TECHNICAL REPORT ON ENVIRONMENTALLY SUSTAINABLE LIVESTOCK PRODUCTION AND PROCESSING

A. Introduction

1. The contribution of livestock to the diet, and thus food security of the People’s Republic of China (PRC) is growing in importance. Over the decade to 2005, the per capita share of total protein from livestock products grew at an annualized rate of 3.3% from 21.4% to 29.7%; and calorie intake by 4.0% per year from 13.6% to 20.1%.\(^1\) As the population, urbanization, and livestock products consumption exploded over the past century, huge industrial scale livestock enterprises grew up to feed cities; and many with peri-urban farming systems based on bought-in animals, feed, and fodder.

2. Livestock production and processing is a complex activity. Beyond a direct role in generating food and income, livestock are a valuable asset, serving as store of wealth, collateral for credit, and an essential safety net during times of crisis for huge numbers of rural households. Livestock are essential to mixed farming systems’ consuming waste products from crop and food production, while producing manure for fertilizing and conditioning fields. In some parts of the PRC, livestock still provide draught power and transport; and perform a public sanitation function by consuming waste products that would otherwise pose pollution and public health problems. Other non-food livestock products, such as hides and skins, are processed by the PRC manufacturers into important end products, such as clothes and footwear for domestic and export markets.

3. Today, Henan Province is the largest producer of livestock and livestock products in the PRC; and home to some of the largest livestock enterprises in the world. This is largely because the province is also the grain basket of the PRC, and rich in the multiple feed resources needed for intensive industrial livestock and poultry farming. Many are huge vertically integrated farm to consumer food businesses raising, slaughtering, processing, and distributing meat from hundreds of thousands of cattle and pigs annually; or meat and eggs from tens of millions of chickens and ducks.

4. With huge industrial food chain scale, there are challenges concerning the handling of animals and animal waste; and potential disease risks and threats. If not managed correctly, these can impact adversely on people, rural jobs, and the environment. Climate change poses an additional challenge as food animals are a significant source of anthropogenic greenhouse gas emissions (GHG) worldwide, contributing between 7% and 18% to global GHG emissions, depending on the accounting approach.\(^2\) With proper management, technologies, and practices (improved animal husbandry, manure management, improved feeding practices), livestock can deliver a significant share of the mitigation effort required.

5. The project plans to demonstrate how to mitigate these threats at the nine large-scale project participating enterprises (PPEs), while boosting the availability of safe livestock products; and at the same time, improving rural livelihoods, combating poverty, and enriching women’s well-being. In so doing, the project will play a catalytic role in demonstrating how to make natural resource conservation sustainable and financially attractive in the longer term.

\(^1\) Food and Agriculture Organization (FAO) of the United Nations. 2011.
B. Environmentally Sustainable Livestock Policy Framework

1. Livestock Production and Processing

6. Livestock are expected to contribute 36% of total agricultural output value in the Twelfth Five-Year Plan (2011–2015) of the PRC.\(^3\) The Ministry of Agriculture (MOA) is responsible for livestock. Recognizing the importance of livestock, the first policy document issued by MOA in 2013 prioritizes the following: (i) modernizing industrial agriculture with more focus on production of livestock products, (ii) improving food safety, (iii) safeguarding the environment, and (iv) professional training. MOA implements livestock production and processing through the Henan Provincial Animal Husbandry Bureau (HAHB), the municipal animal husbandry bureaus (MAHBs), and the county animal husbandry bureaus (CAHBs) as reflected in the current Five-Year Plan for the Development of the Livestock Sector of Henan Province.\(^4\)

7. To encourage the production of safe and affordable livestock products and the use of renewable energy, central and provincial authorities have promulgated a series of policies and measures, backed by laws and regulations, to proactively advance environmental sustainable livestock production and processing. The legal framework includes the comprehensive Animal Husbandry Law (2005)\(^5\) and the Renewable Energy Law (2006).\(^6\) The animal husbandry legislation has 73 articles covering all aspects of livestock production.\(^7\) Included are the licensing of farms and livestock processing enterprises supported by articles dealing with animal health, animal waste, and wastewater in the context of other State, provincial, and county regulations. Eight chapters deal with the following: (i) general provisions; (ii) protecting livestock and poultry genetic resources; (iii) selective breeding of livestock and poultry, production, and animal health; (iv) breeding livestock and poultry; (v) trading in and transportation of livestock and poultry; (vi) certification for quality and safety; (vii) legal requirements; and (viii) supplementary provisions.\(^8\)

2. Environment

8. The pioneering Circular Economy Promotion Law of 2008 is highly relevant.\(^9\) The law promotes the principle of ‘reducing–reusing–recycling’ (3Rs) in the broad food chain cycle of production, circulation and consumption. The use of agricultural waste for fertilizer and the production of green or renewable energy are within the scope of this law.

9. Since 2000, the PRC has reformed and continues to reform its laws, policies, and strategies related to climate change and environmentally sustainable livestock production and processing. These aim to follow international best practice and are being applied with increasing vigor in Henan Province by the concerned provincial, municipal, and county authorities. Current overarching livestock strategies initiatives in the province include (i) production and processing zoning for different animals, (ii) financial incentives and guarantees for scaling-up, (iii) subsidies

\(^7\) Sometimes called breeding in the English translation of the Law provided by the project preparatory technical assistance (PPTA) team.
\(^8\) Food safety and traceability are considered in detail in Appendix 14.
for changing to non-polluting production and processing systems, and (iv) important improvements in food quality, safety, and traceability.

