

EXPANSION OF THE BUFFALO AGRI-SYSTEM AND INDUSTRY FOLLOWING THE ONE HEALTH APPROACH

Expansión del sistema agrícola y la industria del búfalo siguiendo el enfoque One Health

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ABSTRACT

One Health approach is looking for conceiving health as a consequence of interaction in the interphase of the human/ animal/environment complex as an interlinked whole, targeting to change how human beings have traditionally managed health. Lessons learned with the recent Covid 19 pandemic and the silent pandemic of antimicrobial resistance (AMR), among others known as potential pandemics, have put on top the need to change how to tackle health threats. The world is constantly challenged by zoonotic diseases, the emergence of new diseases promoted by human ecosystem invasion, climate change, loss of biodiversity, and the inability of nature to restore exhausted ecosystems due to human activity. The increasing world population demands sufficient, safe, and nutritious food, but food production also needs good practices and fair trade. Otherwise, food can become an essential source of illness, disseminating pathogens and AMR, leading to an unsustainable economy. Links between food and health are currently well recognized. Risk assessment and traceability during food production and distribution are crucial to ensure food safety, security, and sustainability. As growing food producers and suppliers, Buffalo Agri-systems and industry have the opportunity to positively impact the development of sustainable economic systems. Expansion of buffalo Agri-systems and industry will require to be in line with the six areas of action of the One Health Joint Plan of Action 2022-2026 (OH JPA) through incorporation of good production practices, decreasing ecosystem negative impact and processing and distribution of safe food in agreement with national and international standards and guidelines.

Keywords: One Health, Buffalo, Sustainability, AMR.

RESUMEN

El enfoque One Health busca concebir la salud como consecuencia de la interacción en la interfaz del complejo humano/ animal/ambiente como un todo interrelacionado, con el objetivo de cambiar la forma en que los seres humanos han gestionado tradicionalmente la salud. Las lecciones aprendidas con la reciente pandemia de Covid 19 y la pandemia silenciosa de resistencia a los antimicrobianos (RAM), entre otras conocidas como pandemias potenciales, han puesto de relieve la necesidad de cambiar la forma de abordar las amenazas a la salud. El mundo se enfrenta constantemente al desafío de las enfermedades zoonóticas, la aparición de nuevas enfermedades promovidas por la invasión de los ecosistemas humanos, el cambio climático, la pérdida de biodiversidad y la incapacidad de la naturaleza para restaurar ecosistemas agotados debido a la actividad humana. La creciente población mundial exige alimentos suficientes, inocuos y nutritivos, pero la producción de alimentos también necesita buenas prácticas y un comercio justo. De lo contrario, los alimentos pueden convertirse en una fuente esencial de enfermedades, diseminando patógenos y resistencia a los antimicrobianos, lo que conduciría a una economía insostenible. Actualmente, los vínculos entre alimentación y salud son bien reconocidos. La evaluación de riesgos y la trazabilidad durante la producción y distribución de alimentos son cruciales para garantizar la inocuidad, la protección y la sostenibilidad de los alimentos. Los agrosistemas bufalinos y la industria, como productores y proveedores de alimentos en crecimiento, tienen la oportunidad de impactar positivamente el desarrollo de sistemas económicos sostenibles. La expansión de los sistemas agrícolas y la industria del búfalo deberá estar en línea con las seis áreas de acción del Plan de Acción Conjunto Una Salud 2022-2026 (OH JPA) mediante la incorporación de buenas prácticas de producción, la disminución

del impacto negativo en el ecosistema y el procesamiento y distribución. de alimentos seguros de acuerdo con normas y directrices nacionales e internacionales.

Palabras clave: One Health, búfalos, Sostenibilidad, RAM.

