cultural customs, dietary habits, and socioeconomic level. Recognizing these variations enables entrepreneurs to successfully segment their markets.

5.1.1 Consumer Segmentation:

- **Age Groups:** Individuals of various ages may have differing interests for animal products. For instance, younger consumers may prefer exotic dairy products, but older consumers may prefer traditional dairy products.
- **Economic Background:** Customers from various economic classes have distinct buying power and priorities. High-income consumers may be prepared to spend more for organic or responsibly produced animal products, but others may consider cost of the product.

5.2 Value Systems and Cultural variations: Ethnic and spiritual beliefs can impact consumer decisions. For example, certain cultures may boycott certain animal-based goods due to religious convictions.

Entrepreneurs can design targeted marketing strategies, optimise product lines, and uncover niche markets by categorising people according to these parameters.

5.3 Product Stratification and Market Analysis

Product stratification entails providing a variety of items geared to specific consumer segments. For example, an animal husbandry entrepreneur may provide a basic line of dairy products for budget-conscious customers and a premium line for those looking for high-quality, organic options. Product stratification helps to maximize distribution and profitability.

5.4 Geographical variations: Understanding regional demand fluctuations is critical. For example, some regions may have a larger need for sheep products due to local gastronomic traditions, whilst others may prefer dairy products. Entrepreneurs can better allocate resources by tracking demand geographically, such as focusing on providing specific products to the most popular locations.

6. Statistical Tools and Techniques

Several statistical tools and techniques can be employed to analyse socio-spatial variations:

6.1 Chi-Square Test: This test is used to examine whether there is a significant association among categorical variables, such as the association among socioeconomic status and preference for specific animal products. It can reveal whether there are statistically significant differences in customer preferences between social groupings.

6.2 ANOVA (Analysis of Variance): ANOVA is used to analyze the means of various groups and determine whether there are any significant differences. For instance, it can be used to determine whether there are substantial variances in product demand between geographical areas or demographic groupings.

6.3 Cluster Analysis: This approach combines related data points. It can be used to discover consumer segments who share similar tastes, which is helpful in focused marketing.

6.4 Regression Analysis: Regression analysis may assist animal husbandry entrepreneurs to uncover the elements that drive consumer demand. For example, it can demonstrate how income, age, and geographic location influence the likelihood of consuming specific animal products.

7. Statistical software

These statistical analyses can be carried out using a variety of statistical applications. SPSS is a complete tool for organizing data and statistical analysis. It is commonly used to perform complex statistical tests such as Chi-square and ANOVA. Excel, while not as sophisticated,

provides basic statistical operations that are useful for data management. JASP is open-source statistical software which provides a user-friendly interface for performing various statistical analyses, including Bayesian analysis, PCA, SEM etc. Using this software, animal husbandry entrepreneurs can acquire useful insights into consumer behaviour and industry trends. This insight enables them to make more educated decisions about developing products, advertising initiatives, and business growth. Finally, a data-driven approach contributes to enhancing efficiency, decreasing risks, and increasing profitability in the highly competitive marketplace of animal husbandry products.

8. Conclusion

The combination of Geographic Information Systems (GIS) and statistical software for socio-spatial analysis forms a solid platform for data-driven decision-making in animal husbandry (A.H.) enterprise. Using these tools, entrepreneurs may analyse and visualize complicated spatial and statistical data, allowing for more efficient resource usage and market access. This method enables the selection of appropriate places for farming activities, the evaluation of environmental and socioeconomic aspects, and compliance with regulatory criteria. Entrepreneurs may increase the efficiency and earnings of their livestock enterprises through making sensible choices based on accurate data. Furthermore, this integrated technique promotes sustainable operations by assuring responsible resource use and reducing environmental impacts. It also fosters inclusive growth by developing ways to involve marginalized people in the value chain of agriculture. Overall, the combination of GIS and statistical analysis improves the planning process and operational leadership in A.H. entrepreneurship, helping to achieve the sector's broader goals of socioeconomic development and sustainability.

9. References

Anderson, T. (2019, June 19). Towards the integration of complex systems theory, geographic information science, and network science for modelling geospatial phenomena. https://summit.sfu.ca/item/20420

Hartman, J. B., & Kear, M. T. (2024). Governing by entrepreneurship: Entrepreneurial ecosystems and socio-spatial difference. Competition & Change, 28(1), 209–227. https://doi.org/10.1177/10245294231180297

Huggins, R., & Thompson, P. (2014). Culture, entrepreneurship and uneven development: A spatial analysis. Entrepreneurship & Regional Development, 26(9–10), 726–752. https://doi.org/10.1080/08985626.2014.985740

Huggins, R., & Thompson, P. (2016). Socio-spatial culture and entrepreneurship: Some theoretical and empirical observations. Economic Geography, 92(3), 269–300. https://doi.org/10.1080/00130095.2016.1146075

Jelonek, D., Pawełoszek, I., Stępniak, C., & Turek, T. (2015). Spatial tools for supporting regional e-entrepreneurship. Procedia Computer Science, 65, 988–995. https://doi.org/10.1016/j.procs.2015.09.061

Lelo, K., Monni, S., & Tomassi, F. (2019). Socio-spatial inequalities and urban transformation. The case of Rome districts. Socio-Economic Planning Sciences, 68, 100696. https://doi.org/10.1016/j.seps.2019.03.002

Muñoz, P., & Kimmitt, J. (2019). Rural entrepreneurship in place: An integrated framework. Entrepreneurship & Regional Development, 31(9–10), 842–873. https://doi.org/10.1080/08985626.2019.1609593

Trettin, L., & Welter, F. (2011). Challenges for spatially oriented entrepreneurship research. Entrepreneurship & Regional Development, 23(7–8), 575–602. https://doi.org/10.1080/08985621003792988

Vincent Ugochukwu Oguanobi & Oloruntosin Tolulope Joel. (2024). Scalable business models for start-ups in renewable energy: Strategies for using GIS technology to enhance SME scaling. Engineering Science & Technology Journal, 5(5), 1571–1587. https://doi.org/10.51594/estj.v5i5.1109

Chapter-4

ZOONOSES & PUBLIC HEALTH: IMPORTANCE IN BETTER ANIMAL HEALTH AND SUSTAINABILITY

Dr. Siddhartha Narayan Joardar,
Professor
Department of Veterinary Microbiology
Faculty of Veterinary and Animal and Fishery Sciences
37, K.B. Sarani, P.O.-Belgachia, Kolkata-700037
E-Mail: joardar69@gmail.com

Summary

There are strong evidences that modern farming practices and intensified systems can be linked to disease emergence and amplification. However, the evidence is not sufficient to judge whether the net effect of intensified agricultural production is more or less propitious to disease emergence and amplification than if it was not used. Expansion of agriculture promotes encroachment into wildlife habitats, leading to ecosystem changes and bringing humans and livestock into closer proximity to wildlife and vectors, and the sylvatic cycles of potential zoonotic pathogens. Extensive studies on human–animal interface are quite expedient to understand the ways of emergence of zoonotic diseases and to explore the possible prevention mechanisms. Awareness and updated knowledge are quite expedient to venture successful entrepreneurship at the local level. Preparedness to address emergence of zoonotic pathogens is considered as a key to successful animal husbandry practice as well as sustainable entrepreneurship. Biosecurity is defined as the set of measures put in place to prevent the spread of potentially harmful biological substances and contaminants—in this case pathogens with the potential to cause emerging infectious diseases (EIDs). Improved biosecurity reduces EID risk by minimizing and managing direct and indirect contacts between livestock, people and wildlife. Tremendous deterioration in livestock-affiliated economic activity in addition to a major shock to livelihoods of those affected by the disease warrant collaborative efforts at national and international level to minimize emerging diseases in livestock and humans. Awareness and updated knowledge in these regards are quite pertinent and expedient to cater sustainable entrepreneurship at the local level.

Key words: Animal Health, Emerging infectious diseases, Livestock, Public health, Zoonosis

INTRODUCTION

The risks of emerging infectious diseases (EIDs) are escalating, and livestock production plays three key roles in this rise. First, rapidly increasing global demand for animal products means that the total livestock population is now higher than ever and still growing. Livestock biomass now vastly exceeds that of wild mammals and birds, and livestock hosts increasingly outnumber wildlife hosts for pathogens they share. Second, growing demand has in part been met with marked expansion of 'intensive' production systems which now provide most of our animal products: 81% of chicken, 61% of pork and 86% of eggs. These systems are reported to be driving EID emergence through risky livestock movements like long-distance live transport, high livestock densities, poor animal health and welfare, low disease resistance and low genetic diversity. Third, escalating animal product demand has also seen the dramatic expansion of land use for livestock and feed production. The resulting conversion and fragmentation of natural habitats means that we are farming in places where livestock and people are intimately associated with demographically disrupted and physiologically stressed populations of wild animals.

It is now known that, globally over 60% of human infectious diseases are caused by pathogens that are shared with wild or domestic animals. In this context, extensive studies on human–animal interface are quite expedient to understand the ways of emergence of zoonotic diseases and to explore the possible prevention mechanisms. It is an established fact that, the transformation of the natural landscape promotes encroachment into wildlife habitats, thereby creating opportunities for closer and more frequent interactions between humans, livestock, wildlife and vectors, while the intensification of livestock farming, associated with increased animal numbers and density facilitates disease transmission when effective management and bio-security measures are not in place. Concurrent anthropogenic factors, such as changes in land-use provide new wildlife-domestic species interfaces by creating shared ecologies, with opportunity for spill over and amplification of new emerging zoonotic diseases.

The diseases and infections which are naturally transmitted and/or shared between vertebrate animals and man are known as zoonotic diseases. It is documented that nearly 13% of the human pathogens are emerging and re-emerging and 75% of the emerging and re-emerging pathogens are classified as zoonotic pathogens. Globally over 60% of human infectious diseases are caused by pathogens that are shared with wild or domestic animals.

In India, the predominant zoonotic diseases affecting public health are rabies, brucellosis, toxoplasmosis, cysticercosis, echinococcosis, Japanese Encephalitis, trypanosomiasis, plague, leptospirosis, Scrub typhus, kyasanur forest disease, nipah and congo-crimean haemorrhagic fever. As per a study conducted by International Livestock Research Institute, 2.4 billion human cases and 2.2 million deaths occur in India per year. Incidentally, burden of the highest zoonotic diseases with wide spread human diseases exist in Ethiopia, Nigeria, Tanzania and India. New zoonotic diseases such as cutaneous leishmaniasis, Japanese Encephalitis, leptospirosis and scrub typhus are spreading to a much wider area at an alarming rate. It is anticipated that the re-emergence of neglected zoonotic disease such as kyasanur forest disease may pose problems in future as the strategies and policies to address this disease issues is wanting.

Exploring zoonotic risk factors

The main risk factors directly linked to management practices (references below) are biosecurity, livestock movements, livestock population size, livestock density, livestock health and welfare, disease resistance and genetic diversity. Factors that impact EID risk through land use are the extent, condition and distribution of natural habitats, Eco tones (defined here as transition zones between natural habitats and anthropogenic land-covers) and on-farm microhabitats where livestock and wild species that may harbour pathogens interact.

Biosecurity is defined as the set of measures put in place to prevent the spread of potentially harmful biological substances and contaminants -in this case pathogens with the potential to cause EIDs. Improved biosecurity reduces EID risk by minimizing and managing direct and indirect contacts between livestock, people and wildlife.

Studies on biosecurity practices and EID risk typically focus on a few practices or systems and have small sample sizes and restricted geographical range. The limited evidence available reveals a complex picture of how risks might vary. In general, ‘extensive’, ‘hobby’ and ‘free-range’ (typically low-yield) systems have poorer farm biosecurity allowing a greater number of direct and indirect contacts with wildlife compared with indoor or ‘intensive’ systems. Low-yield (especially ‘backyard’) systems are also more likely to engage in specific high-risk, poor-biosecurity practices, such as the feeding of untreated catering waste and allowing interspecies mixing both on and off farm. In addition, low-yield systems have higher labour requirements which requires more dwellings spread across larger agricultural areas and hence higher rates of human–livestock contact.

Livestock population size, density and health and welfare can all influence zoonosis spill over and transmission. A larger livestock population—on individual farms and overall—presents a larger potential host population with more opportunities for contact and transmission within

and between farms, which in turn can drive greater pathogen diversification. Population size and livestock density can interact to have a synergistic effect on EID risk, as seen with bovine tuberculosis incidence and swine influenza persistence. High farm densities within a landscape are associated with an increased probability of inter-farm transmission and hence take-off within the livestock population and spill over into people. Poor livestock health and welfare can cause immunosuppression and facilitate pathogen shedding and transmission, although the mechanisms underlying this are poorly described.

Activities manipulating wildlife species provides an animal-human interface facilitating a potential pathogen spill over. Hunters and persons handling dead animals during trade and cooking are often exposed to potential pathogens present in animal carcasses and their body fluids. Bush meat consumption has led to the emergence of Ebola virus disease outbreaks in Central Africa and West Africa. Moreover, fruit bats were identified as reservoir species and spill over to human may happen via an intermediate wildlife species. In contrast to this, in some Ebola outbreaks in Central Africa, Chimpanzee or gorilla carcasses were identified as source of human infection indicating the role of animal species in zoonotic spill over.

Role of Modern Farming Practices in emerging zoonotic diseases

There are strong evidences that modern farming practices and intensified systems can be linked to disease emergence and amplification. However, the evidence is not sufficient to judge whether the net effect of intensified agricultural production is more or less propitious to disease emergence and amplification than if it was not used. Expansion of agriculture promotes encroachment into wildlife habitats, leading to ecosystem changes and bringing humans and livestock into closer proximity to wildlife and vectors, and the sylvatic cycles of potential zoonotic pathogens. This greater intensity of interaction creates opportunities for spill over of previously unknown pathogens into livestock or humans and establishment of new transmission cycles. Anthropogenic environmental changes arising from settlement and agriculture include habitat fragmentation, deforestation, and replacement of natural vegetation by crops. These modify wildlife population structure and migration and reduce biodiversity by creating environments that favour particular hosts, vectors, and/or pathogens.

Role of livestock in emerging zoonotic diseases

Transformation of the natural landscape promotes encroachment into wildlife habitats, thereby, creating opportunities for closer and more frequent interactions between humans, livestock, wildlife and vectors. Moreover, intensification of livestock farming, besides high animal numbers and density facilitates disease transmission where effective disease management

strategies and biodiversity measures are absent. It is now recognized that a considerable share of human diseases of evolutionary and historical significance originated in livestock. The pathogen pool of food animals is itself not static but also constantly undergoing evolutionary changes. For example, in swine between the study period of 1985 and 2010, 173 new pathogens variants from 91 species could be detected. It is surprising to note that, out of these 91 species, 73 had not been reported previously. Furthermore, one third of these new species was zoonotic. Rapid expansion and intensification of livestock industries without incorporation of stringent biosecurity measures and animal health/veterinary oversight enhances the likelihood of zoonotic disease emergence from food animals. Pathogen characteristics and relative importance of surmised drivers of emergence differ significantly between food and non-food animal associated emerging zoonosis. The main drivers of food animal associated emerging zoonosis are changes in agricultural practices at farm level and transformations of the food industries along the livestock value chain, from transporting through processing to retailing.

Intensification of livestock production, especially pigs and poultry, facilitates disease transmission by increasing population size and density, although effective management and biosecurity measures will mitigate the between-herd spread of zoonotic diseases, such as brucellosis and tuberculosis. As an alternative to investing in improved husbandry or in situations of poor animal health service provision, antimicrobials are often used for growth promotion, disease prevention, or therapeutically, which in turn promotes the evolution of antimicrobial resistance in zoonotic pathogens. Intensification also requires greater frequency of movement of people and vehicles on and off farms, which further increases the risk of pathogen transmission. Intensive livestock farming can promote disease transmission through environmental pathways. Ventilation systems expel material, including pathogens such as Campylobacter and avian influenza virus, into the environment, increasing risk of transmission to wild and domestic animals. Large quantities of waste are produced that contain a variety of pathogens capable of survival for several months if left untreated. Much of the waste is spread on land, where it can come into contact with wild animals and contaminate water. Intensive farms use fewer workers per animal, thereby reducing the number of people exposed to zoonosis compared with extensive systems. However, several cross-sectional studies report higher sero-prevalence in farm workers of pandemic H1N1/09 influenza, hepatitis E, and highly pathogenic avian influenza H5 and H7 compared with the general community. Intensive livestock systems generally have high density populations of low genetic diversity, which may favour increased transmission and adaptation.

The first known outbreak of Nipah virus occurred in Malaysia during 1998–1999, causing respiratory disease in pigs and high case fatality in humans. Epidemiological outbreak investigation showed that pig and human cases had occurred in 1997 on a large intensive pig farm in northern Malaysia, where Nipah virus-infected fruit bats were attracted to fruit trees planted around the farm. Respiratory spread of infection between pigs was facilitated by high pig and farm density and transport of pigs between farms to the main outbreak area in south Malaysia. Pigs then acted as amplifier hosts for human infection. Almost all human cases had contact with pigs; there was no evidence of direct spill over from bats to humans or of human-to-human transmission.

Both extensive and intensive farming practices can influence the likelihood of influenza virus spill over from wild birds to domestic birds and pigs and the subsequent evolution and amplification in domestic animals and transmission to humans. Rice paddies combined with free-grazing duck farming in wetland areas bring wild water birds into close proximity with domestic water birds. The latter are susceptible to infection but less likely to develop disease than chickens and are infectious to other domestic poultry by direct contact or environmental contamination. Other low biosecurity rearing systems, such as scavenging poultry, household poultry, and small-scale commercial poultry, also allow direct or indirect contact between wild and domestic birds.