10. The scale and nature of the interaction between livestock production and processing, and the environment has been the subject of much concern in making informed policy decisions; and devising technical intervention programs, e.g., this project and other ongoing livestock projects in Henan Province. It is increasingly clear that livestock–environment linkages should be seen in the context of human, economic, and political aspects as well as natural resource utilization. It is also clear these linkages should be considered within an emerging pattern of broader food systems.

11. Many policies, laws, and standards for upgrading the environmental sustainability of livestock production and processing have been introduced by the PRC over the past decade in response to the polluting potential posed by the accelerating shift to industrialized farming. These include the following:
   (i) China National Climate Change Program (National Development and Reform Commission [NDRC], 2007).
   (iii) Discharge Standards of Pollutants for Livestock and Poultry Breeding (State Environmental Protection Administration [SEPA]/Ministry of Environment [MOE], 2003).
   (vi) National Rural Biogas Construction Plan (MOA, 2006).

12. The intention of the PRC’s livestock policy framework is more efficient, safe, and responsible use of natural resources that “combine prevention and control with precaution, combine economy and practicality, combine management with technical measures, and combine effective use with comprehensive treatment”; and finally perform the technical requirement of “source reduction, clean production, comprehensive resources utilization, and preventative secondary pollution.”

C. International Best Practices in Livestock Farming and Food Systems

13. Conventional livestock farming and food production can cause soil (and pasture) degradation and pollution because they involve intensive tillage and concentration of animals. Modern technologies and management systems can boost productivity per livestock unit and preserve the natural resource base. The adaptation and use of international best practices offer key solutions for enhancing intensive livestock production, while safeguarding the environment through prudent and efficient resource use.

1. Livestock Feeding and Watering

13. Large-scale industrial livestock production systems are associated with a concentration of animals into large units, generally a single species. They aim to produce affordable food

efficiently and safely. In so-doing, they also (i) produce large volumes of waste material; (ii) can lead to high animal and human health risks, especially in close proximity to urban population centers; and (iii) often pay less attention to animal welfare.

14. Sustainable productive application of the industrial farming system requires advanced levels of management and modern technology and large areas of arable land to satisfy the requirement for large quantities of high-quality roughage and supplementary feed concentrates. However, the system has the potential to absorb large quantities of crop by-products and waste from agro-food industries, including small farming households. Intensive crop and livestock farming is reported to have degraded the soils of over half of the arable land in the PRC, with use of nitrogen fertilizer three times the world average. Modern technologies for the production of non-toxic organic fertilizer from manure to replace chemicals can contribute to sustainable soil use and reduce toxic run off.

15. Clean water supply is a prerequisite for intensive livestock production. A high-yielding dairy cow, for example, needs 70 to 90 liters of clean drinking water daily. Water is also used for general cleaning and disinfection. Recycled water may be used for general cleaning water; but its use should be kept to a minimum and matched with how the manure is handled, e.g., for spreading on agricultural land, or for biogas or organic fertilizer production. Other water-saving measures include (i) water harvesting from buildings, (ii) loose housing for cattle, (iii) slatted pig pens, (iv) washing down between batches rather than daily, and (v) separating urine and water from solid manure.

2. Biosecurity, and Animal and Human Health

16. Diseases affecting livestock can have a devastating impact on (i) animal productivity; (ii) trade in live animals, meat, and other animal products; and (iii) human health; and consequently, on overall food security and economic development. Animal diseases may be infectious or endemic to other animals or zoonotic, i.e., have the potential to infect people with pathogens carried by animals. Ensuring safe food is paramount for the protection of human health and the food chain systems approach is internationally recognized as an important step towards ensuring food safety from farm to consumer. An animal’s welfare is disadvantaged if it is diseased; potentially leading to human health risks along the entire food chain. The disease may be related to the production system, e.g., (i) overcrowding and poor ventilation may lead to increased respiratory problems, or (ii) enteric diseases. A solution used in industrial poultry rearing is to use antibiotics prophylactically administered in feed or water to mitigate potential disease risks. Following the administration of antibiotics and veterinary drugs, their residues may persist in edible products of treated animals; and so, production practices must ensure animals are clear before slaughter.

17. The use of internationally accepted good agricultural practices (GAPs) and standard operating procedures (SOPs) are tools for ensuring modern livestock management and welfare systems, and human and food safety procedures are correctly followed (see Box 1). Biosecurity in industrial livestock production and processing connects to having measures in place for the protection of health, human, and animal through the avoidance of disease and any potential hazards resulting from inappropriate use of medicines, growth promoters, and pesticides. The

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11 State of Food and Agriculture, FAO. 2009.
12 FAO. 2010. FAO Animal Production and Health Paper 169: Good Practices for Biosecurity in the Pig Sector (FAO, OIE, World Bank). In its common usage, biosecurity refers to the protection of health through avoidance of disease. For the purposes of the project, biosecurity may be defined as the implementation of measures that reduce the risk
Codex Alimentarius Commission (CAC) of the Food and Agriculture Organization (FAO) of the United Nations and the World Health Organization (WHO) develops and publishes harmonized international food standards, guidelines, and codes of practice to protect consumer health and safeguard fair practice in the food trade. The CAC also promotes coordination of all food standards work undertaken by international governmental and nongovernmental organizations. Good manufacturing practices (GMPs) and SOPs are essential stepping stones in setting up internationally recognized hazard analysis and critical control points (HACCPs) food safety systems leading to International Organization for Standardization (ISO) 9000 certification.