INTRODUCTION

Buffalo husbandry has progressively developed worldwide from its origin lands in Asia and Africa to the Americas, especially in tropical and sub-tropical countries. In the last decades, it has emerged as an economic alternative due to its adaptation capacity, high-quality meat and milk, and resistance to infectious diseases, among other vital traits [1, 2]. The increasing Buffalo production can bring a significant contribution to achieving United Nations-Sustainable Development Goals (SDGs) by supplying a demanding market of animal protein, promoting at the same time employment generation and human well-being improvements.

Water buffaloes can better resist climate change than other food-producing livestock types; the husbandry can be profitable and sustainable in small and large production systems [2]. However, buffalo breeding practices impact the food production environment (environment and ecosystem shared with humans, other food-producing animals, and wildlife) and could also affect public health. One Health approach and SDGs seek a positive balance in the complex interlink of animal husbandry/environment/health/economy development. The SDGs 2023 report has stated the urgent need to implement policies that support a shift towards sustainable practices and new resource-independent indexes to measure economic growth. The establishment of an exemplary structure of governance is critical to generating appropriate policies supporting legal and financial development or improvements of food production systems focused on sustainable development. Sustainability reports at the company level have been increasing since 2016, showing a rise in industries' awareness to prioritize sustainable practices [3]. As a growing industry, expansion of buffalo Agri-systems and industry will require to promote assessment of the current husbandry and trade practices and then, gradually implement the required adaptations to guarantee a sustainable food production system.

Scientific research and epidemiological analysis have brought to light unquestionable evidence of how human behavior and uncontrolled risk factors have led to cumulative effects generating negative consequences. Depicted by climate change, modified natural ecosystems, diminished biodiversity, emergence and re-emergence of infectious diseases, and increased zoonotic potential of some microorganisms, these changes seriously challenge efforts to guarantee global health and food supply [4].

The primary products of the buffalo industry, meat, and dairy, pose a great responsibility for producing and supplying nutritious and safe food. The complexity of the food chain (from

farm to fork), which includes primary production at the farm level, processing, packaging, transportation, and points of sale to reach the end consumer, implies vulnerabilities at any point of this chain, increasing the probability of contamination of food with potential risk to human health. This is why the traceability of produce represents a key factor for risk analysis: identification of potential risk factors, risk assessment, risk control measures, and ability to measure the impact of risk management. Beyond that, it is also essential to design preparedness strategies for further potential risks [5]. Expansion of buffalo Agri-systems and industry will depend on good food production practices, processing, distribution, and trade, and should be in sound with established national and international standards and regulations.

ONE HEALTH OVERVIEW

Throughout modern history, human health has mostly been considered an isolated area, merely the competency and responsibility of human physicians, and in a narrow point of view, it has to be that way due to areas of specialization needed to treat the variety nature of human diseases. Such a perspective also prevailed for animal health, where animal issues, especially those linked with animal husbandry for food production, are just of veterinary services and producers' competency. Zoonotic diseases are well recognized as an essential link between humans and animals, profoundly impacting human health and wellness; these two branches of health usually work apart from each other, even though both are looking for population development and well-being. Also, for a long time, environmental consequences of the impact of human activities and animal breeding (food-producing animals) were ignored. This narrow perspective of health has paved unprecedented global consequences due to neglected risk factors and critical points at different areas of health on earth.

Moving toward sustainability of field productive activities that guarantee the well-being of human beings, animals, and ecosystems in an equilibrated process of gain and loss, the concept of One Health emerged as the most suitable and efficient approach to face health challenges to achieve everyone's positive balance.

Leader health organizations: World Health Organization (WHO), the Food and Agriculture Organization (FAO), and the World Organization for Animal Health (WOAH) have jointly worked for decades. Nevertheless, it was not until 2010 that the Tripartite commitment surged as a strategic alignment and a global governance structure to face public and animal health and environmental risks under the One Health perspective [6]. Special attention to health hazards associated with zoonoses and animal diseases, food safety, and antimicrobial resistance was settled. In February of 2021, a fourth partnership, the United Nations Environment Program (UNEP), joined Tripartite, currently named Quadripartite, reinforced the crucial role of the environment and ecosystem.