H5N1 virus has emerged as early as 1996 in farmed geese in Guangdong Province of southern China but was not notable until the H5N1 virus made a dead-end jump from poultry to humans in Hong Kong in 1997, where the outbreaks of H5N1 infection in poultry coincided with severe respiratory infection and fatalities in human. Avian influenza was formally reported in South East Asia in Vietnam at the end of 2003. The infection rapidly spread in the country's poultry population where severe respiratory infection and lethality occurred among poultry and humans. Within a few ensuing months the disease had spread to Thailand, Cambodia, Indonesia, Laos, and Malaysia. Most outbreaks occurred among backyard poultry with instances of virus transmission to local commercial poultry farms usually via fomites (such as trucks, crates, and cages) and personnel. Even though the poultry industry is the major livestock industry undergoing rapid intensification in this region, 50–70% of poultry are raised in backyard farms where little biosecurity exists. Since its emergence in 2003 to January 2014, the World Health Organization has tallied 650 human confirmed cases of avian influenza and 386 deaths worldwide. South East Asia contributed to more than 50% of the cases and fatalities related to human H5N1 infection.

Determinants contributing to the emergence of zoonotic events

A ‘‘Convergence Model’’ was developed to emphasize the complexity of interacting determinants favouring the emergence of pathogens. Of all the following interacting determinants, those that contribute to the emergence of host range extensions, that is ‘‘species jumping’’ events leading to new zoonosis, may be the most important.

- Microbial/viral determinants (mutation, natural selection, and evolution)
- Determinants pertaining to the host (natural resistance, innate and acquired immunity)
- Natural determinants (ecologic, environmental, and zoonotic influences)
- Determinants pertaining to human activity (personal behaviour, societal, commercial, and iatrogenic factors)
- Accidental or malicious release

It is highly likely that there will not be any way to predict when or where the next important, new zoonotic pathogen will emerge; nor will there likely be any way to predict a new pathogen’s ultimate importance from its early behaviour. However, preparedness in this regard is considered as a key to successful animal husbandry practice as well as sustainable entrepreneurship.

CONCLUSION

Many infectious diseases in humans originated from animals and agricultural expansion and intensification/diversification promotes disease emergence through ecosystem–livestock–human interface. In addition, encroachments of livestock into wild animal habitat enhance disease transmission at livestock–wildlife interface. The spread of these infections would threaten regional food security and safety. Emerging zoonosis causes major losses through reduced economic activity directly from trade restriction. The ripple effect from reduction in economic activity can spread to other livestock-related sectors at the national and international levels. Emerging and re-emerging infection causes additional cost to the country through general precautionary and preventive measures such as establishment of quarantine station and procedures, restriction of animal importation, pre-movement testing, vaccination, surveillance, and monitoring. Tremendous deterioration in livestock-affiliated economic activity in addition to a major shock to livelihoods of those affected by the disease warrant collaborative efforts at national and international level to minimize emerging diseases in livestock and humans. Awareness and updated knowledge in these regards are quite pertinent and expedient to cater sustainable entrepreneurship at the local level. There is also a need for strengthening surveillance with a strong laboratory network to pick up diseases both in animals and humans early to launch prompt containment action before an outbreak becomes an epidemic. The “one health” approach bringing veterinarians, health-care providers, and other sectors. Apart from that, it also requires

robust public health facilities, trained frontline workers, early diagnosis, treatment, prevention, control, and management of zoonotic diseases.

References

Daszak, P., Cunningham, A.A. and Hyatt, A.D. (2001). Anthropogenic environmental change and the emergence of infectious diseases in wildlife. *Acta Tropica* **78**: 103–116. (doi:10.1016/S0001-706X(00)00179-0)

Durrnce-Bagale, A., Rudge, J.W., Singh, N.B. and Belmain, S.R. (2021). Drivers of zoonotic diseas risk on the Indian subcontinent: a scoping review. *One Health*, **13**: 100310. https://doi.org/10.1016/j.onehlt.2021.100310

Gilbert, W., Thomas, L., Coyne, L. and Rushton, J. (2020). Review: mitigating the risks posed by intensification in livestock production: the examples of antimicrobial resistance and zoonoses. *Animal* **15**: 100123.

Johnson, C.K., Hitchens, P.L., Pandit, P.S., Rushmore, J., Evans, T.S., Young, C.C. and Doyle, M.M. (2020). Global shifts in mammalian population trends reveal key predictors of virus spillover risk. *Proceedings of Royal Society of Biology* **287**: 20192736. (doi:10.1098/rspb.2019.2736)

Jones, B.A., Grace, D., Kock, R., Alonso, S., Rushton, J. et al. (2013). Zoonoses emergence linked to agricultural intensification and environmental change. Proceedings of National Academy of Science **110**(21): 8399-8404. www.pnas.org/lookup/suppl/doi:10. 1073/pnas.1208059110/-/DCSupplemental

Jones, K.E., Patel, N.G., Levy, M.A., Storeygard, A., Balk, D., Gittleman, J.L. and Daszak, P. (2008). Global trends in emerging infectious diseases. *Nature* , **451**: 990–993. (doi:10.1038/nature06536)

Kumar, S., Swain, S., Preetha, G.S., Singh, B.S. and Aggarwal, D. (2020). Zoonotic diseases in India. *Indian Journal of Community Medicine*, **45**: S1-2.

Maggouras, I., Brookes, V.J., Jori, F., Martin, A., Pfeiffer, D.U. and Durr, S. (2020). Emerging zoonotic diseass; should we rethink the animal-human interface? *Frontiers in Veterinary Science*, **7**: 582743. http://doi: 10.3389/fvets.2020.582743

Macleod, M., Gerber, P., Mottet, A., Tempio, G., Falcucci, A., Opio, C., Vellinga, T., Henderson, B., and Steinfeld, H. (2013). Greenhouse gas emissions from pig and chicken supply chains – a global life cycle assessment. Rome, Italy: Food and Agricultural Organization of the United Nations (FAO).

Murphy, F.A. (2008). Emerging zoonoses: the challenge for public health and biodefense. *Preventive veterinary Medicine*, **86**: 216-223. http://doi:10.1016/j.prevetmed.2008.02.009

Otte J and Pica-Ciamarra U. (2021). Emerging infectious zoonotic diseases: the neglected role of food animals. *One Health*, **13**: 100323. https://doi.org/10.1016/j.onehlt.2021.100323

Pendrill, F., Persson, U.M., Godar, J. and Kastner, T. (2019). Deforestation displaced: trade in forest-risk commodities and the prospects for a global forest transition. *Environmental Research Letters* **14**: 055003. (doi:10.1088/1748-9326/ab0d41)

Plowright, R.K., Parrish, C.R., McCallum, H., Hudson, P.J., Ko, A.I., Graham, A.L. and Lloyd-Smith, J.O. 2017 Pathways to zoonotic spillover. *Nature Reviews in Microbiology* **15**: 502–510. (doi:10.1038/nrmicro.2017.45)

Rohr, J.R., Barrett, C.B., Civitello, D.J., Craft, M.E., Delius, B et al. (2019). Emerging human infectious diseases and the links to global food production. *Nature Sustainability* **2**: 445–456. https://doi.org/10.1038/ s41893-019-0293-3.

Woolhouse M.E., Gowtage-Sequeria, S. (2005). Host range and emerging and reemerging pathogens. *Emerging and Infectious diseases*, **11**: 1842-1847.

Chapter-5

Aquapreneurship for Economic Empowerment of stakeholders

Dr. Bimal Kinkar Chand
Joint Director of Research
Directorate of research, Extension & Farms
West Bengal University of Animal & Fishery Sciences
68 K B Sarani, Kolkata 700037
E mail: bkchandnfdb@gmail.com

Fishery sector in India contributes to the national income, exports, food production, nutritional security, and employment generation. Fish is the best and cheapest source of animal protein. After Green and White Revolution, India is currently focusing on Blue Revolution to exploit the huge potential in fishery sector. Our country is endowed with rich freshwater, brackish water, and marine resources. Besides its coastline of 8,118 km, and continental shelf of 0.42 million sq. km., India possesses vast inland aquatic resources in the form of 195,210 km of rivers and canal, 2.9 million ha of reservoirs, 2.41 million ha of ponds and tanks, 1.07 million ha of *beels*, ox bow lakes and derelict waters and 1.24 million ha of brackish water area. The river system of the country comprises 14 major rivers (catchments > 20,000 sq. km.), 44 medium rivers (catchments 2,000-20,000 sq. km.) and innumerable small rivers and desert streams. The floodplain lakes are primarily continuum of rivers Ganga and Brahmaputra. These are in the form of oxbow lakes (*Mauns, Chaurs, Jheels, Beels* as they are called locally), especially in Assam, Manipur, West Bengal, Bihar, and eastern Uttar Pradesh. Globally it stands as third largest producer of fish (capture and culture production combined) and second in aquaculture production.

Table 1: Indian Fishery Resources

Inland Resources	
Total inland water bodies ('00000 ha)	73.59
Rivers & canals (km)	195210
Reservoirs ('00000 ha)	29.07
Tanks & ponds ('00000 ha)	24.14
Flood plain lakes/derelict waters ('00000 ha)	7.98
Brackish water ('00000 ha)	12.40
Marine Resources	
Length of coast line (km)	8,118

Exclusive Economic Zone (EEZ) million sq. km.	2.02
Continental Shelf ('000 sq. km.)	530
Number of Fish Landing Centers	1,548
No of Fishing villages	3,461
Fisher-folk population (includes fishers, fish farmers and fish worker)	2,80,68,537

Source: *Dept. of Fisheries, M/o Fisheries, Animal Husbandry & Dairying, Govt. of India*

Fish Production Trends in India

Fishery in India is a very important economic activity and a flourishing sector with varied resources and potentials. The fish production in India witnessed a spectacular growth since independence. The vibrancy of the sector can be visualized by the 21-fold increase that India achieved in fish production in just seven decades, *i.e.*, from 0.75 million tonnes in 1950-51 to 16.18 million tonnes (provisional) during 2021-22. This has placed the country on the forefront of global fish production. The contribution of fisheries sector to India economy (Gross value added-GVA) in 2019-20 is Rs. 2, 12, 915 crore; which is 1.24% of total Indian economy and 7.28% of Indian agricultural economy. Total expenditure for the development of fisheries sector in 2019-20 was Rs. 640.26 crore (DOF, 2020). Besides meeting the domestic needs, the dependence of over 28 million people on fisheries activities (directly and indirectly) for their livelihood and foreign exchange earnings to the tune of US$ 7.38 billion (₹ 60,523.89 Crore) in 2023-24, amply justifies the importance of the sector on the country's economy and in livelihood security. Proper post-harvest handling, reduction of losses and hygienic primary processing are important to realize full potentials of this sector. Although per capita annual availability of fish (from all sources) in India is 12 kg, which is less than the world average of 20.5 kg (FAO, 2020), the fishery sector continues to be the main source of animal protein, at affordable prices, for the poor and more vulnerable members of society.

Table 2: Fish production of India in last fifteen years (Production in lakh tones)

Year	Inland Fish Production	Marine Fish Production	Total Fish Production	Annual Average Growth Rate (%)
2008-09	46.38	29.78	76.16	6.87
2009-10	48.94	31.04	79.98	5.02
2010-11	49.81	32.50	82.31	2.91
2011-12	52.94	33.72	86.66	5.28
2012-13	57.19	33.20	90.40	4.32
2013-14	61.36	34.43	95.79	5.96
2014-15	66.91	35.69	102.60	7.11
2015-16	71.62	36.00	107.62	4.89
2016-17	78.06	36.25	114.31	6.12
2017-18	89.48	37.56	127.04	11.13

2018-19	97.20	38.53	135.73	6.84
2019-20	104.37	37.27	141.64	4.35
2020-21	112.49	34.76	147.25	4.00
2021-22	121.21	41.27	162.48	10.34
2022-23	131.13	44.32	175.45	7.98

Source: *Handbook of Fisheries Statistics 2023, Govt. of India*

Table 3: Fish Production by States / Union Territories of India (in lakh tonnes)

Sl.	States / U.T.	2000-01	2010-11	2022-23
1	Andhra Pradesh	5.89	16.03	51.06
2	Arunachal Pradesh	0.02	0.03	0.09
3	Assam	1.58	2.28	4.43
4	Bihar	2.22	3.44	8.46
5	Chhattisgarh	0.43	2.50	6.52
6	Goa	0.71	0.89	1.40
7	Gujarat	6.60	7.83	8.97
8	Haryana	0.33	1.06	2.12
9	Himachal Pradesh	0.07	0.08	0.17
10	Jammu & Kashmir	0.17	0.19	0.27
11	Jharkhand	0.42	0.91	2.80
12	Karnataka	3.33	5.46	12.25
13	Kerala	6.51	6.93	9.21
14	Madhya Pradesh	0.48	0.75	3.42
15	Maharashtra	5.26	5.78	5.90
16	Manipur	0.16	0.22	0.34
17	Meghalaya	0.06	0.04	0.19
18	Mizoram	0.02	0.02	0.05
19	Nagaland	0.05	0.06	0.09
20	Odisha	2.59	3.81	10.52
21	Punjab	0.52	0.97	1.85
22	Rajasthan	0.12	0.47	0.79
23	Sikkim	0.01	0.02	0.01
24	Tamil Nadu	4.81	6.11	8.29
25	Telangana	-	-	4.38
26	Tripura	0.29	0.53	0.83
27	Uttarakhand	0.09	0.03	0.07
28	Uttar Pradesh	2.08	4.29	9.15
29	West Bengal	10.60	14.72	20.45
30	A and N Islands	0.27	0.35	0.47
31	Chandigarh	Negligible	Negligible	Negligible
32	Dadra and Nagar Haveli	Negligible	Negligible	Negligible
33	Daman and Diu	0.16	0.17	0.29
34	Delhi	0.03	0.02	0.01
35	Lakshadweep	0.12	0.12	0.11
36	Puducherry	0.43	0.42	0.47
India (Total)		**56.55**	**82.30**	**175.45**

Source: *Handbook of Fisheries Statistics 2023, Govt. of India*

India shipped 13, 69, 264 tons of fish and fishery products worth Rs. 57,586.48 crore (USD 7.76 billion) during 2021-22, despite the several challenges in its major export markets caused by the COVID pandemic. During the FY 2021-22, the export improved in rupee term by 31.71%, in USD terms by 30.26% and in quantity terms by 19.12%. In 2020-21, India had exported 11, 49, 510 MT of seafood worth Rs. 43,720.98 crore (USD 5,956.93 million). Marine Products Export Development Authority (MPEDA) envisages an ambitious target of exporting the fish and fishery products worth of Rs. One lakh crore from India by 2025. Increase in shrimp production, quality control measures and increase in infrastructure facilities for production of value-added items are expected to help in achieving this target.

Table 4: Export of Fish and Fishery Products from India (last fifteen years)

Year	Quantity (in thousand tonnes)	Value (Rs. in crore)
2007-08	541.701	7620.92
2008-09	602.835	8607.94
2009-10	678.436	10048.53
2010-11	813.091	12901.47
2011-12	862.021	16597.23
2012-13	928.21	18856.26
2013-14	983.75	30213.26
2014-15	1051.00	33,441.61
2015-16	945.00	30,420.83
2016-17	1134.00	37,870.90
2017-18	1377.00	45,106.89
2018-19	1392.00	46,589.37
2019-20	1289.00	46,662.85
2020-21	1149.00	43,717.26
2021-22	1369.00	57,586.48
2022-23	1735.286	63,969.14
2023-24	1781.602	60,523.89

Source: *Marine Product Export Development Authority, Govt. of India*

Concept of Aquapreneurship

Aquapreneurship is the amalgamation of aquaculture and entrepreneurship. The entrepreneurs involved in aqua enterprise establishment are referred to as aqua entrepreneurs or aquapreneurs. Aquapreneurship helps in turning a farm into an aqua business. Since aquaculture requires both scientific capacity and business skills, hence promoting aquapreneurship development through skilled professionals can be a viable option in exploiting and expanding the aquaculture potentials of this country. It involves all the activities like farming, marketing, processing, trading, value addition, etc. and helps in reaping benefits for the stakeholders. Nurturing budding entrepreneurs is a pre-requisite for ensuring the sustained economic growth

and expansion of the fisheries and aquaculture sector. Aquapreneurship models would open avenues for rapid commercialization of the available technologies and further, enable the establishment of a nation-wide network of entrepreneurs, investors, research institutions, leading industry players and financial agencies operating in this sector. Thus, the aquapreneur models would empower emerging firms to leverage local knowledge banks and the afore-mentioned business networks to enable convergence with existing interventions and would thereby amplify outcomes.

Objectives of Aquapreneurship

The objectives of the entrepreneur models are as under:

(i) To attract enhanced private investment in fisheries and aquaculture sector.

(ii) To enhance production, productivity, and profitability across the value chain by achieving economies of scale, encouraging technology uptake and addressing value chain gaps.

(iii) To foster linkages among producers, aggregators, processors and exporters for better price realization and enhanced incomes.

(iv) To generate sustainable employment and livelihood opportunities, especially among youth and women in rural and semi-urban areas.

(v) To leverage the existing knowledge capital and expand into newer, untapped markets.

(vi) To create an ecosystem for growth of entrepreneurship in the fisheries and aquaculture sector.

Aquapreneurship Models

Viable entrepreneur models come under three broad categories, i.e. (i) Investment driven models, (ii) Industry driven models, and (iii) Incubator driven models.

Investment driven models: This will include business models based on a congenial policy environment, with structured incentives and access to water resources to support development of fisheries enterprises.

Industry driven models: These include contract farming-based business models that boost engagement between entrepreneurs and fishers & fish farmers along the fisheries value chain (including seaweed, ornamental and recreational fisheries) covering production, processing, post-harvest, and value addition.

Incubator driven models: The Fisheries and Aquaculture Business Incubation Centres are intended to play a key role in fostering entrepreneurship by providing infrastructure and operations support, facilitating technical and financial expertise and guidance, and thus, will lay the foundation for establishing technology-driven, sustainable business ventures that will contribute to the emerging knowledge-based economy. The incubation driven models will

promote technology and value chain-based entrepreneurs through tech-enablement, tech transfer, training, mentoring and handholding.

Benefits of Aquapreneurship

Entrepreneur models bring following benefits for the aquaculture and fisheries sector.