3. **Slaughter and Livestock Products Processing**

18. To produce clean safe carcasses, slaughterhouses adopt various internationally recommended practices—the GMPs and SOPs mentioned above—making use of the latest technology to reduce possible pathogenic contamination. Hygienic and humane handling of animals, using fresh and uncontaminated water and maintaining cleanliness at the slaughter floor and other operational areas, is essential during the slaughter process. According to animal species, the process involves the following stages: (i) receiving and unloading; (ii) holding in pens; (iii) washing; (iv) stunning; (v) bleeding; (vi) hide, skin, or feather/down removal; (vii) separating body parts; (viii) carcass washing; (ix) chilling, freezing, or ageing depending on product and end-use; (x) cutting and packing various meat cuts and joints; (xi) production of other processed meat products, such as sausages and cooked meats; (xii) cold storage; and (xiii) distribution to wholesale and retail outlets.

4. **Animal Welfare**

19. During slaughter and processing, poor operational techniques and facilities lead to unnecessary animal suffering, injury, and loss of production. There are many advantages to improving conditions for livestock destined for slaughter, and the products produced from

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13 Available at: [http://www.codexalimentarius.org](http://www.codexalimentarius.org)
properly slaughtered animals. These include benefits from improvements in productivity, animal welfare, personnel safety, and biosecurity. Under modern industrial-scale farming systems, humane treatment of food animals results in increased production through (i) reduced carcass damage and waste, and higher value due to less bruising and injury; (ii) decreased mortality; (iii) improved quality of meat by reducing animal stress; and (iv) increased quality of hides and skins. Improving animal welfare is necessary to reduce suffering, in line with the PRC’s and international best practices and standards. Consumers are becoming more concerned with the welfare of food animals. Better conditions for livestock operations also improve the safety of workers in the livestock and food industry.

5. Livestock and Processing Waste

20. The production and manufacture of animal products for human consumption (meat, dairy products, and eggs); or for other human needs, e.g., leather and down, leads inevitably to the production of waste.

21. Most processes in slaughterhouses, meat processing plants, and tanneries require the use of large volumes of water. Water is also used for general cleaning and disinfection purposes. The strength and composition of the pollutants in the waste water depend on the nature of the processes involved. The solid waste produced in animal processing is mainly organic waste. Depending on the product and the situation, this is composted or converted into useful by-products. Solid waste with toxic compounds requires special disposal arrangements. Animal processing can also cause (i) air pollution in the form of greenhouse gases (GHG), i.e., carbon dioxide from the use of fossil energy; (ii) dust from handling powdered material; and (iii) smell from wastewater treatment and rotting material.

22. Anaerobic digestion is the most suitable technology for treating waste with high concentrations of organic matter, such as animal manure and wastewater from production and processing facilities. Apart from waste treatment and management, anaerobic digestion has secondary benefits, such as biogas production which can be used for thermal and electrical energy; and organic fertilizer produced from the spent biogas slurry which is rich in key soil nutrients (nitrogen, phosphorus, potassium) and especially organic matter.

23. Commonly known as biogas digesters, anaerobic digestion may use a variety of anaerobic reaction techniques. At present, upflow solid reactor (USR) and upflow anaerobic sludge blanket (UASB) were the most commonly applied technologies; and now, continuous stirred-tank reactor (CSTR) and high-concentration flow (HCF) anaerobic processes are also applied. The follow section describes the technologies and presents a comparison in Table 1.

(i) **Upflow solid reactor anaerobic technology.** Applied widely, the structure of USR is simple and suitable for treating waste with high suspended solids. Anaerobic materials are added to the bottom of reactor which when coming into contact with the activated sludge are digested rapidly. The anaerobic condition of the tank is maintained, allowing for natural settlement, undigested biomass at the base, and supernatant overflow from upper reactor, which allows for higher solid retention time (SRT) and microbial retention Time (MRT). This feature enhances the rate of decomposition of organic solids and anaerobic reactor’s efficiency.

(ii) **Upflow anaerobic sludge blanket anaerobic technology.** The principal of UASB technology is the three-phase separator and water distribution system which can maintain anaerobic microorganisms’ high activity and good
performance. Wastewater added to the bottom of reactor moves upward through the sludge bed containing sewage sludge particles or flocculent sludge, causing anaerobic reaction upon contact. Gas rises to the upper part of the reactor going into the gas collector while sludge particles after precipitation settle down to the surface of the sludge bed. Compared to general anaerobic devices, UASB has higher efficiency, lower investment, and needs less floor space; but it is not suitable to treat liquid materials with high suspended solids, requiring solid–liquid separation before waste can be added to the digester.

(iii) **Continuous stirred-tank reactor anaerobic technology.** CSTR technology users mix devices in the conventional anaerobic reactor. The raw materials and microorganism are in a completely mixed state; and its efficiency is markedly higher than conventional layered anaerobic reactors. At present, this technology is widely used outside of the PRC. The reactor often uses constant temperature continuous feed or semi-continuous feed operation, and it is fit to treat raw materials that contain large quantities of suspended solids of high concentrations.