The Quadripartite currently defines One Health as “an **integrated, unifying approach that aims to sustainably balance and optimize the health of humans, animals, plants and ecosystems. It recognizes that the health of humans, domestic and wild animals, plants, and the wider environment (including ecosystems) are closely linked and inter-dependent**” [4]*.

This collaborative work has also resulted in the development of the first Global Action Plan on Antimicrobial Resistance (GAP) as a leading global guidance to tackle this silent pandemic under the One Health perspective [8, 9]. Antimicrobial resistance (AMR) is recognized as an increasingly serious threat to public health and sustainable food production, and participation of all sectors of government and society is a primary requirement to generate an adequate response (39th Conference of FAO, June 2015). In Latin America and the Caribbean, essential achievements have been made by the technical support of regional organizations such as the Inter-American Institute for Cooperation on Agriculture (IICA), joined with academia represented by Ohio State University. Their efforts in capacity building and designing programs have enabled nearly ten Latin American and Caribbean countries to develop and implement monitoring and surveillance programs on AMR under the One Health perspective.

Having faced the COVID-19 pandemic, the main lesson is the need for a joint vision of One Health implementation, intersectoral collaboration, and political will as the only way to prevent future pandemics. Besides the One Health holistic concept, the functional consideration for the implementation of the One Health approach necessarily requires collaborative, multisectoral, and trans-disciplinary work with active participation at different levels of society, from policymakers to the public general, to achieve the primary goal of optimal health outcomes, always recognizing the interconnection between humans, animals, plants and their shared environment [5]. Collaborative efforts on tackling health and environmental threats mainly aim to contribute to sustainable development, looking for balance and integration of the social, environmental, and economic dimensions. This is the operational definition of One Health.

In summary, the “One Health” approach recognizes that people’s health is connected to the health of animals and the environment [8]. It acknowledges the indivisible interlink between the three focal points of health and how they impact each other.

The One Health Joint Plan of Action (OH JPA) 2022-2026 is guided by the theory of change and focuses on six action areas:

1. **Enhancing One Health capacities to strengthen health systems**
2. **Reducing the risks from emerging and re-emerging zoonotic epidemics and pandemics.**
3. **Controlling and eliminating zoonotic, neglected tropical and vector-borne diseases.**
4. **Strengthening the assessment, management and communication of food safety risks.**
5. **Curbing the silent pandemic of Antimicrobial Resistance (AMR)**
6. **Integrating the Environment into One Health.** [4]



SUSTAINABLE DEVELOPMENT GOALS OF THE UNITED NATIONS 2030 AGENDA

The Sustainable Development Goals (SDG) are a call for action by all countries independently of their wealth index, looking for economic growth addressing social needs. At the same time, protect the planet.¹⁰ There have been established 17 SDGs constituting the focal point of the 2030 Agenda adopted by the United Nations General Assembly (UNGA) in 2015 (see annex 1). All United Nations Member States adopted the SDGs to end poverty, reduce inequality, and build more peaceful, prosperous societies by 2030, seeking economic development, promoting environmental sustainability, and guaranteeing social inclusion [10, 11].

Sustainable development is “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” [12, 13].

According to this, efforts must focus on reversing the triple planetary climate change crisis, nature depletion, biodiversity loss, and pollution and residues [10].

FOOD PRODUCTION CHALLENGES

The world population is expected to climb to 8.5 billion souls by 2030. With an increase of 2 billion in the next thirty years, it has been estimated to be 9.7 billion by 2050 and nearly 10.9 billion by 2100 [14]. With such growth, food demand increases as fast as the population. Thus, several of the seventeen SDGs are directly related to food production (see annex 1), and it is essential to highlight that this increasing world population requires higher food production levels and massive food distribution, and both rely necessarily on agriculture development and food safety systems.

* **Note:** In this definition, the environment is considered a whole, including ecosystems. From a more specific and operational point of view, environment refers to abiotic components (e.g., water, soil, air, chemicals), and ecosystems refer to biotic components (fauna, flora, microorganisms) of a geographic area [7].