(i) Facilitate creative and innovative ways for linking public sector resources with private sector initiatives within and across regional and national boundaries for driving economic growth;

(ii) Establish linkages to appropriate strategies aimed at overcoming the constraints and barriers hindering the growth of businesses in fisheries and aquaculture;

(iii) Evolve structures and strategies to help small enterprises grow sustainably and ensure a promising future for them in the global market;

(iv) Encourage collaborative efforts between the community and corporate institutions, while nurturing positive government-research-business relationships;

(v) Foster and support fledgling start-ups in business development including expansion of scale of operations;

(vi) Drive infusion of technology and creation of modern infrastructure facilities;

(vii) Develop supporting and spin-off industries;

(viii) Strengthen the institutional capacity and innovation capability by honing technical and managerial skills and bringing in new skill-sets, especially in emerging technologies;

(ix) Enable development of value-added products including production lines and facilitate the infusion of capital-intensive processing equipment;

(x) Promote adoption of demand-based branding and marketing techniques;

(xi) Augment livelihoods and thus, enhancing incomes in the aquaculture and fisheries sector.

Strategic Areas for Aquapreneurship Development

Resource-wise strategic areas for aquapreneurship development are highlighted below.

Ponds Aquaculture: (i) Diversification of Species (ii) Creation of Infrastructure: Hatcheries, Creation of seed rearing space for Fingerling Production, establishment of Feed Mills (iii) Improved Culture methods: Re-circulatory Aquaculture, Water Quality & Health Management

Reservoirs: (i) Fingerling Stocking by creation of in-situ rearing of Fingerling, (ii) Improvement of Craft & Gears, (iii) Large Scale Cage Culture, (iv) Integrated Fisheries Development

Brackish water Aquaculture: (i) Creation of infrastructure like Brood multiplication center, Nucleus Breeding Centre, (ii) Development of Aquatic quarantine Facilities, (iii) Water quality testing and disease diagnostic centers (iv) Establishment of more hatcheries and seed rearing units

for shrimps, (v) Focusing on indigenous shrimp (*F. indicus*) as alternative species to *M. vannamei*, (vi) Tapping ground saline areas for shrimp farming (Haryana, Punjab, Westen UP)

Wetlands: (i) Development of culture-based fishery in wetland, (ii Creation of infrastructure like hatcheries and fingerling production for seed stocking, Feed mills, etc. (iii) Restoration of health of natural ecosystem in wetland

Cold water Fisheries: (i) Commercialization of rainbow trout aquaculture in raceways, (ii) Import of quality germplasm of rainbow trout for productivity increase, (iii) Development of sports / ecotourism-based Fisheries like Trout, Mahaseer, (iv) Recreational fisheries with necessary backward and forward integration/linkages and convergence.

Ornamental Fisheries: (i) Quality brood stock development, (ii) Captive breeding of indigenous ornamental fish species, (iii) Commercialization of captive breeding and production of marine ornamental species

Mari culture: (i) Focusing on candidate species like Cobia, Pompano and Sea bass for open sea cage culture, (ii) Emphasis on seed production & feed for open sea mariculture, (iii) Involving women groups for seaweed culture, bivalve and pearl culture, etc., (iv) Seaweed cultivation, processing and marketing.

Postharvest Processing, value addition & Marketing: (i) Creation of Cold chain facility, (ii) Development of modern hygienic fish markets in strategic locations, (iii) Establishment of micro and small market infrastructure like mobile fish vending units, fish kiosk, etc., (iv) Hub-and-spoke models in urban areas for promotion of domestic consumption of fin fish and shellfish.

Adoption of New Technologies: (i) Re-circulatory aquaculture System (RAS), (iii) Bio-floc Technology, (iii) In-pond Raceway System (IPR), etc.

Aquapreneurship Ecosystem

Aquapreneurs should play a key role in addressing ever-evolving challenges in aquaculture such as (i) low productivity in ponds and tanks, reservoirs, Open waters, etc. (ii) limited availability of Quality Seed, (iii) poor diversification in species & System, (iv) genetic degradation, biodiversity loss and ecosystem Deterioration, (v) low use of supplementary feed, (vi) inadequate health management, (vii) Inadequate post-harvest infrastructure /cold chains, etc. It is a common phenomenon among Indian entrepreneurs to focus on low-cost frugal innovations yet with a highly functional impact.

The aquapreneurship ecosystem in India should encompass policies, schemes, and programme that would balance the profitability with sustainability. A schematic framework on aquapreneurship ecosystem in India is illustrated below. An ideal ecosystem should encourage a congenial ecosystem for private sector participation, development of entrepreneurship, promotion

of ease of doing business, innovations and innovative project activities including start-ups, incubators etc. in fisheries sector.

Figure 1: A schematic framework on aquapreneurship ecosystem in India

Source: Suman Day and Chinmay Nanda (2023), Aquapreneurship: a viable option for the next generation of entrepreneurship, Aquaculture Magazine, August, 2023

Role of the Government in promoting aquapreneurship

The Department of Fisheries, Ministry of fisheries, Animal Husbandry and Dairying, Govt. of India has issued guidelines on entrepreneur models on fisheries and aquaculture under Pradhan Mantri Matsya Sampada Yojana (PMMSY). The Government of India in May, 2020 launched the umbrella scheme of PMMSY with an estimated investment of Rs. 20050 crores comprising of Central share of Rs. 9407 crores, State share of Rs 4880 crores and Beneficiaries contribution of Rs. 5763 crores for its implementation during a period of 5 years from FY 2020-21 to FY 2024-25 in all States/Union Territories. The various activities / sub-components under PMMSY are under three broad heads; i.e. (i) Enhancement of Production and Productivity, (ii) Infrastructure and Post-harvest Management, and (iii) Fisheries Management and Regulatory Framework. The PMMSY addresses critical gaps in fish production and productivity, quality, technology, traceability, post-harvest infrastructure and management. It will further modernize and strengthen the value chain by establishing a robust fisheries management framework and will promote fishers‟ welfare. PMMSY also aims to empower youth and women through capacity building, innovation, and entrepreneurship. The key implementation strategies of PMMSY are “cluster/area-based approaches‟ including aqua parks with requisite forward and backward linkages, focus on gap filling, convergence, end to end solutions, technology infusion, productive utilization of land

and water, promotion of good aquaculture practices, traceability from "catch to consumer", fisheries development and management plans, innovations, entrepreneurship models, collectivization of fishers and fish farmers, model integrated coastal fishing villages, species diversification and genetic improvement, comprehensive fisheries database etc.

Rs. 100 crores had been earmarked under the Central Sector Scheme Component of PMMSY for taking up of projects under entrepreneur models over a period of 5 years from FY 2020-21 to FY 2024-25 at the rate of approximately Rs. 20 crore per year as a part of Annual Action Plan. The annual allocations for projects under entrepreneur models would actually depend on availability of funds under PMMSY and subject to budgetary allocations. Any unutilized budgetary allocation in a particular financial year under entrepreneur models may be carried forward to the next financial year for utilization. The earmarked budget in a financial year under entrepreneur models would be the maximum limit of subsidy that would be released in a financial year; thus, the sanctions would be limited to that extent. It is envisaged that the National Fisheries Development Board (NFDB) would undertake primarily need based beneficiary-oriented fisheries development activities as entrepreneur models with an aim to address the needs and priorities of the fisheries sector which are either unmet or sub- optimally/partially met under PMMSY within the broad framework of PMMSY scheme. Accordingly, NFDB from time to time would identify sectorial priority areas/activities that may be supported for taking up under the entrepreneur models.

Conclusion

It is very important that the aquapreneurs balance the profitability with sustainability in their ventures. They must ensure that their businesses are both financially successful and environmentally responsible. For that they have to navigate a complex regulatory landscape, leveraging technology and innovation to overcome obstacles and stay ahead of the competition. By managing risks and building strong, sustainable businesses, aquapreneurs can produce high-quality aquatic food for the consumers around the world. For optimal and judicious utilization of public resources and to consolidate outcomes, wherever feasible, suitable linkages and convergence with various Central/State/UT government schemes should be forged in undertaking and implementing the aquapreneur models in accordance with the relevant provisions of the Operational Guidelines of Government Schemes. The scheme like PMMSY should promote technology and value chain-based entrepreneurs through tech-based business models, technology transfer, training, mentoring and handholding. Establishment of and handholding of Fisheries and Aquaculture Startups are the priority interventions under PMMSY. Further, establishment of Fisheries Incubation Centers (FICs) should be supported under PMMSY both through government

and private sector. They would be managed through the State/Central Government entities including NDFB and/or through professional private firms/agencies. Fisheries Incubation Centers should provide opportunities to the incubatees like young professionals/entrepreneurs, fisheries institutes, fisheries researchers, cooperatives/federations, progressive fish farmers, fisheries-based industries and other entities to showcase their innovations and innovative ideas, technologies in fisheries and commercialize them for the benefit of fishers/fish farmers.

Chapter-6

EXTENSION-PLUS: NEW DIMENSION OF FUTURE EXTENSION

Prof. Arunasis Goswami & Dr. Sukanta Biswas
Dept. of Veterinary & A.H. Extension Education
W.B. University of Animal & Fishery Science
Kolkata-700037, West Bengal, India
arunasisvet@gmail.com

EMERGING PARADIGM OF EXTENSION PLUS:

This is now widely recognized that Animal Husbandry extension needs to reform in ways that allow it tofulfill a diverse set of objectives in worldwide. This ranges from better linking of farmers to input and output markets, to reducing the vulnerability and enhancing voice of the rural poor, development of micro-enterprises, poverty reduction and environmental conservation and strengthening and support of farmer organizations'. So while technology transfer is important, what is also required is the strengthening of locally relevant innovation processes and knowledge systems. Extension is being forced to embrace a broadened mandate that while in reality has always existed, has rarely been addressed. The limitations of a single model of extension for all kinds of situations are now well recognized and there is an increasing realization that new extension approaches need to emerge locally, based on experimentation, learning and adaptation to prevailing circumstances. The need for this new and expanded view of extension is clearly emerging in the case of Indian agriculture, which is characterized by declining land and water availability, degradation of natural resources, an unfavourable price regime, low value addition, particularly in rural areas and increasing competition from import of agricultural commodities. Farmers thus find themselves in an ever more complex production and market environment, with an expanding need for information and services.

EXTENSION PLUS IN ACTION:

A range of experiences of extension initiatives from the public & private sectors that display the expanded agenda embodied in the concept of extension-plus. The four (04) cases of KHDP, MSSL, BASIX & BAIF's are illustrative of a number of points, concerning both content and process of extension innovations. All the four cases illustrate the need for extension type organizations' to act as a nodal point for linking farmers to both technology & non-technology services.

As instance, for *Kerala Horticultural Development Programme (KHDP)*, *extension-plus* meant development and strengthening farmer organizations; improving farmers' ability to find solutions to technical, credit related and marketing problems; assisting sourcing better

technical knowledge available with other organizations; and strengthening the capability of farmer organizations' to negotiate with the state, traders and banks for changes in terms, policy and practice.

In *Mahindra Shubh Labh Services Limited (MSSL), extension-plus* includes the delivery of a wide range of services, namely, making available quality inputs at the right time, provision of field based advice on technology use, reduction of number of intermediaries, and getting better prices. The central innovation of MSSL is that, it has evolved an integrated system that delivers all these services to farmers at one point, and delivering it as a viable business.

Similarly for BASIX, extension-plus means, linking primary producers to processors, promoting value addition at the local level and linking producer groups to other agencies, in addition to providing technical support and credit.

In BAIF Development Foundation (BAIF), setting up producer co-operatives, helping farmers acquire production, processing, managerial and marketing skills, and linking their produce to new and existing markets are all part of extension-plus.

All these cases reveal the importance of experimenting with new strategies and learning from them as a way of developing optimal arrangements. For instance, KHDP's farmer markets and new credit package for lease land farmers evolved through a series of failures *(eg: reluctance of banks to provide credit to lease-land farmers, resistance from traders to procure goods from farmer markets, etc.),* but these failures provided KHDP with lessons on how to go forward and try better arrangements each time. Similarly for MSSL, the failures from its first Mahindra Krishi Vihar (MKV) established at Madurai and its subsequent closure and the series of innovations made by its own franchisee "Bhuvi-care" to the MSSL approach helped it to evolve new location specific approaches while expanding MKVs to new locations. BASIX's interventions are based on system diagnosis in each location to identify critical interventions and potential partners. The key operational strategy is learning through small experimental interventions. Similarly BAIF's interventions were experimental.

Learning from each of these experiments led to the development of subsequent interventions. All the above cases thus reveal the *processes adopted, viz, experimentation, reflection and learning to evolve successful arrangements.* Moreover, these new institutional arrangements evolved through *partnership with other organizations',* networks and schemes already in place. For instance, KHDP partnered with research organizations', banks and traders to make the whole arrangement work. MSSL has evolved this new business venture in partnership with input companies, agro-processors and financial institutions. BAIF and Dhruva are working in partnership with people's organizations', producer co-operatives and a rural

development bank. Similarly, BASIX has been building its interventions around existing organizations' and is working in collaboration with *NGOs, such as Association of Sarva Seva Farms in Virudhnagar, Gram Abhyudaya Mandal in Nizamabad, and Rural Development Trust in Anantapur and with producer co-operatives like Andhra Pradesh Diary Development Co-operative Federation in Mahabubnagar and vegetable producer groups in Virudhanagar.*

FROM POLICY TO PRACTICE-KEY CONSTRAINTS IN EXTENSION PLUS:

The National Agricultural Policy of India and the Policy Framework for Agricultural Extension (PFAE) acknowledges the need for extension to engage with issues beyond technology dissemination. The PFAE affirms that the "policy environment will promote private and community driven extension to operate competitively, in roles that complement, supplement, work in partnerships and even substitute for public extension. However, to fulfill this expanded role, extension organizations' need to change considerably both in scope and mode of operation. While the need to provide a wide range of services as envisaged in extension-plus is all too apparent, a clear roadmap on reforming extension is not evident. States face a number of dilemmas: how much of past arrangements should be retained and which innovations in extension provision are desirable, affordable and politically possible given opposition from staff unions, and declining enthusiasm from donors and political patrons for a stand-alone extension that deals with only technology dissemination. The learning from the past does not seem to have made any difference to the way extension reform is approached. For instance, although the limitations of a single model of extension are well known (for example T&V), the merits are being considered of ATMA (Agricultural Technology Management Agency) as a model for extension that can be replicated across all states and districts.

Moreover, the planning and implementation of extension programs still rests only on extending technologies to farmers. Public sector extension is yet to make any experimentation with perfecting new marketing arrangements that reduce the number of intermediaries, eliminate exploitative weighing and payment methods, and help farmers to get better prices. Current efforts that provide information on prices and market arrivals in major markets alone have limited operational merit. But policy can't seem to get beyond this impasse of prescription without subsequent analysis and refinement. The cases described above suggest a number of broad principles: the need to build on existing structures and strengths in different locations; the need to establish new programs in ways that explicitly recognize the experimental nature of the reform and change process; and the need to recognize the value of diversity of approaches and arrangements. Those involved in the reform process will need to

build skills that allow them to reflect on progress (both successes and failures) and change course accordingly. It will require approaches that are less target-driven and more concerned with learning and the development of new capacities to deal with local circumstances. However, the current organizational culture in general restrict the ability of public sector extension to realize the vision of extension-plus precisely because the principles outlined above are counter to deeply held norms in the public sector. *Table-1 illustrates the key shifts required for operationalizing extension-plus.*

The following features need to be the focus of measures to reform the existing extension arrangements.

· Rigid professional hierarchies and patterns of control, with highly centralized modes of planning. This tends to stifle deviation from prescribed procedures, restricting innovation, particularly by middle and lower level staff.

· A tradition of assessing performance in terms of technology adoption and hence a focus on improved technology transfer mechanisms at the expense of other activities that may have a perfectly legitimate role in supporting farmers.

· A history of only rewarding successes and thus a reluctance to report and analyze the reasons of failure of a technology or a new approach.

· A tradition of working independently and a mistrust of other agencies. This is particularly so with regard to external agencies, NGO's and private sector, but also with other public agencies including research organisations.

· A tradition of up-ward accountability for resource utilization rather than output achievement and client satisfaction.

Rules and conventions related to recruitment, qualifications, transfer, contractual appointments and performance assessment further prevent accessing a wider range of expertise. The combined effect of these professional and administrative traditions is a prevailing culture in public sector extension that views its operational mandate-technology transfer-in very narrow terms, but also a culture in which the incentives and capabilities to learn and innovate are highly restricted. It is perhaps this weakness in the current culture of extension agencies and associated planning bodies that need to be addressed as one of the key issues by the reform process.

WAY FORWARD IN EXTENSION PLUS:

The underlying principles of extension-plus include a broad scope of service provision; the extensive use of partnerships to fulfil an expanded mandate; a learning-based approach that includes negotiations with a wide range of stakeholders in order to develop workable and

effective arrangements in line with specific local circumstances and objectives; and a larger degree of accountability to client groups.

To operationalize extension plus, there is a need for a broad agreement on the need to reinvent extension as a nodal agency that provides technological and non-technological services to farmers. Extension needs to play a facilitating role enabling access to services by acting as a bridge connecting farmers, the poor and vulnerable groups with different service providers.