(iv) **High-concentration flow anaerobic technology.** Uses sludge flow mixing technology and is suited to high concentrations of suspended (up to 8%) solids. The constant mixing within the reactor makes for efficient treatment of waste matter.

**Table 1: Comparison of Technology and Cost-Effectiveness of Anaerobic Treatment Technologies**

<table>
<thead>
<tr>
<th>Categories</th>
<th>Ordinary Digester</th>
<th>CSTR</th>
<th>UASB</th>
<th>HCF</th>
<th>USR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organic load, g/l</td>
<td>&lt;3.0</td>
<td>5.0~10.0</td>
<td>8.0~15.0</td>
<td>5.0~10.0</td>
<td>5.0~10.0</td>
</tr>
<tr>
<td>Inflow - organic suspended substance, g/l</td>
<td>up to 50</td>
<td>50~120</td>
<td>&lt;4</td>
<td>50~120</td>
<td>50~120</td>
</tr>
<tr>
<td>COD removal %</td>
<td>Lower</td>
<td>Medium</td>
<td>Higher</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>HRT (d)</td>
<td>Longer</td>
<td>Medium</td>
<td>Shorter</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>Power consumption (kW)</td>
<td>More</td>
<td>More</td>
<td>Little</td>
<td>Less</td>
<td>Less</td>
</tr>
<tr>
<td>Production control</td>
<td>Easy</td>
<td>Easy</td>
<td>More difficult</td>
<td>Easy</td>
<td>Easy</td>
</tr>
<tr>
<td>Investment</td>
<td>Larger</td>
<td>Medium</td>
<td>Less</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>Area</td>
<td>Larger</td>
<td>Medium</td>
<td>Smaller</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>Production experience</td>
<td>Little</td>
<td>More</td>
<td>More</td>
<td>Less</td>
<td>More</td>
</tr>
<tr>
<td>Operating cost</td>
<td>Low</td>
<td>Lower</td>
<td>Lower</td>
<td>Lower</td>
<td>Lower</td>
</tr>
<tr>
<td>Single reactor volume (m³)</td>
<td>Medium</td>
<td>Bigger</td>
<td>Bigger</td>
<td>Smaller</td>
<td>Bigger</td>
</tr>
<tr>
<td>Waste types</td>
<td>Cow manure, pig manure, poultry manure</td>
<td>Cow manure, pig manure, poultry manure</td>
<td>Waste water</td>
<td>Cow manure, pig manure</td>
<td>Cow manure, pig manure, poultry manure</td>
</tr>
</tbody>
</table>

= less than, CSTR = continuous stirred-tank reactor, g/l = gram per liter, HCF = high-concentration flow, kW = kilowatt, m³ = cubic meter, UASB = upflow anaerobic sludge blanket, USR = upflow solid reactor.


24. Through the comparative analysis, we find that each technology has its advantages. As a more mature technology used worldwide and in the PRC, USR technology is well applied for use in livestock and poultry farm waste treatment, with the produced biogas meeting the energy need of farms for cooking and biogas power generation effectively. Generally, HCF technology
is suitable for various types of small biogas projects that treat waste; UASB technology is applied to treat wastewater from livestock farms requiring separation of manure and wastewater to remove suspended solids and solids; and so, its application is limited; and CSTR technology is fit to treat raw materials that contain large quantities of suspended solids of high concentrations which has great capacity of methane, though the resulting slurry is not suitable to use for farmland irrigation as the slurry does not meet the discharge standards.

25. Biogas residues and slurry have achieved very good results as organic fertilizer. If the objective is to use the digestion end products for fertilizer or irrigate with the slurry, use of solid manure should be avoided; however, this will result in a lower biogas yield. As for sewage that meets the discharge standards, aerobic biological treatment after anaerobic digestion is also necessary. Commonly used technologies are intermittent aeration biological method, two levels of A/O wastewater treatment process, biological oxidation pond multistage degradation process, and model of artificial wetland treatment.

26. Organic fertilizers produced by aerobic fermentation of animal manure have less energy consumption, are low polluting and are commonly used worldwide and in the PRC. The solid organic fertilizer production is based on dry collection technology and solid–liquid separation technology. At present, there are many aerobic fermentation technologies for livestock manure, including fermented dry tower, rotary tillage-type shallow trough fermented dry, spiral-type deep groove dry fermentation, and microbial degradation with fermentation tank as well as the pile machine. Microbial degradation has many advantages, such as the ability to adjust the ratio of raw materials, control over the fermentation process, mineralizing of the nutrient, and eliminating pathogenic microbes and bad odor. The organic fertilizer production process does not use water; and as such, has no wastewater discharge; and no toxic or harmful gases produced in the fermentation process making the process simple, safe, and pollution-free.

27. Management practices for livestock and poultry waste handling and treatment include the following:

(i) **Waste source-point control and management.** Site and technical designs for new facility construction, rebuilding, and expansion of existing livestock and poultry facilities. Stocking densities within the limited regulated allowance of available land area; regulated distance between the water source and livestock facility; adequate capacity (volume and technical specifications) for waste treatment facilities;

(ii) **Balanced production systems.** Accessibility to and availability of feed resources with sufficient cropping land, which is also suitable to use and return animal waste (manure, biogas slurry, organic fertilizer) reducing chemical fertilizer demand;

(iii) **Treated waste discharge quality standards.** Treated water and waste should reach quality standards for discharge

(iv) **Controlled disposal of treated livestock waste.** Animal waste applied to land should not exceed plant utilization demand and soil capacity to absorb nutrients (nitrogen, phosphorus); and

(v) **Preferential policies.** To encourage farmers to manage waste responsibly policies should support farmer's investment.