Globalization and the growing world population, among other causes, have pushed massive movements of people worldwide and changed consumption behavior. High food production levels to supply world requirements have then induced increased movements of live animals and food products across borders, facilitating the emergence of new pathogens and faster dissemination of zoonosis and antimicrobial resistance.

The world is constantly challenged by zoonotic diseases, food safety, antimicrobial resistance (AMR), disruption of ecosystems, availability of food and water, and economic well-being, among others. These challenges are especially important in communities where agriculture is the main economic activity or when agriculture significantly contributes to the country's wealth, but also in distant communities due to food demand. It is necessary to remember that the advancement or evolution of humanity will always rely on our capacity to protect and ensure safe food systems [15].

Even though buffaloes are more resistant to infectious diseases and can adapt better than cattle, they can be an important source of disseminating pathogens and antimicrobial resistance. Moreover, microorganisms from food-producing animals could alter the composition of the human microbiome, and both human and animal microbiomes can coevolve due to their close interdependence [16]. This coevolution increases the probability of susceptibility to the same pathogens and facilitates both senses sharing of microorganisms (animal to human and human to animal). Then, good practices in buffalo husbandry, appropriate animal health programs (e.g., timely vaccination, parasites, and vector control), and rational use of antimicrobials are crucial to reduce the possibilities of exchanging microorganisms between humans and buffaloes and avoid significant microbiome variations.

Food-producing animals represent a crucial intersection between humans, animals, and the environment and ecosystem in the primary production sector. On one hand, food safety starts on the farm, and it depends on animal and ecosystem health. Food from buffalo origin will enter the food chain to reach humans as final consumers, and deviations from good practices from farm to table can impact human health in various ways. In addition, food of buffalo origin is as susceptible to contamination as any other food type. On the other hand, if buffalo farming is driven at the expense of the ecosystem, environmental health, and/or animal welfare, tremendous pressure will be placed on natural resources with a rapid utilization rate, and nature will not be able to keep up the pace to replenish resources [4]. Thus, the production of food of buffalo origin requires implementing the One Health approach to be safe, efficiently produced, economically profitable, and sustainable.

SAFE FOOD FROM BUFFALO ORIGIN AND TRADE

Access to safe food is a human right. However, over 420,000 people die after consumption of contaminated food

(whatever the cause be, microorganisms, chemical residues, or toxins), and nearly 600 million people currently get ill due to consumption of food lacking minimum quality standards. Foodborne hazards are different and can be present or enter at any point in the food chain. They also cause different natures of acute or chronic diseases, from digestive tract infections to cancer [15].

In order to assure food safety during production, processing, distribution, and trade, the food-producing buffalo industry should meet the international food standards established by FAO/WHO Codex Alimentarius, and in those cases of exporting should comply with World Trade Organization (WTO) standards. In all cases, following the World Organization of Animal Health (WOAH, founded as OIE) guidelines to meet food-producing animal health requirements is necessary [17].

International trade of food from buffalo origin will require to meet these standards in order to get an appropriate registration of the products according to international trade regulations and commercial partner's legislations, e.g., [Food and Drug Administration](#) (FDA), [Food Safety and Inspection Service](#) (FSIS, USDA), [Canadian Food Inspection Agency](#), [European Food Safety Authority](#) (EFSA), and [Food Standards Australia New Zealand](#) (FSANZ) [18-22]. Following food safety standards will facilitate fair practices in the international food trade. Buffalo health, food safety, and fair food trade go alongside the generation of healthy, nutritious, and sufficient food, reinforcing at the same time opportunities for buffalo products and byproducts marketing and food industry expansion.