TABLE-1: KEY SHIFTS IN OPERATIONALIZING EXTENSION-PLUS

ITEMS	FROM	TO
Form/Content	Technology dissemination Improving farm productivity Forming farmer groups Providing services Market information	Supporting rural livelihoods Improving farm and non-farm income Building independent farmer operated organizations Enabling farmers to access services from other agencies; Market development
Monitoring & Evaluation	Input and output targets	Learning
Planning & Implementation Strategy	Doing it alone	Partnerships
Sources of innovation in Extension	Centrally generated	Locally evolved (through local experimentation)
Approaches	Fixed/uniform	Evolving/diverse
Capacity Development of staff	Training	Learning by doing, facilitated experimentation
Capacity development of Extension system	Personnel and infrastructure	Development of linkages and networks
Policy Approach	Prescriptive/blue prints	Facilitating evolution of locally relevant approaches
Introducing new working practices	Staff training	Changing organizational culture through action learning
Underpinning paradigm	Transfer of Technology	Innovation system

Operationalizing extension-plus requires a new organizational culture. Next steps to developing this new culture might include:

a. Capacity Development. Shifting from training to a "learning by doing" approach whereby staff are encouraged and enabled to initiate small experimental projects that address broad livelihood needs and use partnership as a central approach. By treating small projects experimentally and facilitating staff to reflect on their meaning and outcomes, this would build skills related to experimentation, learning and evaluating innovative extension approaches.

b. New skills. Constituting a core group of specialists at the district level with non-traditional extension skills such as: market development; institutional development; post-harvest; enterprise development and agribusiness management.

c. Organizational & Monitoring Review. An organizational & management review of existing extension system, primarily to explore possibilities of recruiting limited number of better qualified field staff, creating new incentive structures and to provide more administrative and financial freedom at the lower levels.

d. Better informed policy process. As part of the reform and planning process, resources should be used for systematic institutional analysis of promising extension innovations so that generalizable principles can be drawn and new strategies suitably informed.

Only if extension takes learning-based approach to changing its role and improving its performance, will reforms succeed. But if this cultural change is to flourish, it needs to be supported and legitimized wholeheartedly and unambiguously at the most senior levels of the extension services and in other allied organisations. Challenging as this may be, without a new organizational culture, the far-reaching reforms needed to operationalize extension-plus will not succeed.

EXTENSION-PLUS-EXAMPLES FROM THE FIELD:

Government initiative: *Kerala Horticultural Development Programme (KHDP)* was conceived in 1992 as a project to improve the overall situation of fruit and vegetable farmers in Kerala; by increasing and stabilizing their income; reducing cost of production and improving the marketing system. KHDP used SHGs as its key concept for promoting the development of farmers and experimented with different approaches to provide better access by farmers to technology markets and credit. Every SHG selects three master farmers; one each for production, marketing and credit related activities and each one of them are trained by KHDP. KHDP has so far constituted 2312 SHGs, involving 41913 registered farmers. KHDP has encouraged group marketing where farmers now form their own market and got traders to come and buy. In the year 2002-03, about 31 thousand tons of produce worth around Rs.29 crore was traded through 112 marketing centres. KHDP developed a unique credit package that could be availed by lease-land farmers and at the same time acceptable to the banks. Loans totalling Rs. 52 crore has been disbursed to farmers. To generate and access needed technologies for its farmers, KHDP contracted the state agricultural university for research and also undertook participatory technology development with farmers. With the end of funding support from European Union in 2001, the organization was registered as a company and it currently provide support to growers in 11 districts. An impact study reported a significant

increase in area under fruit and vegetables in 86% of the SHGs and an increase in income in 75% of the SHGs7. The same study also reported that the number of farmers availing credit increased from 21% in the pre-KHDP period to 41% by 1999 and an increase in the efficiency of loan disbursal and increase in size of loans.

Agri-business initiative: *Mahindra Shubh Labh Services Limited (MSSL)* was formed in 2001 as a subsidiary by Mahindra and Mahindra, one of the leading tractor manufacturing firm in India. The objective was to provide what the company describes as "integrated yield and profit solutions". The company has established through its franchises "Mahindra Krishi Vihar" (MKV), a one stop shop for farmers (who registers with them on a fee), that provide access to quality inputs and machinery, credit, access to advisory and field supervision services, buy back and better prices. MSSL initiated this service in paddy in Tamil Nadu and currently this service is being expanded to more crops and districts. In Tirunelveli, the Mahindra franchise, Bhuvi Care Private Ltd has successfully established this scheme in paddy and maize. In 2003-04 II season (October -February), 105 farmers have registered 305 acres of paddy at Rs.500/ per acre/season and 314 farmers have registered 1392 acres of maize at Rs.150/per acre/per season. In paddy, the participant farmers realized 12% increase in yield and 27% increases in net returns per acre and for maize, 10% and 40% respectively.

Financial institution initiative: *BASIX is a group of financial services* and technical assistance companies, established for the promotion of sustainable livelihoods. It is currently operating in five states, namely, Andhra Pradesh, Karnataka, Maharashtra, Orissa and Jharkhand. According to BASIX, credit is necessary, but not a sufficient condition for generating sustainable livelihoods. In Andhra Pradesh, BASIX has identified a few sub-sectors in its area of operation (districts) such as groundnut in Anantpur, cotton in Adilabad and milk in Mahabubnagar. In Tamil Nadu (Virudhanagar) and Jharkhand (Ranchi), BASIX has initiated activities in vegetables9. Besides intervening in areas, which leads to direct increase in productivity or output, BASIX has been involved in finding out alternate market channels (eg: directly linking of cotton growers to spinning mills and groundnut growers to oil millers or wholesale traders) or value addition possibilities in these subsectors (eg; contracting with decorticating unit to decorticate groundnut by farmers) with an objective of raising the income of the primary producers. BASIX in all these cases worked in collaboration with local NGOs, or producer groups.

NGO initiative: *BAIF Development Foundation, an NGO* has been implementing the Wadi programme in three states, Gujarat, Maharashtra and Karnataka covering more than 50,000 families. In South Gujarat, Dhruva, an NGO promoted by BAIF has facilitated

establishment of fruit orchard (wadi) on the land belonging to adivasis. When the trees (mango and cashew) started yielding, the project realized the need to intervene in value addition and marketing if the tribal producers have to benefit from the intervention. At Vansda, BAIF facilitated the establishment of a producer co-operative "Vasundhara VrixVanwadi Jal sinchan Vikas Sahkari Mandal Samiti" with an objective to help the member producers to increase income through post-harvest processing of fruits into marketable products and establish marketing linkages. By 2002-03, 13,000 adivasis have been assisted and an area of 11,897 acres of private land has been covered. Dhruva assisted the Vasunadhara Co-operative in designing appropriate systems (technical and organisational) to preserve fruits, process them (eg: cashew nuts, and as mango pickles, jams, and jellies) and access local and urban markets under the brand name "Vrindavan". This project funded by KfW, (a German donor) is implemented by Dhruva in partnership with "Village Ayojan Samities" and the National Bank for Agriculture and Rural Development (NABARD).

Acknowledgement: *The authors are tankful & acknowledge the great contribution in the research Paper of Sulaiman, R.V. and Hall A.J. of 2017 & 2004 published in https://www.researchget.net.*

References:

Sulaiman, R.V. and Hall A.J. (2017).The Emergence of Extension Plus: Future for Extension-Beyond TOT. Agriculture and Rural Development Discussion Paper 8; Extension Reform for Rural Development. https://www.researchgate.net/publication/316736871

Sulaiman, R.V. and Hall A.J. (2004) Towards Extension Plus: opportunities & Challenges (Policy Brief). National Centre for Agriculture Economics & Policy research, ICAR, New Delhi.

Sulaiman, R.V. and Hall A.J. (2002). An innovation system perspective on the restructuring of agricultural extension- evidence from India, Outlook on Agriculture 30(4); 235-243.

Sulaiman, R.V., Hall, A.J. and Suresh, N. (2004) Emerging trends in private extension provision: a case of MSSL in India, Ag Ren Network Paper (forthcoming), Overseas Development Institute, UK.

Chapter-7

ICT in Extension: Prospect and potentialities in climate resilient holistic farming practices

Dr. Aditya Sinha[1*] & Dr. Sukanta Biswas[2]

[1]Dept. of Extension Education, Bihar Agricultural University, Sabour – 813210, Bhagalpur

[2]Associate Professor & HOD, Dept. of Veterinary and Animal Husbandry Extension Education, W.B. University of Animal & Fishery Sciences

Mohanpur, Dist.-Nadia & Belgachia, Kolkata-700037, West Bengal

*Corresponding author Email: inc.aditya@gmail.com

Abstract

This Study explores the transformative role of Information and Communication Technology (ICT) in promoting climate-resilient holistic farming practices. As agriculture faces unprecedented challenges due to climate change, ICT emerges as a powerful tool for adaptation and resilience. The chapter examines the current state of ICT in agricultural extension and its potential to revolutionize farming in the face of climate variability. It delves into various ICT tools and technologies, including weather forecasting systems, precision agriculture, mobile applications, and remote sensing, highlighting their applications in supporting holistic farming practices. The integration of ICT with soil health management, water conservation, integrated pest management, and crop diversification strategies is discussed, emphasizing the synergies between technology and sustainable agriculture. The chapter also explores innovative approaches to knowledge dissemination and farmer education through e-learning platforms, social media, and immersive technologies. Additionally, it addresses the challenges and limitations of ICT adoption in agriculture, such as the digital divide and data security concerns, while presenting future prospects and potential developments in the field. The conclusion underscores the transformative potential of ICT in building resilient agricultural systems and calls for collaborative efforts among stakeholders to fully realize this potential. This comprehensive analysis provides valuable insights for researchers, policymakers, and practitioners working towards sustainable and climate-resilient agriculture.

***Keywords**: Climate-resilient agriculture, Information and Communication Technology (ICT), Precision farming, Agricultural extension, Holistic farming practices*

1. Introduction

1.1 Definition of ICT in agricultural extension

Information and Communication Technology (ICT) in agricultural extension refers to the use of digital tools, platforms, and technologies to disseminate knowledge, facilitate communication, and support decision-making processes in the agricultural sector. It encompasses a wide range of technologies, including mobile devices, computers, internet-based applications, and specialized software designed to address the unique needs of farmers and agricultural stakeholders (Anastasios, Koutsouris & Konstadinos, 2010).

1.2 Importance of climate-resilient holistic farming practices

Climate-resilient holistic farming practices are becoming increasingly crucial in the face of global climate change. These practices aim to create sustainable agricultural systems that can withstand and adapt to changing environmental conditions while maintaining productivity and ecosystem health. Holistic farming approaches consider the entire farm ecosystem, including soil health, water management, biodiversity, and the socio-economic aspects of agriculture. By integrating climate resilience into these practices, farmers can better mitigate risks associated with extreme weather events, changing precipitation patterns, and temperature fluctuations.

1.3 Overview of chapter objectives

This chapter aims to explore the intersection of ICT, agricultural extension, and climate-resilient holistic farming practices. The objectives are to:

- Examine the current state of ICT implementation in agricultural extension services
- Analyze the impacts of climate change on agriculture and the need for resilient practices
- Investigate the potential of ICT tools and technologies in promoting and supporting climate-resilient holistic farming
- Discuss challenges and future prospects for integrating ICT into climate-smart agriculture

By addressing these objectives, the chapter will provide a comprehensive overview of how ICT can transform agricultural extension services to better support farmers in adopting climate-resilient and holistic farming practices.

2. Current state of ICT in agricultural extension

2.1 Traditional extension methods

Traditional agricultural extension methods have primarily relied on face-to-face interactions between extension agents and farmers. These methods include:

- Farm visits by extension agents
- Demonstration plots and field days
- Group meetings and workshops

- Printed materials such as leaflets and posters
- Radio and television broadcasts

While these methods have been effective in disseminating information, they often face limitations in terms of reach, timeliness, and the ability to provide personalized advice to large numbers of farmers.

2.2 Emergence of ICT-based extension services

The integration of ICT into agricultural extension has led to the development of new and innovative approaches to farmer support:

- Mobile-based advisory services: SMS and voice message systems provide farmers with timely information on weather, market prices, and best practices.
- Smartphone applications: Dedicated apps offer a range of services, from pest identification to crop management recommendations.
- Web-based platforms: Online portals provide comprehensive information resources, e-learning modules, and interactive forums for farmers.
- Call centres: Dedicated helplines staffed by experts offer real-time support to farmers.
- Remote sensing and GIS: These technologies enable precise monitoring of crop health and environmental conditions across large areas.

These ICT-based services complement traditional extension methods, enhancing the reach and effectiveness of agricultural information dissemination (Siraj, 2010).

2.3 Case studies of successful ICT implementations

Several successful implementations of ICT in agricultural extension have demonstrated the potential of these technologies:

- Digital Green (India): This organization uses participatory video and digital technology to share best practices among small-scale farmers (Gandhi et al., 2007).
- M-Farm (Kenya): A mobile and web-based platform that connects farmers with markets and provides real-time price information (Bradford, 2022).
- Plantix (Global): A mobile app that uses image recognition and machine learning to diagnose plant diseases and offer treatment recommendations (Ng et al., 2021)

These case studies highlight how ICT can address specific challenges in agricultural extension, such as information accessibility, market linkages, and specialized knowledge dissemination.

3. Climate change impacts on agriculture

3.1 Overview of climate change effects on farming

Climate change is having profound and diverse impacts on agriculture worldwide:

- Temperature changes: Rising temperatures affect crop growth cycles, pest and disease prevalence, and water availability.
- Precipitation patterns: Changes in rainfall patterns lead to droughts in some regions and flooding in others, disrupting traditional farming calendars.
- Extreme weather events: Increased frequency and intensity of events such as hurricanes, heat waves, and frosts cause crop damage and yield losses.
- Sea-level rise: Coastal agricultural lands face threats from saltwater intrusion and inundation.
- Biodiversity loss: Changes in climate affect pollinator populations and the distribution of beneficial and harmful species.

These impacts vary by region and crop type, creating complex challenges for farmers and agricultural systems worldwide.

3.2 Need for resilient farming practices

The unpredictable and often adverse effects of climate change necessitate the adoption of resilient farming practices:

- Drought-resistant crop varieties and farming techniques
- Improved water management and conservation methods
- Diversified cropping systems to spread risk
- Soil conservation and enhancement practices
- Integrated pest management adapted to changing pest pressures
- Flexible planting and harvesting schedules

Resilient practices help farmers adapt to changing conditions, maintain productivity, and ensure food security in the face of climate uncertainty.

3.3 Role of ICT in climate change adaptation

ICT plays a crucial role in supporting climate change adaptation in agriculture:

- Early warning systems: ICT-enabled weather forecasting and alert systems help farmers prepare for extreme events.
- Decision support tools: Data-driven applications assist farmers in making informed decisions about planting, irrigation, and harvesting based on climate projections.
- Knowledge sharing platforms: Online networks facilitate the exchange of adaptation strategies and experiences among farmers and experts.
- Precision agriculture: ICT-powered technologies enable resource-efficient farming practices, reducing environmental impact and increasing resilience.
- Monitoring and evaluation: Remote sensing and data analytics help track the effectiveness of adaptation measures over time (Abbass et al., 2022).

By leveraging ICT, agricultural extension services can more effectively support farmers in implementing climate-resilient practices and responding to the challenges posed by climate change.

4. ICT tools and technologies for climate-resilient farming

4.1 Weather forecasting and early warning systems

Advanced weather forecasting and early warning systems are crucial for climate-resilient farming. These systems utilize a combination of technologies:

- Satellite imagery: Provides broad-scale atmospheric data and cloud patterns.
- Ground-based weather stations: Offer localized, real-time weather data.
- Doppler radar: Enables precise precipitation tracking and severe weather detection.
- Machine learning algorithms: Improve forecast accuracy by analysing historical and real-time data.

Farmers can access this information through:

- Mobile apps delivering personalized weather alerts
- SMS services providing daily forecasts and extreme weather warnings
- Web portals offering detailed meteorological data and agricultural advisories

These systems help farmers make informed decisions about planting dates, irrigation scheduling, and harvest timing, reducing climate-related risks.

4.2 Precision agriculture technologies

Precision agriculture leverages ICT to optimize resource use and increase resilience:

- GPS-guided machinery: Enables precise planting, fertilizer application, and harvesting, reducing waste and improving efficiency.
- Soil sensors: Monitor moisture levels, nutrient content, and pH, allowing for targeted interventions.
- Drones and satellite imagery: Provide high-resolution field maps for crop health assessment and yield prediction.
- Variable rate technology (VRT): Allows for customized application of inputs based on field variability.
- IoT devices: Connect various farm equipment and sensors, creating a network of smart farming tools.

These technologies enable farmers to adapt quickly to changing conditions, conserve resources, and maintain productivity in the face of climate variability.

4.3 Mobile applications for farmers

Mobile apps have become powerful tools for climate-resilient farming:

- Crop management apps: Provide tailored advice on crop selection, planting times, and management practices based on local climate data.
- Pest and disease identification apps: Use image recognition to diagnose plant health issues and suggest treatments.
- Market information apps: Connect farmers to real-time price data and potential buyers, improving economic resilience.
- Water management apps: Help optimize irrigation schedules based on crop needs and weather forecasts.
- Carbon footprint calculators: Allow farmers to assess and reduce their greenhouse gas emissions.

These apps put critical information and decision-support tools directly into farmers' hands, enhancing their ability to respond to climate challenges.

4.4 Remote sensing and GIS in agriculture

Remote sensing and Geographic Information Systems (GIS) offer valuable insights for climate-resilient farming:

- Crop monitoring: Satellite and drone imagery track crop growth and health over large areas.
- Land use mapping: GIS tools help plan crop rotations and assess land suitability for different crops under changing climate conditions.
- Soil mapping: Detailed soil characteristic maps guide precision farming practices.
- Water resource management: Remote sensing data aids in assessing water availability and planning irrigation strategies.
- Climate risk assessment: GIS analysis of historical and projected climate data identifies vulnerable areas and informs adaptation strategies.

These technologies enable data-driven decision-making at both farm and regional levels, supporting more resilient agricultural systems.

5. Holistic farming practices and ICT integration

5.1 Definition and principles of holistic farming

Holistic farming, also known as regenerative agriculture, is an approach that views the farm as an interconnected ecosystem. It aims to enhance biodiversity, improve soil health, increase water retention, and promote overall system resilience. Key principles include:

- Minimizing soil disturbance
- Maintaining soil cover
- Increasing plant diversity
- Integrating livestock

- Reducing chemical inputs

ICT integration supports these principles by providing tools for monitoring, analysis, and decision-making that considers the whole farm ecosystem.