6. **Climate Change Mitigation**

28. Food animals are a significant source of GHG emissions worldwide. Improved animal husbandry and manure management practices, including feeding, can mitigate emissions.
Increasing productivity per livestock unit is the aim, with improved animal waste handling practices (farm and processing) likely to have the most impact. Potential mitigation practices include: (i) increasing animal productivity by improving reproductive efficiency, animal health and reproductive lifespan, and using feeds that are low emitters; (ii) earlier slaughter to reduce overall feed intake and animal lifecycle; (iii) improving feed nutrient and roughage balance, digestibility, and feeding protein close to animal requirements; and (iv) promoting lower energy and renewable options within the value chain, use of biogas, solar, non-CFC refrigeration, transport etc. The promotion of balanced crop nutrient management to reduce nitrogen dioxide (NO₂) emission and production practices like minimum tillage and reduced pesticides and fertilizer application, as well as selection of climate-resilient crop varieties also mitigate GHG emissions.

D. Project Design Approach

1. Project Framework

29. Reflecting current national and provincial policy, output 2 focusses on environmental sustainable livestock production and processing. For the purpose of the project environmental sustainable livestock production and processing is defined as

The production and processing of safe and affordable food sited, designed, and operated to minimize the use of external resources (e.g., land, feed, water, energy, chemicals) and to maximize recycling and reuse of its waste products.

This output comprises nine PPEs (Afanti, Dadi, Donghan, Fenghua, Hengtianran, Kerchin, Muyuan, Niuniu, Sangao PPEs) engaged in intensive livestock production in nine counties across Henan Province. As indicated in Table 3, some PPEs will use the loan to invest in selected parts of the livestock production and processing value chain, e.g., Niuniu PPE will expand their cattle fattening units. Others will invest at more stages of the chain, including slaughter, processing, and distribution, e.g., Afanti and Fenghua PPEs. Common to all investments are plans to install or upgrade (i) waste handling systems, including energy- and water-saving technologies; and (ii) food safety systems, including product traceability (Output 1).

2. Situation Analysis of Project Participating Enterprises

30. The nine PPEs broadly demonstrate the shifting demand for meat in the PRC from pork to beef and poultry: four are cattle, three pig, and two poultry enterprises. The feasibility study reports (FSRs) described how each PPE plans to use the loan to grow its livestock business in an environmental sustainable way.¹⁴ Each PPE is at a different stage of development and experience. The FSRs indicate PPEs fall into two groups. First, two thirds have been established recently and plan to grow their businesses considerably; these PPEs will require technical support to introduce appropriate international best practice. The second group has more experience and already operates at significant scale employing modern technologies and systems (e.g., Kerchin, Muyuan, and Sangao PPEs); these PPEs plan to consolidate their leading positions, respectively, in industrial cattle, pig, and poultry production in Henan Province and in the PRC. A summary of the PPE activities is presented in Table 3.

¹⁴ PPE Final FSRs. PPTA Design Institute, 2014 (in Chinese) and FSR Executive Summaries and Value Chain Maps (in English), May–June 2014. The PPTA-prepared FSR working briefs for each PPE in English.
31. Review of the FSR working briefs indicates the five key elements of environmental sustainable livestock production and processing that the PPEs should address during project implementation to demonstrate international best practices as required by the current PRC policy which involves overlapping technologies and systems.

32. **Livestock production.** Introduce or upgrade appropriate technologies and practices (SOPs, GAPs) for all aspects of livestock production, including (i) breeding and fattening, (ii) balanced feeding for improved productivity and GHG emission reduction, (iii) animal health and biosecurity, (iv) human and animal welfare, (v) beneficiary farmer and/or farming household and gender participation, and (vi) integration of the practices into the PPE business. All FSRs indicate that only certified additives are used; and that their use is discontinued the specified period before slaughter in accordance with animal husbandry bureau (AHB) regulations.

33. **Livestock processing.** Introduce or upgrade appropriate technologies and practices (SOPs, GMPs) for all aspects of livestock processing, including (i) humane slaughter; (ii) meat processing; (iii) meat storage, distribution, and marketing; (iv) meet quality, safety, and traceability; (v) staff health and safety; and (vi) integration of the practices into the PPE business.

34. **Manure and waste handling.** Introduce or upgrade appropriate environmental sustainable energy/water saving and soil nutrient recycling technologies and practices (SOPs, GAPs/GMPs) for the following: (i) livestock manure and waste handling, (ii) biogas production and use, (iii) organic fertilizer production and use, (iv) design and introduction of a performance monitoring program for energy and water saving, and (v) integration of the practices into the PPE business.

35. **Cross-cutting.** Some of the technologies and systems, e.g., biosecurity; and energy- and water-saving measures, are common to environmentally sustainable livestock production and processing. All the best practice technologies will demonstrate climate change mitigation measures compliant with reduced or non-polluting farming systems. Some PPEs have systematic biosecurity measures in place that include (i) quarantining new and sick animals; (ii) vaccination programs; (iii) robust entry and sanitation procedures; and (iv) ear tagging and record keeping, e.g., Muyuan and Sangao PPEs; while others will be improved under the project. Sangao PPE is already ISO 9000 certified. The FSRs indicate that most PPEs have introduced, or plan to introduce water-saving measures, such as (i) loose housing for cattle, (ii) slatted pig pens, (iii) washing down between batches rather than daily, and (iv) separating urine and water from solid manure.