Non-compliance with food safety standards could lead to the withdrawal of food products from the market and legal action against the involved food enterprise. Most important, a single foodborne disease outbreak could cause lives toll and loss of businesses. Main food safety issues are associated with contamination with microorganisms altering nutritional and microbiology characteristics of food that could lead to foodborne diseases and reduce the market life span of produce [23]. Contaminating microorganisms could be pathogens or not, but harboring antimicrobial resistance that efficiently disseminates through food is possible. Any of these cases, foodborne outbreaks, AMR, or reduced produce life span, represent a severe threat to public health and impact the economy.

Some remarkable features of buffalo are the innate resistance to some bacteria, parasites, and even ticks and the extensive nature of husbandry in most countries where buffalo breeding has emerged [23]. Both imply less use of antibiotics, antiparasitics, and other biocides, providing benefits beyond the breeding and production. Less use of antimicrobials results in lower selective pressure on resistant microorganisms, reducing the chances of disseminating antimicrobial resistance and antimicrobial residues to the environment. This feature represents a significant advantage, positioning food of buffalo origin as a source of safer food for human consumption and improving trading opportunities.

The advantages of buffalo nature could be reduced or lost due to some human practices. For example, to solve farming issues regarding scarcity or lack of fresh water, in some countries, buffaloes are bathed with sewage. This practice increases the risk of diseases such as clinical mastitis, foot and mouth disease, and tick infestation (increasing vector-borne disease likelihood), reducing at the same time milk production and slaughter value and impacting the economy, productivity, animal welfare, and undoubtedly quality of food from buffalo origin [25]. Although buffaloes have shown to be more resistant than cattle, they still bear susceptibility to a variety of infectious diseases such as leptospirosis, brucellosis, tuberculosis, and bovine viral diarrhea, and parasitic diseases like fasciolosis and schistosomiasis, all impacting animal and/or public health [26]. Thus, it is crucial to assess farming practices that could reduce the advantages traits that buffalo naturally express and mitigate them to ensure food quality and better trade opportunities.

IMPLEMENTING ONE HEALTH APPROACH IN THE AGRIFOOD CHAIN

More buffalo farmers than we can think to have some One Health practices without even knowing. If they are part of a community dedicated to buffalo husbandry or farmers' organizations with standard plans, or if good practices for livestock rearing and food production are considered, and ecosystem preservation is of interest, they have started on the right foot. However, if it is not, the best way is to start simply by integrating into working groups and inducing simple changes with what farmer has available regarding resources and installed capacity. To move toward sustainability, it is crucial to remember that excellent infrastructure investment is optional as long as feasible objectives are established and gradually scale up to integrating humans, animals, and ecosystem wellbeing. Implementing the One Health approach can only be achieved with integrative, collaborative, multisectoral, and transdisciplinary actions. However, good governance is required to build legal basement and regulatory policies.

The best example of implementing the One Health approach in the agrifood chain is the monitoring and surveillance programs on antimicrobial resistance (AMR). Since 2015, a Global Action Plan on AMR has been ongoing, and specific directives and objectives have been established [9]. Although developed countries like the United States of America, Canada, Denmark, Sweden, and Korea, among others, have been working on such programs long ago, many countries worldwide have started designing and implementing their own national action plan according to their resources and capacities. Harmonized methodologies have been established and updated to assess critical points along the human and animal health systems related to the agrifood chain from farm to table. Different animal production systems (mainly poultry, cattle, and swine) are monitored to identify phenotype-resistant bacteria in various sample types and critical points throughout the food chain.

In Latin America and the Caribbean, the InterAmerican Institute for Cooperation on Agriculture (IICA), joint with the Veterinary Preventive Medicine Department of Ohio State University (OSU), has been providing technical support on the designing and implementation of such plans under One Health perspective for several countries in the region. This collaborative work has yielded National monitoring and surveillance programs for AMR already in implementation or the designing phase (e.g., Paraguay, Ecuador, Costa Rica, Belize, Chile, Brazil, Jamaica, and Colombia). Multisectoral and transdisciplinary teamwork has been constituted with the active participation of Ministries of human and animal health, agriculture and environment, academies, reference laboratories, producers' associations, private industry, and retailers, among other stakeholders called to participate.