5.2 ICT support for soil health management

Soil health is fundamental to holistic farming. ICT tools supporting soil management include:

- Digital soil mapping: Combines field data with satellite imagery to create detailed soil property maps.
- Soil health monitoring apps: Allow farmers to track key indicators like organic matter content, microbial activity, and soil structure.
- Precision composting systems: Use sensors and automated controls to optimize compost production.
- Carbon sequestration calculators: Help farmers quantify and maximize soil carbon storage.

These tools enable farmers to make informed decisions about soil management practices, enhancing overall farm resilience.

5.3 Water conservation and irrigation efficiency

ICT plays a crucial role in water management for holistic farming:

- Smart irrigation systems: Use soil moisture sensors, weather data, and crop models to optimize irrigation timing and amounts.
- Rainwater harvesting planning tools: Help design and implement efficient rainwater capture systems.
- Virtual water trade platforms: Enable farmers to make informed decisions about crop choices based on water availability and market demand.
- Watershed management software: Supports community-level water resource planning and conservation efforts.

These technologies help farmers adapt to changing precipitation patterns and improve water use efficiency.

5.4 Integrated pest management (IPM) systems

ICT enhances IPM strategies in holistic farming:

- Pest prediction models: Combine weather data, crop phenology, and pest life cycles to forecast outbreaks.
- Beneficial insect monitoring apps: Help farmers track and encourage natural pest predators.
- Precision pesticide application: Uses drone or tractor-mounted sensors to target pest hotspots, reducing overall chemical use.

- Community alert systems: Enable farmers to share pest observations and coordinate management efforts.

These tools support a more balanced and resilient approach to pest management, reducing reliance on chemical interventions.

5.5 Crop diversification and rotation planning

ICT supports complex crop diversification and rotation strategies:

- Crop rotation planning software: Helps design optimal rotations based on soil health, pest cycles, and market demand.
- Intercropping calculators: Assist in planning complementary crop combinations to maximize land use and biodiversity.
- Market diversification platforms: Connect farmers with diverse market opportunities, supporting economically resilient diversification strategies.
- Biodiversity monitoring tools: Help assess and enhance on-farm biodiversity, a key aspect of holistic farming.

These technologies enable farmers to implement and manage more diverse and resilient farming systems.

6. Knowledge dissemination and farmer education

6.1 E-learning platforms for farmers

E-learning platforms are revolutionizing agricultural education:

- Massive Open Online Courses (MOOCs): Offer free or low-cost courses on climate-resilient farming practices from leading institutions.
- Interactive learning management systems: Provide structured, self-paced learning experiences tailored to local farming contexts.
- Mobile learning apps: Deliver bite-sized lessons and quizzes that farmers can access anytime, anywhere.
- Virtual field schools: Use video conferencing and virtual reality to connect farmers with experts and peers for collaborative learning.

These platforms democratize access to agricultural knowledge, enabling continuous learning and adaptation to changing conditions.

6.2 Social media and networking for information sharing

Social media and digital networking tools facilitate peer-to-peer learning and community building:

- Farmer-to-farmer networks: Platforms like WhatsApp groups or Facebook pages where farmers share experiences and advice.

- Expert Q&A forums: Online spaces where farmers can ask questions and receive answers from agricultural specialists.
- YouTube channels: Video platforms where successful farmers and extension agents share practical demonstrations and tips.
- Twitter for real-time updates: Used by extension services to share timely information on weather, market prices, and emerging issues.

These tools create dynamic, farmer-centric knowledge ecosystems that complement formal extension services.

6.3 Virtual reality and augmented reality in farmer training

Emerging technologies are creating immersive learning experiences:

- Virtual reality (VR) farm simulations: Allow farmers to practice new techniques in a risk-free environment.
- Augmented reality (AR) field guides: Overlay digital information on real-world views, helping farmers identify pests, diseases, or soil issues.
- 360-degree video tours: Enable farmers to virtually visit and learn from successful climate-resilient farms around the world.
- AR-enhanced equipment training: Provides step-by-step guidance for operating and maintaining farm machinery.

These technologies make complex concepts more accessible and engaging, accelerating the adoption of climate-resilient practices.

7. Data-driven decision making in farming

7.1 Big data analytics in agriculture

Big data is transforming agricultural decision-making:

- Yield prediction models: Combine historical yield data, weather patterns, and satellite imagery to forecast crop production.
- Market trend analysis: Process vast amounts of price and demand data to guide planting and marketing decisions.
- Climate risk assessment: Analyse long-term climate data to identify trends and inform adaptation strategies.
- Resource optimization algorithms: Process farm-level data to suggest the most efficient use of inputs like water, fertilizer, and labour.

These analytics tools help farmers make more informed, data-driven decisions in the face of climate uncertainty.

7.2 Artificial intelligence and machine learning applications

AI and machine learning are driving innovation in climate-resilient farming:

- Crop disease diagnosis: AI-powered image recognition systems can identify plant diseases from smartphone photos.
- Autonomous farming systems: Self-driving tractors and robotic harvesters optimize field operations.
- Predictive maintenance: Machine learning algorithms predict equipment failures before they occur, reducing downtime.
- Personalized crop recommendations: AI systems analyse farm-specific data to suggest optimal crop varieties and management practices.

These technologies enhance farm efficiency and adaptability, crucial for resilience in a changing climate.

7.3 Block chain for traceability and transparency

Block chain technology is improving supply chain management and market access:

- Product traceability: Allows consumers to track the origin and journey of agricultural products, supporting sustainable and local food systems.
- Smart contracts: Automate transactions between farmers and buyers, reducing intermediaries and ensuring fair prices.
- Carbon credit tracking: Enables farmers to participate in carbon markets by verifying and trading carbon sequestration credits.
- Input authenticity verification: Helps combat counterfeit seeds, fertilizers, and pesticides, ensuring quality and safety (Sinha et al., 2021).

Block chain supports more transparent, efficient, and resilient agricultural value chains.

This extensive elaboration covers the key aspects of ICT tools and technologies for climate-resilient farming, their integration with holistic farming practices, and approaches to knowledge dissemination and farmer education. It also touches on data-driven decision-making in farming, highlighting how these technologies work together to support more resilient and sustainable agricultural systems.

8. Challenges and limitations

8.1 Digital divides in rural areas

The digital divide remains a significant challenge in implementing ICT solutions for climate-resilient farming:

- Infrastructure gaps: Many rural areas lack reliable internet connectivity and electricity, limiting access to online resources and IoT devices.

- Device availability: Smartphones and computers may be unaffordable or unavailable for some farmers, particularly in developing countries.
- Digital literacy: Older farmers or those with limited education may struggle to adopt and effectively use digital technologies.
- Language barriers: Many ICT tools are not available in local languages, limiting their accessibility to non-English speaking farmers.

To address these issues, initiatives focusing on rural connectivity, community technology centres, and digital literacy programs are crucial.

8.2 Data privacy and security concerns

As agriculture becomes more data-driven, privacy and security issues emerge:

- Data ownership: Questions arise about who owns the data collected from farms and how it can be used.
- Cyber security risks: Internet-connected farm systems may be vulnerable to hacking, potentially compromising operations or sensitive information.
- Corporate data control: Large agribusinesses may gain disproportionate power through data accumulation, potentially disadvantaging small-scale farmers.
- Regulatory gaps: Many countries lack comprehensive regulations for agricultural data protection and use.

Developing robust data governance frameworks and cyber security measures is essential for building trust in agricultural ICT systems.

8.3 Technological literacy among farmers

The complexity of some ICT tools poses adoption challenges:

- Learning curve: Advanced technologies like precision agriculture systems often require significant training and support.
- Generational differences: Younger farmers may adapt more quickly to new technologies, potentially leaving older farmers behind.
- Continuous updates: Rapidly evolving technology requires on going learning and adaptation, which can be overwhelming for some farmers.
- Technical support: Limited access to expert technical assistance in rural areas can hinder the effective use and maintenance of ICT tools.

Addressing these issues requires comprehensive training programs, user-friendly design, and accessible technical support systems.

8.4 Cost and accessibility of ICT tools

Financial barriers can limit the adoption of climate-resilient farming technologies:

- High initial investment: Advanced systems like precision agriculture equipment often have substantial upfront costs.
- On going expenses: Subscription fees for data services, software updates, and maintenance can be burdensome for small-scale farmers.
- Return on investment uncertainty: Farmers may be hesitant to invest in new technologies without clear evidence of economic benefits.
- Scale-appropriate solutions: Many advanced technologies are designed for large-scale operations, leaving small farmers with fewer options.

Developing affordable, scalable solutions and innovative financing models is crucial for wider adoption of agricultural ICT.

9. Future prospects and potential developments

9.1 Emerging technologies in agricultural ICT

Several cutting-edge technologies show promise for enhancing climate-resilient farming:

- Edge computing: Enables real-time data processing on farm devices, reducing reliance on internet connectivity.
- 5G networks: Will support more connected devices and faster data transmission, enabling more sophisticated IoT applications.
- Quantum computing: Could revolutionize complex modelling for climate prediction and crop optimization.
- Advanced robotics: Developments in soft robotics and swarm robotics may lead to more versatile and efficient automated farming systems.
- Nanotechnology: Nano-sensors and smart materials could provide unprecedented precision in monitoring and managing crop health.

These technologies have the potential to address current limitations and open new possibilities in climate-resilient agriculture.

9.2 Integration of ICT with other sectors

The future of agricultural ICT lies in its integration with other domains:

- Fintech: Integration with financial technologies could improve access to credit, insurance, and markets for small-scale farmers.
- Energy: Combining renewable energy systems with smart farming technologies could enhance farm sustainability and resilience.
- Health: Connecting agricultural data with human health information could support more holistic approaches to food systems and nutrition.

- Transportation: Integration with smart logistics systems could reduce food waste and improve market access.
- Education: Closer links between agricultural ICT and formal education systems could foster a new generation of tech-savvy farmers.

These inter-sectoral connections will be crucial for developing more comprehensive and effective climate resilience strategies.

9.3 Policy recommendations for ICT adoption in extension services

To fully leverage ICT for climate-resilient farming, supportive policies are needed:

- Digital infrastructure investment: Governments should prioritize rural broadband and mobile network expansion.
- ICT education: Integrate digital literacy and agri-tech training into agricultural education curricula.
- Research and development support: Increase funding for agricultural ICT research, with a focus on small-scale and resource-poor farming contexts.
- Data governance frameworks: Develop comprehensive policies for agricultural data ownership, privacy, and security.
- Public-private partnerships: Encourage collaboration between tech companies, research institutions, and extension services to develop and deploy appropriate technologies.
- Incentive programs: Offer subsidies or tax incentives for farmers adopting climate-resilient ICT solutions.

These policy measures can create an enabling environment for the widespread adoption of ICT in climate-resilient agriculture.

10. Conclusion

In conclusion, the integration of Information and Communication Technology (ICT) into climate-resilient holistic farming practices represents a transformative approach to addressing the complex challenges posed by climate change in agriculture. This chapter has highlighted how diverse ICT tools, from advanced weather forecasting systems to precision agriculture technologies, are empowering farmers to adapt to changing climatic conditions while promoting sustainable and efficient farming practices. The adoption of holistic farming approaches, supported by ICT, offers a comprehensive strategy for building resilient agricultural systems that can withstand environmental pressures while maintaining productivity. Through innovative knowledge dissemination methods, including e-learning platforms, social media, and immersive technologies, agricultural education and extension services are being revolutionized, making critical information more accessible to farmers worldwide. The emergence of data-driven

decision-making, powered by big data analytics, artificial intelligence, and block chain technology, is enabling farmers to make more informed choices, optimize resource use, and increase their adaptive capacity. While challenges such as the digital divide and data security concerns persist, the potential of ICT in agriculture continues to expand, offering unprecedented opportunities for enhancing food security and agricultural sustainability. The realization of this potential, however, requires a concerted effort from all stakeholders – farmers, policymakers, researchers, extension services, technology developers, and consumers – to embrace innovation, invest in infrastructure, and collaborate on developing user-friendly, context-appropriate solutions. As we navigate the complexities of 21st-century agriculture, the integration of ICT into climate-resilient holistic farming practices stands as a beacon of hope, promising a more resilient, sustainable, and productive agricultural sector capable of feeding a growing global population in the face of climate uncertainty.

References

1. Anastasios, M., Koutsouris, A., & Konstadinos, M. (2010). Information and communication technologies as agricultural extension tools: a survey among farmers in West Macedonia, Greece. *Journal of Agri.l Education and Extension*, *16*(3), 249-263.
2. Siraj, M. (2010). A model for ICT based services for agriculture extension in Pakistan. *CABI South Asia, Rawalpindi, Pakistan*.
3. Gandhi, R., Veeraraghavan, R., Toyama, K., & Ramprasad, V. (2007, December). Digital green: Participatory video for agricultural extension. In *2007 International conference on information and communication technologies and development* (pp. 1-10). IEEE.
4. Bradford, F. (2022). Innovating Kenya's Trading System through Mobile Technology: A Case Study of M-Farm in Nairobi, Kenya.
5. Ng, H. F., Lin, C. Y., Chuah, J. H., Tan, H. K., & Leung, K. H. (2021, July). Plant disease detection mobile application development using deep learning. In *2021 International conference on computer & information Scs. (ICCOINS)* (pp. 34-38). IEEE.
6. Abbass, K., Qasim, M. Z., Song, H., Murshed, M., Mahmood, H., & Younis, I. (2022). A review of the global climate change impacts, adaptation, and sustainable mitigation measures. *Environmental Science and Pollution Research*, *29*(28), 42539-42559.
7. Sinha, A., Priyadarshi, P., Bhushan, M., & Debbarma, D. (2021). Worldwide trends in the scientific production of literature on traceability in food safety: A bibliometric analysis. *Artificial Intelligence in Agriculture*, *5*, 252-261.

Chapter-8

Antimicrobial resistance (AMR) in livestock disease & application of Ethno-Veterinary medicine

Samiran Bandyopadhyay, Principal Scientist
ICAR-Indian Veterinary Research Institute, Eastern Regional Station
37 Belgachia Road, Belgachia, Kolkata 700 037

Antimicrobial agents, the wonder drug, have become an essential part of modern medicine, since the appearance of penicillin. The drug has saved lives of million and reduced the morbidity and mortality burden of deadly infections that once reigned the world. But the time has come when this wonder drug has ceased to be as effective as it was with increasing reports of resistance to the newer and higher generation antibiotics. Antimicrobial resistance is considered as the biggest threat ever faced by human civilization as it can jeopardize the global health, economy and human development. Considering the gravity of the problem, it was discussed in United Nations General Assembly in New York in September 2016. Inadvertent and irrational use of antimicrobials is considered as single most important driver for development of antimicrobial resistance. The impact of AMR is far reaching and multifaceted. Currently, AMR is responsible to cause about 700,000 deaths annually worldwide and the same may to reach 10 million by 2050. It can cause world economy a loss of $100 trillion by 2050 which can drop the global GDP by 3.5 per cent and around 28 million people will be slipped under poverty. Livestock production will be dwindled by 7.5% to have an adverse impact on food security.

The problem is more intense for poor and developing world where people are already down by magnitude of problems like scarcity of resources, poverty and poor access to medical facilities and proper nutrition. As animal sector along with agriculture is the mainstay of economy for a country like India, we have to tackle this problem in a unique manner so that the food security for millions did not get disturbed. The solution adopted by the developed world may not fit for us. Most of our farming communities may not have adequate access to the veterinary facilities which leads to poor diagnosis and faulty therapeutics.

World Health Organization (WHO) came with the Global Action Plan (GAP) to ensure " for as long as possible, continuity of successful treatment and prevention of infectious diseases with effective and safe medicines that are quality-assured, used in a responsible way, and accessible to all who need them". Subsequently, The Food and Agriculture Organization (FAO) and World Organization for Animal Health (WOAH/OIE) endorsed the WHO GAP. In 2017, India came with the National Action Plan on AMR with multi-sectorial One Health approach.

In order to obtain or generate a data base throughout the country, Indian Council of Agricultural Research has established a network INFAAR (Indian Network for Fishery and Animals Antimicrobial Resistance) in collaboration with FAO with an aim to explore the resistance pattern of the indicator and pathogenic bacteria isolated from food animals and fishes. Currently, it has been reshaped with 31 animal science and fisheries institutes in the name of All India Network Programme on AMR under exclusive funding from ICAR.

Off-label or over-the counter use of antibiotics in any sector is the major hindrance to reduce the antimicrobial usage. In a vast country like India, where people are rearing animals in backyard system have little scope to bring the ill animals to the veterinary dispensaries which are also inadequate to cater the need of huge number of animals. The number of veterinary diagnostics is also very less. Therefore, people often have to rely on over-the-counter medicine for their ailing animals. Now when we are calling for reduction of antimicrobial usage in animal sectors, we have to give some alternative options to these people. National Dairy Development Board (NDDB) have come up with some ethno-veterinary medicine (EVM) or therapeutics which can be adopted for treating the ill animals at least as a primary care. However, farmers must keep in mind that EVM may not provide optimum relieve in extremely sick animals or in case of emergency. They must be in touch with the available veterinary doctor in such scenario.

Here a few disease conditions are discussed where there are possibilities of antibiotic usage. Readers are advised go through videos published from NDDB.