36. **Farming households.** All PPEs are purposely planning to involve as many local farming households in the implementation of their loans as is feasible given their scale. This includes the direct supply of labor and raw materials for livestock and poultry feeding. Indirectly, the new investments will boost local (i) crop production, (ii) feed processing, (iii) slaughter, (iv) meat products processing, (v) by-products processing, (vi) equipment maintenance and repair, (vii) transportation, and (viii) service industries in the surrounding area bringing further employment and earning opportunities and benefits.

3. **Key Design Elements for Output 2**

37. According to the initial environmental examination, the objective of environmentally sustainable livestock production and processing is targeted under the project through the inclusion of the following:
(i) Facilities for wastewater interception and treatment  
(ii) Biogas generation  
(iii) Processing of manure waste to organic fertilizer  
(iv) Integrated product monitoring and inspection systems  
(v) Environmental monitoring of resource use (water, electricity, veterinary products)

38. To achieve this objective, it will be necessary to include the fundamental target of improved production and processing practices. The key design elements for Output 2 will thus comprise the following:

(i) Livestock production and processing  
(ii) Feed processing  
(iii) Biogas generation  
(iv) Organic fertilizer processing

39. For output 2, each of these elements should be designed to mitigate the impact of existing and new PPE operations on local communities and the environment using the most appropriate technologies and reducing and/or non-polluting practices described in Chapter C. The mitigating measures will differ according to the scope and scale of each PPE value chain as detailed in the FSRs. Supported by the project management office (PMO) and AHB, each PPE will prepare a livestock environmental implementation plan (LEIP) to operationalize project intervention investments. To ensure the interventions are lasting, the LEIP should be part of each PPE’s rolling strategic (business) plan and annual operating plan and budget. The design and implementation of each PPE’s LEIP will include the following major activities: (i) livestock production and processing, (ii) feed processing, (iii) biogas generation, and (iv) organic fertilizer processing.

40. The climate change mitigating interventions likely to achieve the sustainable livestock value chains outcome of the project are the technologies and practices that provide payback on the investments, i.e., boost productivity and net margins per animal or bird. These mitigation practices are described in Chapter C, section 6.

41. Project implementation will be aligned with (i) national practices, procedures, and standards issued by HAHB, and (ii) international best practices for livestock production and processing and food safety from production through to consumption. It is understood there are national SOPs for cattle and pig value chains but not for poultry. Some of the larger PPEs have adapted the national cattle and pig SOPs to their farming and processing systems and developed their own poultry SOPs, e.g., Donghan, Kerchin, Muyuan, and Sangao PPEs. The smaller PPEs especially will require support through the PMO and AHB for implementing the loans for activities demonstrating the following.\(^\text{15}\)

(i) **General farm management.** (i) legal obligations, (ii) record keeping; (iii) livestock procurement (stocking), (iv) feeding and watering, (v) animal identification and traceability, (vi) hygiene and disease prevention, and (vii) farmer training;

(ii) **Animal health management.** (i) addressing biohazards and physical hazards, and (ii) common measures for veterinary medicines and biologicals;

(iii) **Animal handling and product processing.** (i) human and animal welfare; (ii) food safety and traceability; (iii) addressing biohazards, and chemical and physical hazards;

(iv) **Environment and infrastructure.** (i) common measures; (ii) addressing biohazards, and chemical and physical hazards; and (iii) waste management.

42. Kerchin (beef), Muyuan (pork), and Sangao (poultry) PPEs have modern farm to consumer systems in place, including for feeding, product traceability, and manure handling. Others plan to introduce fit for purpose practices under the project, including water management and biogas production. Kerchin PPE uses least-cost (total mixed ration) cattle feeding technology; Muyuan PPE uses a robust organic manure handling and processing system; and Donghan PPE employs community-resilient production and processing practices. These PPEs may be tapped to support the project capacity building program (output 3) through PPE to PPE demonstration and learning; and afterwards, for scaling out knowledge sharing to other livestock production and processing enterprises in Henan Province and further afield.

4. **Risks**

43. The main risks associated with project implementation will include (i) management challenges associated with the substantial increases in operational scale and introducing new technologies; (ii) damaging publicity resulting from potential disease threats; or (iii) high recurring costs associated with operating new waste management, or energy- and water-saving technologies, especially for those PPEs introducing or upgrading biogas systems. These are addressed in the risk assessment and risk management plan for the project with mitigation measures that include providing expert support to the PMO to build the capacity of concerned PPEs. Each PPE will require technical assistance and financial resources to tailor best animal production and products processing practices to GHG emission mitigation approaches into its food chain SOPs.

E. **Project Activities**

1. **Major Activities**

44. Project output 2 will deliver environmental sustainability and energy conservation in the livestock food chain at the nine PPEs focusing on the livestock production and processing stages (Table 3). The project will help PPEs finance civil works and equipment to establish facilities for (i) livestock production; (ii) livestock processing; (iii) feed manufacturing; and (iv) in-house animal waste and wastewater treatment and/or processing, including biogas generation and organic fertilizer production. These facilities will be equipped with energy- and water-saving technologies. The output is expected to generate (i) significant environmental benefits, including avoidance of GHG emissions per unit of livestock product; and (ii) employment and income-generating opportunities at PPEs for local people and farmers who supply livestock, raw materials for feed, and other inputs to PPEs; and/or receive organic fertilizer from PPEs.