In addition, pilot projects have been successfully designed and executed; the CISARA project involved seven poultry-producing Caribbean countries [27]; last year, pilot projects for Honduras, El Salvador, and Nicaragua were designed and are ahead to be implemented (IICA et al. of Pilot Plan for Monitoring Antimicrobial Resistance in the Agricultural sector in Honduras, El Salvador, and Nicaragua, financially supported by USDA). As a result of the IICA-OSU collaboration, a systematic design process has been developed, establishing harmonized methodologies, and following the One Health perspective. The technical support and guidance IICA-OSU is bringing to countries in Latin America and the Caribbean is crucial for strengthening the monitoring and surveillance systems of AMR under the One Health approach.

On a global scale, many countries worldwide have been collecting AMR and antimicrobial use (AMU) information in the food and agriculture sectors. However, unexpectedly, the data obtained has yet to be thoroughly analyzed, generating gaps in epidemiological data. Thus, FAO aims to promote and facilitate AMR stewardship by developing the International FAO AMR Monitoring (InFARM) System and IT platform as a global epidemiological information system to host, analyze, interpret, and leverage AMR data generated by countries, enhancing the availability and quality of data in a harmonized way [28]. InFARM will generate integrated global data on AMR of the food and agriculture sectors following the One Health perspective. Additionally, the WOAHA (founded as OIE) ANImal antimicrobial USE global database (ANIMUSE) has collected information on the amounts and reasons for animal antimicrobial use since 2015. Free access database allows interactive display of reports on the global and regional trends [29, 30].

In the Buffalo production system, we can mention a few examples. A One Health integrated project has been developed in Thailand and Vietnam. It aims to assess buffalo care practices based on the herder's knowledge and environmental assessment of the impact of extensive farming at the village paddies field and within the forest grazing area. Also, to study the buffalo microbiota for AMR gene detection and microorganisms' distribution in the ecosystem [31]. In other countries, studies

on mitigation of the environmental impact of buffalo production through genetic improvement and mitigation alternatives of the negative environmental impacts of the introduction of buffalo breeding have been done.

The global buffalo population has reached nearly 200 million; 97% are reared in Asia, where many depend on this species for livelihood. Buffalo breeding has roughly grown 2% per year in the last two decades and is still growing in the rest of the world, and currently, more than sixty countries account for buffalo husbandry [2, 32, 23]. The products and byproducts from the buffalo Agri-system and industry are spreading worldwide due to features such as milk and meat nutritional quality. For example, buffalo milk ranks second after cow milk, with a significant share of global milk production [2]. Thus, buffalo farming has gained a worldwide competitive position, generating essential responsibilities for safe and sustainable food production.

ECONOMIC GROWTH UNDER ONE HEALTH APPROACH

Besides food production, the development of the food production system allows society to benefit through employment generation, income increases, infrastructure improvements, industry expansion, and economic growth. Traditionally, the economic indicator Gross Domestic Product (GDP) has determined progress assessment considering the total value of goods produced and services provided by a country, which translates into national wealth [11, 14].

Health world leaders have realized that such indicators exclude accountability for environmental effects and the cost it harbors. In that sense, a new indicator has been proposed named the Inclusive Wealth Index (IWI), Green Gross Domestic Product, or Green National Income (GNI) to weigh environmental sustainability and equity, leading to measuring economic sustainability and well-being. This new indicator aims to assure sustainability and the long-term well-being of the population. This new perspective considers the impact of human productive activity on the ecosystem where such activities are performed. The food production and processing environment will represent the food and agriculture sectors [34, 35].

The Inclusive Wealth Index (IWI) was created by the United Nations University- International Human Dimensions Programme on Global Environmental Change (UNU-IHDP) and the United Nations Environment Programme (UNEP) [34]. In order to achieve an actual measure of changes in the wealth of nations, this index includes assets of a country employing its human, natural, social, and physical capital, moving estimation of nation wealth beyond traditional measurements and updating the way of wealth assessment. This broad approach is expected to facilitate heads of governance better management of the economy, being aware of wealth assets, and understanding promoter factors of their increases and/or depletion [35].