Mastitis (all types):

Mastitis is probably frequently encountered problem in a dairy herd which often require the need of antibiotics. There is water based and oil-based formulations are advocated by NDDB. In water-based formulation, Aloe vera whole leaf (250 g) after removal of thorns are to be cut into pieces into small pieces and blended with turmeric powder (50 g), and lime (15 g) [This is one day paste]. Handful amount of paste after diluted in 200 ml of clean water has to be applied on the affected udder after cleaning and removal of milk about ten times a day for five days. Along with that the cows may be fed two lemons at a time orally (cut into halves) thrice a day for 3 days. In oil-based preparation, mustard or gingerly oil is to be used. The last application of the paste should always be oil based. If there is blood in milk two handfuls of blended moringa leaves in jaggery can be fed to affected cows

Diarrhoea: Whether it is colibacillosis or other bacterial, viral or parasitic diarrhoea, use of antimicrobial or anti-parasitic drugs is very rampant specially when there is little scope to consult with veterinary doctors and to have veterinary diagnostic facility. Many of the diarrhoea are often due to indigestion and are self-limiting and may not require any therapeutic

intervention. However, profuse bacterial or viral diarrhoea may lead to fluid loss and acute renal failure. On the other hand, long standing parasitic infestation may lead to emaciation, weakness, loss of body weight and production. These conditions may require appropriate therapeutic intervention. The ingredient of the EVM include cumin seeds (10 g), asafoetida (5 g), poppy seeds (5 g) and fenugreek seeds (10 g) which all are to be dry fried, cooled and powdered and blended with one onion, one garlic, turmeric Powder (10 g), one handful of curry leaves, pepper (10 g) and jaggery (100 g) to make a paste in the form of small balls which are to be fed for three days.

Fever: In fever, water soaked cumin (10 g), pepper (10 g) and coriander seeds (10 g) are blended with garlic (2) one handful of tulsi, about 10 g of dry cinnamon leaves, five betel leaves, onion(2 bulbs), turmeric powder (10 g), chirata leaf powder (20 g), handful of sweet basil and neem leaves and jaggery (100 g). This mixture is sufficient for a day and to be fed twice a day. Many fevers are of viral origin like ephemeral fever and use of antibiotics is unnecessary, if secondary bacterial infection is not suspected. In such cases of uncomplicated fever this kind of EVM may be adopted.

Cough: Any kind of respiratory infections and allergic reaction starts with cough and often resolve if the infection is not severe. If the cough is not accompanied with fever and other systemic reaction, homemade remedy may give sufficient relief.

Soaked black pepper (10 g) is to be blended with one adhathoda (Adusa) leaf, one handful of tulsi, garlic (5 cloves), 10 g of turmeric powder and jaggery. This paste is to be fed to the affected animal 2-3 times a day and similar preparation is to be continued for a span as required.

Joint swelling: Other the bacterial or mycoplasma infection, injury and other factors may lead to joint swelling and this is usually chronic in nature causing severe lameness and pain. Ingredients like aloe vera - 100 g, lime - 10 g, *Cissus quadrangularis* stem - 100g, turmeric powder - 15 g, garlic - 5 cloves are to be blended and to be boiled in one litre of gingelly oil. The preparation needs to be cooled and to be applied in the affected joint 4-5 times. Hot fomentation may give extra relief.

Udder oedema: The udder oedema developed mainly because of injury. A topical EVM formulation may be prepared by boiling about two pearls of clove and handful of turmeric powder in 200 ml of sesame or mustard oil - 200 ml. This may be applied 3-4 times a day.

These are examples a few EVM protocols which farmers may adopt as first-hand therapy for treating various ailments of their animals.

Chapter-9

Integrated Livestock-Fish farming: Holistic approach towards Sustainable Development

Biswajit Pal[1*] and Susmita Mondal[2]
[1&2]Department of Rural Studies,
West Bengal State University, Barasat, West Bengal, India
***biswajit.pal22@gmail.com**

1. Introduction

In recent days sustainability in the agriculture sector has been a worldwide concern. In earlier days Population was low so food security could be achieved by practicing monoculture farming. The problem arrives when Day by Day population increases gradually. To support this huge population we need to increase productivity. For this through the green revolution use of agrochemicals, HYV seed, and Irrigation was introduced in the Indian agriculture system. As a result, production increases many times which is a positive thing. On the other hand, according to many researchers, the use of agrochemicals negatively impacts the environment and health. Negative impacts like biodiversity loss and native species destruction are happening due to the overuse of agrochemicals. Therefore to minimize this problem exploring integrated livestock-fish farming can be a potential option to achieve sustainable development. It's an interaction between the practice of aquaculture and livestock as a result integration of fish and livestock farming gives social, Cultural, and environmental advantages.

2. Sustainable Development: A Holistic Approach

Sustainable development is a holistic approach to growth and progress that seeks to balance economic, social, and environmental needs. The concept is centered on meeting the needs of the present without compromising the ability of future generations to meet their own needs.

After publishing the Brundtland Report in 1987 this concept was widely known worldwide. Long-term economic viability, environmental stewardship, and social equity need to be integrated into policies and practices. The concept of sustainable development is achieved by a balance between three domains. These domains are interdependent with each other.

1. **Economic Sustainability**: Ensuring that economic activities are efficient, viable, and contribute to long-term economic stability without depleting resources or causing environmental harm. The economic sustainability in this aspect indicates the sustainable return from the farm considering the price index and minimum depletion of the natural resources.
2. **Environmental Sustainability**: Maintaining the health of the planet by protecting ecosystems, reducing pollution, and conserving natural resources to support life now and in the future.

Biodiversity conservation, less utilization of non-renewable resources should be incorporated to maintain environmental sustainability and ensure effective utilization of the available resources without compromising future needs.

3. **Social Sustainability**: Promoting social well-being by addressing issues like poverty, inequality, and access to essential services, and ensuring that communities are empowered and resilient. Social sustainability has been determining the distribution of benefits among all the classes of society. Reducing social inequality and available and accessible resources for all in longer period is very important for this aspect.

Fig.1: Sustainable development through integrated farming

In agriculture integrated farming is a pathway to achieve sustainable development. It's a combination of ecological, social, and economic spheres. Balance in these three spheres leads to achieving sustainability in the farming system. The ecological sphere focuses on protecting against environmental degradation such as loss of soil fertility, and habitat destruction of species. It also protects against the loss of biodiversity and tries to maintain a healthy ecosystem. Integrated farming supports organic farming methods to minimize chemical input in the ecosystem. As an example to control the pest population, farmers can use various IPM methods to lower chemical input in the environment. The social sphere contains four things. First, fulfilling local people's need which means the production of crops and livestock or other things should be based on local people's demands. Second, is saving rural communities by providing diverse income sources for sustainability at times of environmental stress. Apart from that whichever farmers grow, after self-consumption sell their products in the local market in that way they support the local economy and strengthen their community bond. Third is to provide

regional self-sufficiency which means in rural areas most of the households rearing livestock for meat, in a backyard pond they raise fish and also do farming activities for self-consumption. Fourth is a self-provide workforce which means that farm activities are most of the case done by self and with family members in this way, they don't need to depend on others for work, also they hire local workers and support local communities. The economic sphere also contains three things First is relying on local resources, it depicts to achieve long-term sustainability it needs the utilization of local resources which are available locally. Second is long-term yield sustainability to maintain this farmer can buy organic fertilizers which increase sustainability and reduce expenses. And third is the optimal use of resources. The combination of three spheres helps to achieve sustainable development through the integration of diverse practices like livestock rearing, fish cultivation, and intercropping. It efficiently uses locally available resources, diverts income, supports livelihood, and protects nature.

4. Objectives of Sustainable Farming Practices

- Environmental Sustainability: An objective of sustainable farming is to provide safeguard for natural resources and reduce environmental degradation. To reduce these fares, various types of IPM methods minimize the agronomical input. In this way, one side is safe the nature other side maintains the yield productivity for a long time. To prevent soil erosion contour ploughing is a suitable option that farmers can use.
- Enhancement of Soil Health: Maintaining soil health is important for sustaining ecosystem services like nutrient cycling, water quality, and climate regulation. Healthy soil that is rich in microorganisms and beneficial nematodes helps to grow plants. In that way, it maintains the water and nutrient cycle maximizes its efficiency, and reduces environmental degradation. Farmers when practicing sustainable farming practices like tillage and organic farming boost soil health because microbial activity happens. It also reduces soil erosion and increases soil organic matter. So sustainable agriculture practices significantly help to maintain healthy soil.
- Biodiversity Conservation: Through sustainable agriculture practices in the farming area variety of flora and fauna co-exist together and maintain biodiversity. The crop rotation method fixes nitrogen in the soil and improves fertility. It also creates a safer habitat for beneficial insects and microorganisms at the same time it reduces agrochemical input. Sustainable farming includes organic farming which helps to maintain ecosystem services and conserve species diversity. Natural pest control methods are used which are safe for beneficial insects increase their population and support pollination. It generates a healthy environment that sustains human needs and the ecosystem together.

- Healthier Food: In the organic method chemical fertilizer and pesticides are not used therefore they produce chemical-free nutritious food. It also provides grass for livestock which is free. So integrated farming supports healthier food.
- Reduced Chemical Inputs: Organic farming reduces the use of agrochemicals and protects wildlife and the environment from its harmful effects. In IPM techniques various types of natural pest control methods are used which minimizes the chemical input like the use of different traps to control pests.
- Animal Welfare: Through integrated farming, livestock are treated caringly, providing a good living environment. Cattle are raised on a farm where organic methods are adopted allowing cattle to graze on grass in open fields, which provides a more natural diet and environment that provide better health and lower stress levels. It supports the overall growth of animals resulting in healthier by-products.
- Economic Viability: sustainable farming provides a profitable and stable earning source for farm workers. In sustainable agriculture by using integrated farming methods farmers cultivate crops and fish or livestock simultaneously. In this case, if crop failure happens due to natural calamity farmers can mitigate the economic risk through livestock-fish farming.
- Climate Change Impact Mitigation: Food security is sometimes hampered due to natural calamities caused by climate change such as increases in temperature, and emission of greenhouse gases which can reduce crop production .sustainable agriculture practice climate-smart agriculture to overcome this harmful effect. It includes no-tillage farming, rainwater collecting, careful management of nutrients, and cultivating crops that can tolerate changing climate conditions. These methods support crops that become more resistant to climate and secure food supply. Before all of this, it's important to teach farmers how they can practice climate-smart agriculture effectively
- Sustainable Livelihood: Sustainable agriculture gives stable incomes and improves the quality of life for farmers. An example is diversifying farm activities like producing various types of crops, rearing livestock, and practising aquaculture. It ensures a steady income throughout the year and reduces dependency on a single source of income. It supports rural livelihood by providing alternative earning sources if crop failure occurs due to environmental hazards.

5. Integrated Livestock-Fish Farming: An Overview

According to FAO, Integrated livestock-fish farming is a practice that links together two normally separate farming systems, whereby the livestock and fish become subsystems of a whole farming system. In a broader concept integrated farming means management of resources.

There is no particular mention of livestock or fish. However, the common concept is to use livestock waste directly or indirectly in fish ponds. Here waste is considered a resource out of place. It's an integration of fish and livestock within a broad living system. It focuses on optimal waste or by-product utilization efficiency in which the waste of one subsystem (livestock/fish) becomes an input to a second subsystem (fish/livestock).

Using Animal Wastes in Fishponds:

0Livestock manure helps aquaculture by improving plant growth through small plants called phytoplankton. This phytoplankton serves as food for zooplankton. After that fish and other aquatic animals eat zooplankton Apart from that waste supports to growth of bacteria which breaks down detritus that fish can eat. It's very crucial to think that waste is already used for other activities like crop fertilization before using it in a fishpond because if a r livestock is raised only for waste generation the pond is costly. It requires proper management so that the pond's ecosystem is not affected by waste.

Integrated Fish-Pig and Fish-Duck Farming:

In integrated fish-pig farming pigs are raised close to the fish pond to directly pass manure into the pond. It's also used as a natural fertilizer. It saves money by improving pond productivity and reducing extra expenses for fish feed. It's beneficial where pig farming has a demand in the local community. In fish-duck farming, ducks are raised near the fish ponds and their droppings fertilize the water. It improves nutrient availability and fish growth. In both ways, farmers can use their resources efficiently and ensure sustainability. This approach would be beneficial for both environment and livelihood.

6. Benefits of Livestock-Fish Integration

Livestock-fish integration offers many advantages that help to achieve sustainable development:

Resource Efficiency: Through integrated system resource use efficiency increases. From the use of livestock manure to fishpond nutrient recycling, it has reduced fertilizer and feed costs. Conserving water and recycling nutrients help to achieve sustainability in farming.

Economic Resilience: It provides multiple earning sources through diverse production. It reduces the monetary risk for small farmers to ensure consistent income.

Food Security: Integrated systems ensure production throughout the year. It also gives a regular supply of diverse foods enriched with nutrition and healthier for health.

Environmental Sustainability: By reducing chemical use and conserving biodiversity, integrated systems contribute to the health of the environment. It helps to protect biodiversity through minimal use of chemicals. An integrated approach ensures a healthy environment by enhancing resource utilization.

Biodiversity Preservation: Many flora and fauna are nourished by the support of an integrated system. It also promotes species diversification and maintains a stable ecosystem

Types of Livestock-Fish Integration Systems

Integrated livestock-fish farming can be of many types. It depends on the local situation, resource availability and objectives:

1. Pond-Based Livestock-Fish Integration:

Direct Manure Application: animal waste is directly applied to fish ponds as a nutrient source. It enhances plankton growth and supports fish growth.

Ducks on Fish Ponds: In fish ponds, ducks are raised and their droppings provide nutrients. That supports fish growth. On the other hand, ducks benefit from the pond ecosystem.

2. Sequential Integration:

Manure for Fertilization: Firstly Livestock waste is used to fertilize crops. This nutrient-rich water from fish ponds is then used for irrigation.

Irrigation of Crops with Fish Pond Water: Fish ponds provide nutrient-rich water from fish waste. It is then used for crop irrigation, which increases plant growth.

Poly-Culture Systems: interaction of several species of fish and livestock to optimize the use of available resources therefore it maximizes production efficiency.

Integrated Livestock, Fish, and Crop Farming: The interaction of all three elements, livestock, fish, and crops into an integrated farming system results in the enhancement of overall farm production with sustainability.

7. Enhancing Sustainability through Livestock-Fish Integration

Integrated livestock-fish farming increases sustainability in various aspects:

Nutrient Recycling: Livestock manure is known as a source of important nutrients for aquatic animals in the pond. It also helps to reduce dependency on chemical fertilizer by improving soil fertilization through pond sediments that are used for crop cultivation.

Nutrient Concentration: The integrated approach helps to concentrate nutrition by combining off-farm and on-farm methods on farm products such as livestock waste and crop residue recycle nutrients system and back essential nutrients into the soil and increase soil productivity. Off-farm products like by-products help to provide nutrient balance and also improve the dietary pattern of livestock. It's a self-reliant farming method, which reduces the input cost and improves **Environmental Quality.** It creates sustainability in the farming system. In this method, the output of a system like waste is considered an important input for another subsystem like a fishpond and vice versa nutrient pond water is used for crop irrigation which indirectly improves

livestock health. So basically, it creates a closed-loop system of nutrients that supports the overall growth of the planet.

Biodiversity and Pest Management: Integrated farming systems support species diversification and improve the ecosystem. Animal waste provides nutrients that reach sediment on fishponds and also reduces dependency on chemical fertilizer.

Stability and Resilience: Integrated livestock fish farming generates multiple sources of revenue by diversifying them. It also maintains a continuous food supply during environmental stress. It supports rural communities and makes them stable.

Economic Efficiency: It also builds economic resilience through diverse income streams by using waste it reduces input costs and increases economic efficiency. The integration of livestock and fish farming generates employment opportunities and creates a market.

Livestock and fish integration enhances the farm's capability and develops soil fertility. It enhances overall production. It also helps to reduce soil degradation through practices like contour ploughing. it maintains the loss of biodiversity supporting a wide range of beneficial insects and species. Various types of ecosystem services are directly or indirectly regulated by the integration of fish and livestock. Although there are some problems to consider like the risk of overgrazing by animals resulting in soil erosion. Sometimes they face a lack of proper planning. Waste that is used in fish feed can impact the quality of groundwater. Therefore it requires a proper management strategy and a sustainable approach to reduce these risks of environmental degradation and enhancement the advantage of integrating livestock and fish farming. It increases sustainability by improving various aspects of agricultural practices. Livestock helps to create farm diversity through using a variety of feedstuff sources. Which helps to control pests and maintain nutrient recycling? Through the sale of various products like milk, meat, and waste it also gives monetary support to the farmers. This diversity of livestock makes farms more potential to tolerate any kind of environmental stress. Fish pond farming is also important because it maintains the ecosystem of water bodies, lowers the input cost, and regulates the nutrient cycle. It also helps to manage nutrients in a better way by reducing the cost of fertilization and enhancing soil fertility. These integrations provide cost-effective suggestions by creating different chances for the market. It also supports risk management. Farmers can reduce their dependency on a particular income source by diversifying their products. This integration allows a more stable agricultural system that supports both environmental health and economic stability. Thus it leads to achieving sustainability in a scientific and cost-effective manner.

8. Integrated livestock-fish farming aligns with several SDGs through its multifaceted benefits:

In September 2015 United Nations introduced the approach called sustainable development. It comprises with 17 goals and 169 targets to solve missed targets by millennium development goals. These goals are combined with three approaches economic, environmental, and social which are interconnected with each other balance in these three spheres ensures sustainability, and these goals must be achieved in the upcoming 15 years from the declaration. Sustainable development goals focus on improving human well-being and environmental sustainability. Below several goals are discussed which can be attained with the help of integrated fish and livestock farming

No Poverty (SDG 1): Livestock and fish integration ensure a cost-effective farming system. It gives better economic resiliency by providing different revenue sources. Monetary risk due to dependence on a single crop reduces as it produces livestock and fish. Small farmers stabilize their earnings thus helping to reduce poverty levels in rural areas

Zero Hunger (SDG 2): Integrated farming provided diversified and year-round production. Thus it significantly contributes to healthier and nutritious food. Through this integration, malnutrition can be reduced and long-term food security and suitability will be achieved. Through enhancing food production it reduces the hunger problem.

Good Health and Well-Being (SDG 3): Fish and livestock farming produces healthy food products that significantly contribute to improving health conditions. It supports a better diet by providing chemical-free food. Moreover, it provides nutritious and protein-rich food which provides good health and promotes overall well-being.

Clean Water and Sanitation (SDG 6): Integration of fish and livestock method use collecting nutrients from livestock manure and filter pond ecosystem. It helps to maintain the quality of water, reduce pollution, and maintain a healthier aquatic ecosystem

Responsible Consumption and Production (SDG 12): This integration supports the reduction of waste by its wise use Livestock waste recycling reduces input costs and supports more stable production as there is no need for external inputs like fertilizer and feeds.