45. The major activities for output 2 are the following:

(i) Establish production and processing facilities from 2015 to 2018 using SOPs conforming to the PRC and international best practice

(ii) Establish feed processing facilities from 2015 to 2018

(iii) Establish biogas generators from 2015 to 2018

(iv) Establish organic fertilizer processing facilities from 2015 to 2018
2. Implementation

a. General

46. Implementation of each output 2 activity will require the following general actions to be harmonized with activities for output 1 (food safety) and output 3 (capacity building). The PMO will

(i) Establish a project implementation unit (PIU) for each PPE tasked with overseeing project implementation and report to the project coordination group established by the PMO (year 1);
(ii) Based on the detailed FSRs, review current and planned PPE systems and practices; prepare a detailed, fully costed detailed project LEIP for each PPE investment to include the following: (i) equipment specification and procurement, (ii) installation and commissioning, and (iii) integration into the business (years 1–2);
(iii) Include in the PPE’s LEIP a livestock production and processing program that clearly provides the business proposition for (i) sustainable and safe waste management handling; (ii) biogas production and use; (iii) organic fertilizer production and use, and support implementation (years 1–4);
(iv) Ensure robust sustainable animal health, welfare, and biosecurity practices are in-place at each stage of each PPE food chain are included in each PPE’s LEIP.
(v) Ensure that resilient energy and/or water saving and soil nutrient recycling technologies are practiced and included in each PPE’s LEIP (years 1–4);
(vi) Assist each PPE to operationalize the loans, including developing or updating and documenting tailored SOPs for each new production and processing investment and ensuring harmonization with GAPs and GMPs (years 1–4);
(vii) Develop a tailored capacity building program for each PPE based on the outline contained in Chapter E below, and provide support for implementation (years 1–4); and
(viii) Evaluate progress and make recommendations to consolidate and further build environmentally sustainable livestock production and processing into each PPE’s strategic (business) and annual operating plans and budgets (year 4).

b. Livestock Production and Processing

47. The major activities for output 2 are the following:

For livestock production
(i) Manage production to minimize CHG emission;
(ii) Ensure production routines do not injure the animals;
(iii) Ensure production is carried out under hygienic conditions;
(iv) Ensure participation of local community, employment, and input supply; and
(v) Have SOPs for each key production task based on GAPs, and use them.

For animal feeding and water:
(i) Ensure animal feed and water is of adequate quality and quantity;
(ii) Ensure balance feeding for GHG reduction;
(iii) Control storage conditions of feed raw materials and feed;
(iv) Promote and/or ensure traceability of feedstuffs bought off-farm; and
(v) Support for new feed production facilities and to upgrade existing facilities.
For animal health:
(i) Prevent entry of disease onto the farm;
(ii) Have an effective herd health and/or disease management system in place;
(iii) Use veterinary drugs as prescribed by veterinarians or as specified on the label; and
(iv) Have an approved biosecurity system in-place.

For animal welfare:
(i) Ensure animals are free from thirst, hunger, and malnutrition;
(ii) Ensure animals are free from discomfort;
(iii) Ensure animals are free from pain, injury, and disease;
(iv) Ensure animals are free from fear; and
(v) Ensure animals can engage in relatively normal patterns of behavior.

For livestock processing:
(i) Have SOPs for each key processing task (and use them) based on GMPs for (a) transport, (b) slaughter, (c) processing, (d) cold storage, (e) distribution, and (f) food safety and traceability; and
(ii) Ensure the participation of local community with gender-balanced employment.

c. Waste Management and Energy Saving

The major activities for output 2 are shown in table 2 per PPE and include the following:

For wastewater treatment:
(i) Technical design of wastewater treatment facilities that are compliant with technical, operational, and compliance standard requirements;
(ii) Wastewater quality discharge standards for anaerobic digestion, oxidation, and sewage treatment processes are met; and
(iii) Installation, operation, management, and maintenance of the facilities are carried out appropriately for efficient and effective operation.

For biogas digester establishment and utilization:
(i) Technical designs of biogas digesters are compliant with relevant standards for management and technology criterion for efficient operation;
(ii) Standardized construction, technical specifications, and management protocols for biogas digesters are available and used;
(iii) Solutions (such as underground systems and overhead glasshouses) for biogas production during winter are incorporated that minimize heat loss at these times when biogas digesters are less effective;
(iv) Standards for quality of product and discharge criterion for biogas slurry used for fertilizer via irrigation and methods for fertilization are met;
(v) Installation of equipment (generators) for and initiation of energy systems powered by biogas and energy efficient systems; and
(vi) Adequate training for staff using the biogas facilities, including monitoring, quality checking and examination, servicing, and marketing system should be established, which lays the foundation for the commercialization operation of biogas construction and application.
For organic fertilizer production:
(i) Technical designs of fertilizer processing plants are in line with technical and product quality standards;
(ii) Flow and volume of raw materials for fertilizer processing are managed for efficiency and effective operation; and
(iii) Fertilizer produced meets the technical and quality of product standards for organic fertilizer products.