In general, most countries have significantly exhausted their natural capital in efforts to achieve growth, although some have accumulated human and productive capital with relatively low loss of natural capital. According to the Inclusive Wealth Report (IWR) 2023, Latin America and the Caribbean have a higher loss of natural capital than any other region globally. Some of its countries have lost more than half of their natural capital since 1990, which means that economic performance has been made at the expense of natural capital. However, the most significant loss between 1990 and 2019 occurred in Japan, with a 70% loss of natural capital at the expense of fisheries and forest overexploitation. Globally, changes in the estimation of wealth urge order to promote an increase in renewable natural capital and reverse this depletion trend focused on building socially just and environmentally sustainable development pathways [35].

CONCLUSIONS

- One Health approach could seem a utopic health perspective due to its holistic meaning and our usual way to account for development. However, based on the health challenges we are experiencing, the unstoppable increasing demand for food, and the exhaustion of natural resources and biodiversity, the only way to achieve sustainability is to establish practices rendering a positive balance between the triad human/animals/environment. Suitable governance structures are crucial.
- It is imperative to know that the only way to implement the One Health approach is through integrative, multisectoral, and transdisciplinary collaboration.
- Implementing the One Health approach does not necessarily imply great investment; it just requires the establishment of feasible objectives based on existing resources and capacities. Start simple with achievable small goals, progressively scaling up for more significant outcomes according to developed capacities during the process.

RECOMMENDATIONS

- Producers should strengthen their associations and look for new partnerships like academics, researchers, and international organizations to develop systematic ways to embrace changes and challenges based on scientific evidence.
- Identifying risk factors for introducing buffaloes in new areas should account for animal health and welfare and sustainability of the ecosystem and production system.
- Perform a current situation analysis, which is highly recommended to identify the baseline and determine the start point.

- Feedback and suggestions from all interested parties or stakeholders are essential to advance sustainability. Thus, sharing relevant data obtained from the buffalo agri-system and industry assessment will promote capacity building and will allow better and more efficient use of resources.

FUTURE PERSPECTIVES

- Buffalo industry has excellent chances to expand beyond borders if products and byproducts meet the international trade standards of food safety and quality and ensure traceability and security of the food produced.
- Expansion of the buffalo Agri-system, as with any other food-producing system, will require enrolling in a self-assessment of production, processing, distribution, and trade practices to understand how profound the impact on society, environment, and economy is. Production of food from buffalo origin could positively impact achieving the SDGs.
- It is necessary to change in the way we usually think food production should be and the pathway we usually use to measure wealthiness.

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ANNEX

Annex 1. United Nations Sustainable development goals



SUSTAINABLE DEVELOPMENT GOALS (SDGs)

Goal 1	End poverty in all its forms everywhere
Goal 2	End hunger, achieve food security and improved nutrition and promote sustainable agriculture
Goal 3	Ensure healthy lives and promote well-being for all at all ages
Goal 4	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
Goal 5	Achieve gender equality and empower all women and girls
Goal 6	Ensure availability and sustainable management of water and sanitation for all
Goal 7	Ensure access to affordable, reliable, sustainable and modern energy for all
Goal 8	Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
Goal 9	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
Goal 10	Reduce inequality within and among countries
Goal 11	Make cities and human settlements inclusive, safe, resilient and sustainable
Goal 12	Ensure sustainable consumption and production patterns
Goal 13	Take urgent action to combat climate change and its impacts
Goal 14	Conserve and sustainably use the oceans, seas and marine resources for sustainable development
Goal 15	Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss
Goal 16	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels
Goal 17	Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development

Available at: <https://sdgs.un.org/goals>;

SDGs logo use: https://www.un.org/sustainabledevelopment/wp-content/uploads/2019/01/SDG_Guidelines_AUG_2019_Final.pdf