Life on Land (SDG 15): The major target of this goal is to restore and sustain the use of inland water-based ecosystems. The livestock-fish integration promotes the restoration of the natural habitat and makes it possible to develop a sustainable environment for all the components of the ecosystem. The integration also caters for the aspect of enhancing biodiversity, to enhance their capacity to provide benefits that are essential for sustainable development.

9. Conclusion

The pursuit of sustainable development has become a paramount global priority. One of the most crucial strategies for achieving sustainable agriculture involves the utilization of nature-based resources that not only benefit the environment and society but are also economically viable. An exemplary approach towards realizing this goal is the adoption of integrated livestock and fish farming, which is intricately linked with sustainable development. This approach alleviates the pressures on food security through a more efficient management system, while also bolstering the economy, optimizing resource utilization, and promoting long-term sustainability in agriculture.

The implementation of these integrated approaches establishes a clear pathway towards attaining sustainability in agriculture. Particularly, rural areas, especially those vulnerable to climatic conditions such as coastal or drought-prone regions stand to reap substantial benefits from this approach. It provides a definitive solution to alleviate the challenges posed by resource scarcity, diversifying livelihoods and ensuring sustainable returns without compromising future needs. Ultimately, the integration of these approaches equips stakeholders to effectively navigate different climatic factors, ensuring productive outcomes and an improved quality of life

REFERENCES

Edwards, P. (1998). "A Review of Integrated Livestock-Fish Farming Systems." Aquaculture Economics & Management, 2(1), 1-13.

Integrated Agriculture-aquaculture: A Primer. (2001). Italy: FAO.

M. Tahat M, M. Alananbeh K, A. Othman Y, I. Leskovar D. Soil Health and Sustainable Agriculture. *Sustainability*. 2020; 12(12):4859. https://doi.org/10.3390/su12124859

Malhi, G. S., Kaur, M., &Kaushik, P. (2021). Impact of climate change on agriculture and its mitigation strategies: A review. *Sustainability*, *13*(3), 1318.https://doi.org/10.3390/su13031318

Prein, M. (2002).Integration of aquaculture into crop–animal systems in Asia.Agricultural systems, 71(1-2), 127-146.

United Nations (2015)."Transforming Our World: The 2030 Agenda for Sustainable Development.

Van der Zijpp, A. J., Verreth, J. A. J., Le Quang Tri, M. E. F., van Mensvoort, R. H., Bosma, R. H., &Beveridge, M. C. M. (Eds.). (2007). *Fishponds in farming systems*.Wageningen Academic Publishers.https://doi.org/10.3920/978-90-8686-596-3

World Bank.(2008). *Sustainable land management sourcebook*. https://doi.org/10.1596/978-0-8213-7432-0.

Chapter-10

Women livestock Entrepreneurs: A way towards sustainable livelihood

Rituparna Paul[1] and Biswajit Pal[2]*

[1]Department of Agriculture and Rural Development, Chandraketugarh Sahidullah Smriti Mahavidyalaya, Berachampa, West Bengal, India

[2]Department of Rural Studies, West Bengal State University, Barasat, West Bengal, India

*biswajit.pal22@gmail.com

Women are an important part of society. While they have historically been primarily involved in household activities, today, women play an active role in various areas outside the family. As they make up half of the total population, their contribution is crucial for the country's development. Neglecting the female workforce seriously hampers the economic growth of a nation. The participation of women in employment, both in rural and urban areas, is essential for a country's progress. The government of India has implemented various measures to support the development of the female workforce, which has also impacted the socio-economic status of women in India, including in West Bengal.

The economic and financial crisis of the family made women come out from their household duties and take part in various activities related to livelihood. Women have participated in different levels of the workforce but their contribution to this society is not recognized or rarely recognized. Nowadays women are involved in different kinds of work not only to support the family economically but also for their financial security and empowerment. They can also establish their own identity and take an important part in the family as well as in decision-making.

Most of the women in India contribute to the economy in different forms of work but their contributions are not documented officially all the time. Women plough fields and harvest crops while working on farms; they weave and make handicrafts in household industries etc. In the Census, 2011 it was found that in India the total workforce is 47.41 crore out of which 33.69 crores are rural workers and 13.72 crore are urban workers. A significant portion of the workforce is involved in agriculture and related sectors, while others are employed in various forms such as casual labour, self-employment, or working in the government and private sectors. Additionally, the 2011 census reported a male workforce participation rate of 53.26 percent and a female workforce participation rate of 25.51 percent. In rural West Bengal, the female workforce participation rate is 19.4 percent and in urban areas, it is 15.4 percent. Among these female workforces, most are agricultural labourers and then household industry workers. The number of household industry workers increased three times from 4.1lakh in 1991 to 12.5 lakh in 2001.

Women entrepreneurs may be defined as women or a group of women involved or start economic ventures as their livelihood options. According to the European Commission, "a female entrepreneur is a woman who has created a business in which she has a majority shareholding and who takes an active interest in the decision-making, risk-taking and day-to-day management." A woman entrepreneur is therefore a confident, creative and innovative woman desiring economic independence individually and simultaneously creating employment opportunities for others. It is observed that women entrepreneurs become successful because of their confidence, hard work, tenacity, willingness, determination, intelligence, optimism and most importantly their urge to do something positive with their lives.

Factors that influence women entrepreneurs in India:

The following are some factors that influence women entrepreneurship:

- **Geographical and social factors:** The state, area or society to which she belongs has a great impact on women entrepreneurship. The social culture and heritage have been determined by the root of the community and their ancestorial evidence. It plays an important role in determining the involvement of women in entrepreneurial activities.
- **Caste system:** The caste system influences women entrepreneurship. If a woman belongs to a caste that has a custom or trend to start a business it also must influence her to set up an entrepreneur. It is the trend of the women of some castes to be a part of a family business or to start a business of their own. So the trend and the custom of the caste system have a great impact on women entrepreneurs.
- **Family tradition:** Family support and family tradition have an important role in women entrepreneurs. If women get family support it will become easy for them to run an entrepreneur. Women entrepreneurs will remain, entrepreneurs, if their family tradition is so or if they belong to a pioneer entrepreneur.
- **Government Aids and policies:** The government always helps an entrepreneur if she is capable. It also helps poor people with reservations. Government help can be of significance if entrepreneur takes its help for logical conclusions.
- **Inherent capabilities and efficiency:** The ability to withstand competition with males requires courage and daring to become an entrepreneur. Females require the same capabilities as males. They benefit from being female only when the service has to be provided to women, such as in hospitals, etc. Capabilities influence entrepreneurship, but efficiency is also required. If a person starts an entrepreneurship without the ability to run the venture properly, she cannot become a successful entrepreneur.

There are some factors called push factors and pull factors.

Push factors: The push factor is that the situation and environment of the women force them to act or engage in different economic or entrepreneurial ventures, the death of only earning member of the family, sudden fall in family income, inadequate income of the family are different reasons that drive women towards economic activities.

Pull factors: Pull factors are those situations that attract someone to start a new venture. Pull factors have a positive root towards the formation of any entrepreneurship. Need and perception of Women's Liberation, Equity, gaining social status and recognition, utilising their education and talent, utilising their free time, become economically independent are some pull factors.

Development of entrepreneur:

In early age, men invented hand-made axes and wheels. They also discover different ways to grow crops. They made boats to move on rivers and seas and started trade. These were the important events in entrepreneur history.

In India, entrepreneur practices are as old as Harappan culture. It was found that craft man-made hand-crafted items and trade them which was their contribution to society as well as livelihood. These were the first steps of entrepreneurship in India around 2500 BC. In the Middle age, the population of India grew and the development of hand-crafted products like silk, cotton ware and agricultural products flourished. These products are exported to nearby countries. The international trade started from this time. In the industrial period, entrepreneurs invented new products like bicycles, typewriters, and electronic gadgets. The surplus of these products was exported internationally. The modern period saw the rapid growth of information technologies and IT-enabled service industry in India. A new bunch of entrepreneurs in India and Indians abroad have made a name of themselves in this industry.

Women Agri-entrepreneur:

Women play a significant role in agriculture and the allied sector. Although the nature of their involvement varies from region to region, women are actively involved in various agricultural activities. As per the Census 2011, out of the total female main workers, 55 per cent were agricultural labourers and 24 per cent were cultivators. Rural women perform numerous labour-intensive jobs such as weeding, hoeing, grass cutting, picking, cotton stick collection, separation of seeds from fibre, keeping livestock and its other associated activities like milking, milk processing, preparation of ghee, etc.

Livestock farming:

Livestock is the domesticated animals raised in an agricultural set up. The livestock provide food and non-food items for people.

Livestock is one of the most important as well as rapidly growing components of the Indian economy. 5% of the total income and 287% of the agricultural GDP of the country depends on livestock. About 20.5 million people depend upon livestock for their livelihood.

Women entrepreneurs in livestock farming play a vital role in the agriculture and economic growth of the country. Livestock farming includes the breeding and raising of animals like cattle, goats, pigs, sheep and poultry. Nowadays women are involved in small-scale backyard farming to large-scale commercial farms. In spite of facing numerous challenges women are increasingly playing a leadership role in this field.

Economic contribution:

Women in livestock farming contribute to household income as well as the country's economy. In developing countries, women are the primary caretakers of livestock and manage the daily operations like feeding, milking, cleaning, caring and others. The earnings from livestock farming help with household expenses, children's education, and health-related issues and increase the overall economic status of the family.

Sustainable practices:

Women are interested in adopting practices that can work towards long-term productivity without hampering the environment. So, they are at the forefront of sustainable practices.

- **Organic farming:** many women are engaged in organic livestock farming. They are more interested in using organic inputs for their farms rather than chemicals.
- **Traditional knowledge:** sometimes women have traditional knowledge which is very important for livestock care. When traditional knowledge and modern techniques are integrated productivity and animal health are improved.

Problems faced by women livestock entrepreneurs:

Lack of training:

Women needed more training for livestock farming. According to 2021 official reports, only 80,000 women are trained. However several women in the village area are engaged in livestock farming. But they do not get proper training. Only a few women can get training from certified organizations.

Limited access to land:

In society and many cultures, women have limited access to land. In most cases, women have limited right to own or inherit the land. Most of the time men possess land ownership. Even if

the women own land it is small in size. It is often small and less fertile land than land owned by men. So without scarcity of land women struggle to establish or expand their livestock operations.

Financial barriers:

Access to credit and financial services is often more difficult for women, especially in rural areas. Without collateral, many women struggle to obtain loans to invest in their farms. When women do access credit, they often face higher interest rates and less favourable terms than their male counterparts.

Limited access to inputs and technologies:

Women sometimes have limited access to high-quality of inputs like quality breed, feed and veterinary services due to lack of financial support. They also do have not modern farming equipment and technological inputs that could improve their farm productivity.

Social and cultural barriers:

In many societies, women are expected to fulfil household duties rather than income generation activities. As a result, they get less time and encouragement for their farm work. Besides that cultural norms also restrict them from going to market place or making any decisions.

Long working hours:

Women have to perform their household duties as well as their farm activities. They start their day early in the morning to attend to livestock and work for long hours to do all duties including household work with little or no rest. During certain times of the year such as breeding time, harvesting time the workload is significantly high. The constant need to juggle multiple responsibilities can lead to exhaustion and burnout, especially when there is little support from family or community.

Market access:

women have limited access to the market as in some societies the mobilization of women is restricted. They also often face difficulties in accessing markets due to lack of transportation and limited market information.

- **Role of women entrepreneurs in community development:**

Women entrepreneurs in livestock farming play a vital role in community development. The successful women livestock entrepreneur often leads to:

Income generation:

Women livestock entrepreneurs contribute to the family income by selling livestock and livestock products like milk, egg, meat, wool etc. This income helps the family for better living, children's education and other household expenses.

Job creation: The women who run farms create job opportunities in their community. They often employ other local women on their farms. So the local people get the opportunity to income and skill generation.

Knowledge transfer: Sometimes successful women farmers share their knowledge and success stories with other local women and also encourage them in livestock farming. Women livestock entrepreneurs often acquire valuable skills and knowledge in animal husbandry, business management, and marketing. They pass on these skills to their children and other women in the community, contributing to broader educational and skill development.

Empowerment: Through livestock farming women can gain economic independence, confidence, social status and decision-making power in the family as well as in the community. They can also challenge traditional gender roles and stereotypes, demonstrating that women can excel in areas traditionally dominated by men. This can lead to greater gender equality in other sectors as well.

- **Role of Rural Institutions on Women Entrepreneurship:**

  Institutions play a critical role in women empowerment, especially entrepreneurship. Institutions help to create an environment that helps women to build up a successful entrepreneurship. Bank, NGO, Cooperative are some institutions that play important roles for successful entrepreneurship.

  Banks and cooperatives:

  Banks and cooperatives play a critical role in supporting women entrepreneurs, particularly in rural and underdeveloped areas.

- **Access to financial support:**

  Banks provide essential financing support like loans, term loans, microloans for women entrepreneurs. Many banks offer special loan schemes for women, small loans, loans with low interest rates and also flexible loan repayment options which are specially dedicated to women entrepreneurs to encourage more females in this field. Besides these, some banks offer collateral-free loans which help those who might not have substantial assets to pledge.

- **Supportive policies and scheme:**

  Sometimes banks act as the intermediate between the Government and women entrepreneurs. Banks help women access subsidies and grants offered by governments or international organizations. These financial aids reduce the cost of borrowing and make business ventures more feasible for women.

Non-Governmental Organization (NGO):

NGO plays a significant role in women entrepreneurship development.

- Capacity building and training:

NGOs organize many training programmes to increase the skills of women entrepreneurs. These programmes include skill development, leadership development, business management, marketing, technical skills etc. They also provide specialized training on how to start a business, marketing strategies, business plans which are very Important issues for new start-ups. Along with all these NGOs focus on vocational training for specific industries such as agriculture, animal husbandry, handicrafts, textile etc.

- **Access to finance:**

NGOs are instrumental in providing microfinance and microcredit to women entrepreneurs, especially in rural and underserved areas. These small loans help women start or expand businesses when they lack access to traditional banking services. NGOs often act as a linkage between banks and entrepreneurs which helps women entrepreneurs to get loans, grants and other financial supports.

- **Market access and linkage:**

NGOs help to connect women with new markets by connecting them with buyers, suppliers and distributors. Some NGOs assist women entrepreneurs in leveraging e-commerce platforms to reach a broader customer base, especially in international markets.

- **Awareness and Sensitization :**

Sometimes NGOs conduct awareness programmes about the importance of women's economic participation and entrepreneurship. These campaigns help to change societal attitudes. NGOs also conduct workshops to sensitize both men and women about gender equality in business, encouraging a supportive environment for women entrepreneurs.

Women livestock entrepreneurs play a critical role in the agricultural economy, especially in rural and developing regions. Their involvement in livestock farming not only helps provide income for their families but also contributes to community resilience and national food security.Livestock entrepreneurship offers women a significant opportunity to achieve economic independence and empower themselves within their communities. Through livestock farming, they can diversify income streams, build assets, and contribute to decision-making both at household and community levels. Women tend to reinvest their earnings into the education, health, and well-being of their families. Support from governments, NGOs, and international organizations is vital for the growth of women livestock entrepreneurs. As livestock farming is

sensitive to climate change, empowering women with knowledge and tools for sustainable practices is crucial. Women can be drivers of climate-smart agriculture, which includes practices like improved grazing, efficient water use, and waste management. Such practices can increase their resilience against climate shocks and reduce the environmental impact of livestock farming. However, women livestock entrepreneurs face numerous challenges that need addressing to enhance their potential and success. Women often have less access to land, capital, inputs like quality feed and vaccines, and extension services. Financial institutions are hesitant to provide loans to women due to a lack of collateral. In many societies, patriarchal norms limit women's roles in business and decision-making, restricting their ability to own or control resources. Besides this, many women entrepreneurs in rural areas lack formal education or vocational training in modern livestock management techniques, reducing their productivity and competitiveness. Modern technologies like mobile applications for market price alerts, veterinary telemedicine, and e-commerce platforms are increasingly helping women overcome some of the challenges they face. Encouraging the adoption of these technologies among women can improve productivity and broaden market access. Though women livestock entrepreneurs face significant challenges, their potential to transform rural economies and contribute to food security cannot be understated. By addressing barriers to resources, education, and policy support, women can become leaders in sustainable livestock farming. Collective efforts from governments, the private sector, and civil society can create a more enabling environment for women in this sector, allowing them to thrive as entrepreneurs and contribute to broader economic growth.

References:

1. Census of India (2011). Office of the Registrar General and Census Commissioner of India, Ministry of Home Affairs, Govt. of India; Available: https://censusindia.gov.in/
2. Dhekale,V.S, (2016). Performance of Women Entrepreneurship In India. International Journal of Management (IJM), 7(1), 123-131
3. Paul, R., Goswami, A., & Pal, B. (2023). Effect of Socio-economic Aspects on Women Work Force Participation Level in West Bengal, India. *Asian Journal of Agricultural Extension, Economics & Sociology*, *41*(10), 277-288.
4. Paul,R and Goswami,A (2022). Participation of Women in the Workforce: A Comparative Study between Central and Western Plains of West Bengal. South Asian Journal of Social Studies and Economics. 16(4):81-88. DOI: 10.9734/sajsse/2022/v16i4623

Chapter-11

Entrepreneurial Economics for Animal Husbandry based livelihood

Dr.Sukanta Biswas[1] & Sushrirekha Das[2]
Associate Professor[1] & MANAGE Fellow[2]
[1]West Bengal University of Animal & Fishery Scs, Kol-700037, WB
[2]National Institute of Agril. Extension Management, Hyderabad, India

ENTREPRENEUR & ENTREPRENEURSHIP:

Entrepreneur term is derived from French word *'Entrepredre'* which means to undertake i.e. the person who undertakes the risk of new enterprise. Entrepreneur is one who organises, operates and assumes the risk in a new business venture in an expectation of making a profit. The Entrepreneur introduces something new in the economy, which may be a new product or process or find a new market for a product or process already known. The person is hardworking, optimistic, risk taker and set high target of goals and tries to achieve those amidst odd situations.

General characteristics of an Entrepreneur *are*- commitment and determination, leadership, opportunity obsession, tolerance of risk, ambiguity and uncertainty, creativity, self-reliance and ability to adapt & motivation to excel etc. So, Entrepreneurship is a dynamic process with Innovation and risk bearing as its two basic elements involving multiplicity of activities towards establishment of an enterprise. Entrepreneurship or Enterprise is called Udyog & Entrepreneur is Udyogi or Udyogpati. The term Entrepreneur first used by Rechard Cantillon in 1755.

ENTREPRENEURSHIP: NEED IN ECONOMIC DEVELOPMENT

Entrepreneurship in one of the most important input in the economic development of a Country. This plays a pivotal role not only in the development of industrial sector, but also to the development of farm & service sector in the Country.

- ***Entrepreneur Role in economic development of the country ::***
  - Promote capital formation
  - Create large scale employment opportunities
  - promotes balanced regional development
  - Reduces concentration of economic power
  - Wealth creation and distribution
  - Increasing gross national product and per capita income
  - Improvement in the standards of living
  - Promotes countries export trade
  - Induces backward and forward linkages
  - Facilitates overall development

QUALITATIVE ATTRIBUTES OF AN ENTREPRENEUR:

The Entrepreneur is known for their special attributes, which makes them entrepreneurs.

There is no sex determination (Male/Female), to become an Entrepreneur as all are equally competent to become entrepreneur in any sector.

Qualitative attributes of an Entrepreneur:

A) Successful & Achievers

B) Opportunity Explorer

C) Integrative & Goal Achiever

D) Optimistic & confident

E) Energetic & Risk-Taker

G) Independence and Preservence

H) Flexible Planner

I) Face Uncertainty and Seek Feedback

J) Self-Confidence and Starter

K) Motivator and Stress Taker

L) Committed and Able to Move

M) Visionary and Teamwork

FUNCTIONS OF AN ENTREPRENEUR:

The important functions of an Entrepreneur are presented as follows:

i) ***Idea generation***: Most important functions of Entrepreneurs. Idea generation is possible through vision, experience, observation, training & exposure of the entrepreneur.

ii) ***Raising of funds:*** All the activities of a business depends upon the finance & its proper management. It is the responsibility of the entrepreneur to raise funds internally & externally.

iii) **Procurement of raw materials& Machinery**: This is also important functions to identify chief and regular source of supply of raw materials to reduce production cost. Procure equipment's & machinery to setup the venture.

iv) ***Market research:*** Entrepreneur has to undertake market research persistently in order to know details of the intending products i.e. demand for product, nature & size of the consumer & price of the product etc.

v) ***Recruitment of Manpower:*** Entrepreneur has to recruit staff as per need & size of the organisation. Training may also be imparted for CBP.

vi) ***Implementation of the project:*** Identified project is to be implemented at time bound manner. All the activities from the conception steps to commissioning stage are to be accomplished in accordance with the implementation schedule to avoid cost & time overrun.

TYPES OF ENTREPRENEURS:

Broadly classified as per the types of business, use of technology, growth, stage of development, area, organization & gender etc.

VARIOUS TYPES OF ENTREPRENEURS:

Business Entrepreneur: The individual who conceive an idea for a new product or service and then creates a business by utilising both production and marketing resources.

Agricultural Entrepreneur: They undertake agricultural activities such as- raising & marketing of crops by mechanization, value addition and application of technology etc.

Veterinary Dairy & Fishery Entrepreneur: They undertake activities such as- raising & marketing of livestock, Poultry & their products as well as fish and fish product by mechanization, value addition and application of technology etc.

Technical Entrepreneur: They develop new and improved quality of good because office craftsmanship, concentrates more on production than marketing.

Women Entrepreneurs: In 1988, for the first time, definition of women entrepreneur was evolved. The most popular activity of women was food processing, garments making etc.

Rural Entrepreneurs: according to area entrepreneurs may be classified as rural or urban or global entrepreneurs. Rural entrepreneurs include rural artisan, village industries, handicrafts and handlooms etc.

Induced Entrepreneur: they are induced or motivated to take up an entrepreneurial task due to the policy measures of the government that provide assistance incentives concessions and other facilities to start a venture.

Fabian Entrepreneur: This is characterized by great caution and scepticism in practicing any change. Such entrepreneurs do not want any changes and not desire to adopt new methods. They are shy & lazy, their dealings are determined by customs, religion, tradition & past practices.

PHASES OF ENTREPRENEURIAL VENTURE: S*everal phases in Entrepreneur venture as:*

Phase-I-Preparation: Preparation deals with search for solution, seeking information about the problems which arise during the entrepreneur process

Phase-II- Incubation: It is the stage of subconscious assimilation of information, where it is allowed to ferment. The process of mental fermentation allows the entrepreneur to collect and assimilates relevant information and develops clarity of thinking.

Phase-III Idea Generation: various ideas & Solutions are generated at this state the approaches to problem solving relating to the new venture at tested in real life situation using the individual research previous experiences inside and risk.

Phase-IV Identification of Enterprise: This may come from unsatisfied needs of an entrepreneur as well as unsatisfied personal need. The most important task in this phase is to identify a solution, which is likely to be successful and profitable in the long run.

Phase-V Initiation of Enterprise: Entrepreneur needs to create an organisation to transform the concept into marketable products by utilising and combining physical and other resources. the entrepreneur interact with the environment to transform ideas into reality.

Phase-VI Nurturing of Enterprise: Organisation translates the business concept into marketable products or services and offers it to the customer. The entrepreneur gets feedback or market response in terms of sales and profitability etc.

Phase-VII Concluding Phase: Entrepreneurial process does not end with achieving stability and success. The organisation shall require different managerial style as the environment changes and competition gradually builds up more and more.

PROCESS OF ENTREPRENEURSHIP DEVELOPMENT:

EDP is a process involving number of phases and steps which are as follows:

i) Stimulatory Phase: This Phase includes all activities that generate awareness and willingness among the specific target group. Important activities under this stage are-

ii) Support Phase: This phase includes all such activities that help entrepreneurs to setup and run their enterprises. The activities in this phase are-

iii) Sustaining Phase: The activities in this phase are those that help the entrepreneur in continued efficient and profitable running of the enterprise. These includes-

The process of Entrepreneurship development does not end with sustain phase, it is a continuous cycle.

PREPARATION OF PROJECT/SCHEME IN GOAT-SHEEP FARMING:

To prepare an Entrepreneurial Scheme, this should have component as follows:

- Technical assumptions
- Fixed &working capital
- Expenditure & Income schedule
- Bank repayment schedule
- Economic feasibility Analysis
- Bank Appraisal to finance the Project

ECONOMICS OF GOAT FARMING (DUAL PURPOSE) - (4 Female+1 Male)

A. Capital Expenditure	**Amount**
1. Cost of breed able parent stock (Body weight – 25 kg. av.) 5 nos.@ Rs 4,500/- goat	Rs. 22,500.00
2. Cost of shed construction with the use of local materials i.e. bamboo, thatch roof, wooden pillars etc.	Rs. 5,000.00 **Rs.27,500.00**
B. Recurring cost 1. Feeding of 5 nos. of goats for 12 months @300gm/day/goat@ Rs.15/- kg of conc. Feed	Rs. 8,100.00
2. Cost of insurance of parent stock @ 5% for one year	Rs. 1,500.00
3. Cost of medicines and vaccines if any	Rs. 800.00
4. Cost of feeding equipment's and ropes etc.	Rs. 1,000.00
Total:	**Rs.11,400.00**
5. Feeding of the parent stock at the same rate as aboveduring2nd year. 6. Feeding of kids (16 nos.) for four months @ 150 gm on average/day i.e. 2.4 kg/day 7. Feeding of remaining 8 nos. of male kids for the remaining periodic. i.e. 8-9 months (mutton purpose) @ 300 gm/day	Rs.8,100.00 Rs. 4,320.00 Rs. 9,720.00 **Rs 22,140.00**
TOTAL	**Rs 33,540.00**

RETURNS

1. Sale of 8 No's of 3-4 months kids expecting twin kidding after 8-9 months of farming and sale starts from 13-14 months. Average price of young kids expected to be Rs.2500/- 2.Sale of 8 nos. of Buck reared for mutton @ Rs.6000/-goats 3.Sale of manure approximately 20 bags of 50 kgs. Each @Rs.200/bag	Rs.20,000.00 Rs.48,000.00 Rs. 2,000.00 **Rs.70,000.00**
Net income from first generation	Rs.70,000.00 (-) 33,540.00 **Rs.36,460.00**

Total Project Cost for one unit for first year = Rs. 72,440.00

The Income is directly proportionate to the No. of sales of Progeny from second generation onwards.

ENTREPRENEURSHIP DEVELOPMENT PROGRAMME:

The programs designed to help a person to strengthen his entrepreneurial motives, to acquire skills & capacity is necessary for playing his entrepreneurial role effectively.

There are several types of EDP program organised such as: EDP awareness training, motivation program &product oriented EDP training program, skill development program, MDP in the country. EDP program which aims to promote EDP & self-employment avenues in rural & urban areas of the country as follows:

I) National Institute for Entrepreneurship & Small Business Development (NISBUD): Institute was set up in 1983 by the Min. of SSI, GOI as an apex body for coordinating & overseeing activities of business institutions or agencies engaged in EDP particularly in the area of a small industry & business. www.nisbud.nic.in.

ii) Entrepreneurship Development Institute of India (EDI): EDI is an autonomous, non-profits institution set up in 1983 & sponsored by apex financial institutions namely-IDBI bank, SBI, IFCI limited, ICICI limited in Gandhinagar, Gujarat. www.ediindia.org.in

iii) Indian Institute For Entrepreneurship (IIE): IIE was setup in 1993 at Guwahati by the Min. of SSI, GOI as an autonomous national institute in the country.

iv) Ministry of Small Scale Industries (MSSI): The Min. of SSI, GOI is the nodal ministry for the formulation of policy, promotion, development& protection of SSI in the country.

v) Small Industries Development Organization (SIDO): This was set up in 1954 on the recommendations of ford foundation. It provides a wide spectrum of services to the small industries sector through its 26 to offices and 21 autonomous bodies under its management.

vi) National Small Industries Corporation Limited (NSICL): NSICL is an ISO: 9001-2000 company was set up in 1955 by the GOI with a view to promoting, aid dost and faster growth of small industries in the country.

vii) National Institute for Small Industry Extension &Training (NISIET): The NISIET is an autonomous institute of the Min. of SSI, GOI& set up in 1960 as a premier institute for promotion, development & modernization of the small & medium scale industry sector in India.

viii) Small Industries Development Bank of India (SIDBI): SIDBI was set up in April 1990 under an act of the Indian parliament as a prime financial institution to promote, finance, development of small scale industries and co-ordinate functions of other similar institutions in the country.

ix) Khadi and Village Industries Commission (KVIC): KVIC is a statutory body was set up in April 1957 under the act of parliament and took over the work of former all India Khadi and village industries board of the Country.

SPECIALISED EDP PROGRAMS (EDP) IN INDIA:

There are a number of EDP programs for the development of Entrepreneurship in the country, which has made it a hotspot destination for start-ups in the country.

The different agencies of Govt. training & consultancy programs for skill development & empowering rural educated youths in the country.

i) Prime Minister Employment generation program (PMEGP): The PMEGP program is a central sector scheme administered by the Min. of MSME, GOI by merging two schemes namely

PMRY& REGP that were in Operation till 31st March 2008. PMEGP is a new credit linked subsidy program for generation of employment opportunities through set up of micro-enterprises in rural as well as urban areas

ii) Swarna Jayanti Gram Swarozgar Yojana through SHG (SGSY): SGSY program was launched by the Min. of RD, GOI with merging six programs as IRDP,TRYSEM, DWCRA, GKY, SITRA In 1st April 1997. The program is aimed at assisting the poor; realize realizing their latent entrepreneur potential to build sustainable self-employment through developing micro Enterprises among the poor in the country.

iii) National Institute of Rural Development (NIRD): NIRD is an autonomous organization set up by Min. of RD, GOI in April 1962 as a NICD & renamed as a NIRD on 20th Sept. 1977. It focuses on strengthening PRI system & PRI functionaries to network of SIRD of states.

iv) MANAGE: MANAGE is located at Rajendra Nagar, Hyderabad is an Apex national institute set up in 1987 under the Min. of Agriculture, GOI for effective management of Agriculture Extension system through consultancy, Training, Education, Research information & documentation service. Recently manage implemented AC&ABC scheme to train Agriculture & allied graduates which provide service & advice to farmers on agril. &AH allied activities & provided training for start-up loans on any specified ventures can be taken up by trained graduate individually or jointly.

RECENT REFORMS IN EDP PROGRAMS IN INDIA

A. Ministry of Skill Development &Entrepreneurship (MSDE): The Department of SDE has come into existence on 31st July 2014 and later created as a Min. of SDE on 10th Nov. 2014. It is responsible for the coordination of all state-level EDP across the country for better skill and entrepreneurship development in India.

National Skill Development Mission &EDP Scheme: NSD Mission was launched on 15 July 2015 by the GOI on World Youth skill day under the Min. of SKD, GOI. The mission is to create, convergence across sectors & states in terms of skilled training activities to achieve the vision of skilled India.

Pradhan Mantri Kaushal Vikas Yojana(PMKVY): The PMKVY is a flagship outcome-based skill training scheme of the MSD&E,GOI on 16 July 2015. The aim of the scheme is to offer 24 lacs Indian youth a meaningful Industries relevant skills training to rural youth in the country.

Make in India & Start-Up India: This initiative was launched on 25th Sept. 2014 by the GOI to encourage domestic &multinational Enterprises to manufacture their products in the country. This initiative will provide a new dimension to EDP & helps in setting up a network of start-ups in the country.

Atal Innovation Mission (Aim) & Self-Employ For Talent Utilization (SETU):AIM platform was set up to 2015 budget with Niti Aayog, GOI to provide an Innovation& promotion platform involving academicians in the country on 24th Feb 2016.

Self-Employment for Talent utilization (SETU): The Program was launched by Niti Aayog, GOI on 4th March 2016 with aims to create around 01 lakh jobs to start-up in the country. This is a techno financial incubation & facilitation program to support all aspects of start-up business & other self-employment activities in technology-driven areas of the country.

Venture Capital Fund (VCF): *Venture Capital* is long-term financial assistance provided to projects which are set up to introduce new products, inventions, Idea and Technology in a business from Enterprise. Venture capital fund is most suitable to risky businesses which consist of huge investments and provides results after 5 to 7 years. The ICICI venture capital is the first venture capital fund in India and was started with UTI in 1988. ANZ grind lays bank has set up as the first private-sector venture capital fund in India. SBI & Canara Bank are also involved in VCF &provide either equity capital or conditional loans in India on Feb, 1995.

NABARD is central level apex financial institution set up in 1986 by GOI to promotes rural EDP in farm &non-farm sector of country. They provide necessary guidelines &support including financial grant assistance to facilitate in rural EDP.

E. Micro Units Development Refinance Agency (MUDRA): MUDRA bank has been set up on 8 April, 2015 to develop micro-units to encourage EDP in India. Mudra bank has launched three products namely- Shishu, Kishore and Tarun to signify the stage of growth and funding needs of the entrepreneurs. For loans to micro units having loan requirement of rupees 50,000 to 10 lacs.

Central Financial Institutions: IDBI Bank, Industrial Development Bank of India, industrial Finance Corporation of India, industrial credit and Investment Corporation of India, National Small Industries Corporation, Khdi and village Industries Corporation etc.

State level EDP Trg institutes: EDI at various States promotes entrepreneurship in the country at different level, like- commercial banks & state financial corporations, small industries service Institute (SISI) district industrial centre (DIC) at district, subdivision, block & village level.

Finally, this can be concluded that for successful farm & non-farm based EDP a comprehensive knowledge through skill based CBP, Entrepreneurial venture with motivation along with technically viable & economically feasible Project financing are the essential criteria for sustainable & holistic entrepreneurship in the Country.

E-BOOK

INNOVATIVE SKILL BASED ANIMAL HUSBANDRY & ALLIED PRACTICES FOR ENTREPRENEURSHIP

Dr. Sukanta Biswas, Prof. Arunasis Goswami, Dr. Shahaji Shambaji Phand, & Dr. Sushrirekha Das

This E-Book entitled "***Innovative skill based Animal Husbandry & Allied practices for Entrepreneurship***" is an innovative compilation of resource materials that explores the innovative approaches for sustainable entrepreneurship development through Animal Husbandry and allied farming practices. It provides readers with practical insights on how to develop an entrepreneurship through implementing various advanced animal Husbandry and allied farming interventions such as- Advances in Poultry farming, Strategic Nutritional Management of Livestock & Poultry, Integrated farming practices, Anti-microbial resistance, Zoonosis, Sustainable Entrepreneurial process in Animal Husbandry and Fishery sectors, ICT & its application in Extension etc. This book will be highly useful to veterinary & allied science extension professional and functionaries as well as extension workers who are working at the ground level. A myriad of topics from has been covered for the benefit of the readers. With its valuable information and guidance, this E-Book serves as a sustainable roadmap for aspiring and existing Extension Professional, researchers, youths and rural entrepreneurs in the organization, enabling them to create holistic entrepreneurial venture, while promoting sustainability and holistic community development.

Published By: National Institute of Agricultural Extension Management (MANAGE), Rajendranagar, Hyderabad, Telengana, India

Collaboration: **West Bengal University of Animal & Fishery Sciences (WBUAFS), 68, K.B. Sarani, Belgachia, Kolkata-700037, West Bengal.**

Designed By: Dr. S. Lakra, Dept. of VAHEE, WBUAFS, Kolkata

ISBN BAR CODE: 978-81-19663-66-8