Table 2: Waste Management and Energy Saving Technologies to be Applied by the Nine Project Participating Enterprises

<table>
<thead>
<tr>
<th>Built facilities for wastewater interception and treatment</th>
<th>Atani</th>
<th>Dadi</th>
<th>Donghan</th>
<th>Fenghua</th>
<th>Kerchin</th>
<th>Mayuan</th>
<th>Niuniu</th>
<th>Sangao</th>
<th>Hengtianran</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biogas generation for power generation and heating on-site</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Biogas generation for farmer households only</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Processing of manure waste to organic fertilizer (on-site)</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Manure waste used directly off-site</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Greenhouses</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
</tbody>
</table>

49. The major activities for output 2 are the following:

For the environment:
(i) Have an appropriate livestock production and processing waste management system in place;
(ii) Ensure animal raising practices do not adversely impact the local environment;
(iii) Design, install, and/or upgrade biogas systems that operate efficiently year round;
(iv) Support organic fertilizer production with new facilities and/or upgrading; and
(v) Train all people appropriately.

F. Capacity Development

1. Capacity Building

50. This chapter focuses on training and capacity development at the PPEs and HAHB, municipal and county line officials involved in supporting environmental sustainable livestock production and processing at the PPEs. As new technologies, equipment and systems are introduced under the project, SOPs based on best practice (GAPs and GMPs) will be prepared and/or updated for each PPE food chain and included in induction, refresher and specialist training for all staff and farming households. Capacity building (technical assistance and training) will be required from the project to help ensure benefits and results are sustainably delivered (see also Chapter E).
a. Training Needs

51. The following project training needs were identified to build on existing AHB and PPE training activities aimed at embedding and sustaining project investments and intervention technologies and best practice.

(i) Managers and/or supervisors. Generic training for all PPEs involving (i) new technologies and systems to be introduced by the project, (ii) exchange visits and study tours to learn from other similar PPEs, and (iii) preparation of the PPE’s LEIPs with updated and tailored SOPs to ensure best practice national and/or international GAPs and GMPs are followed;

(ii) Technicians. Basic training for all PPEs involving (i) new technologies and equipment; (ii) trainers’ training; and (iii) how to design and implement SOPs for improved food quality and safety, biosecurity, and eco-sustainability;

(iii) Farm hands and plant operators. Tailored PPE-specific training involving regular and/or refresher motivational training in (i) environmental livestock production and processing SOPs and working practices, and (ii) PPE culture and loyalty; and

(iv) Farming households. Tailored PPE-specific training on environmental livestock farming and processing system best practices which include (i) productive animal management; (ii) manure and water management, (iii) animal health and welfare; and (iii) feed raw material production using organics fertilizer, company culture, and loyalty.

52. It is clear that the PPEs visited are enthusiastic to learn about and, where appropriate, introduce improved technologies and practices that will achieve (i) increased productivity and profitability, (ii) better social conditions for staff and farmers, and (iii) improved environmental sustainability.

b. Proposed Program

53. Capacity building will be geared towards environmental sustainable livestock production and processing PPE value chain technologies, practices and systems. Some generic training is proposed for PPE managers and technicians (who will be trainers). The training will be delivered through existing AHB and PPE training units for sustainability. At least one third of trainers and trainees will be women.

54. Some PPEs are very experienced and highly regarded livestock enterprises in Henan and in the PRC. They include (i) Kerchin PPE (cattle), (ii) Muyuan PPE (pigs) and (iii) Sangao PPE (poultry) and may be used for PPE to PPE learning and knowledge-sharing. The Muyuan PPE’s biosecurity and organic fertilizer production practices are especially noteworthy. The Donghan PPE’s cooperative farmer-company system is also noteworthy in directly involving many farming households, as are the Fenghua and Niuniu PPEs’ systems. Donghan PPE also pursues a policy of employing female household heads.

55. The program will likely include following livestock production and processing modules. Other modules will be determined following the updated training needs assessment.

- Module 1: Trainers’ training, including preparing PPE’s LEIPs, SOPs, and Guidelines;
- Module 2: Energy and water conserving livestock production (cattle, pig, poultry);
• Module 3: Energy- and water-conserving livestock slaughter and processing (cattle, pig, poultry);
• Module 4: Animal disease prevention and biosecurity, including safe use of livestock medicines and chemicals;
• Module 5: Human and animal welfare;
• Module 6: Livestock waste and biogas management;
• Module 7: Safe production and use of organic fertilizers in food and feed crop production and livestock production (see Appendix 15);
• Module 8: Market access for farming households and village groups; and
• Module 9: PPE to PPE learning and knowledge sharing field visits.

56. A similar training program is already developed and used by the PMO with local Universities and HAHB under the ongoing World Bank Henan Ecological Livestock Project. Ways and means of leveraging this expertise will be explored. The following training modules were already developed and are especially relevant for the PPE farmhands and farmers: (i) understanding of environmental impact, (ii) nutrient balance and feed mixing technology, and (iii) farm production management.

57. Valuable learning may also be gained from the ongoing ADB project, the Integrated Renewable Biomass Energy Development Project, currently being implemented in Henan Province, particularly the studies on the efficiency of biogas plants and biogas uses in cold regions.

2. Consulting Services
   a. Technical assistance

58. Technical assistance will be required to support delivery of output 2. This will include international expertise in environmental sustainable: (i) livestock production, and (ii) livestock slaughtering and processing; complemented by national expertise in (a) manure handling, organic fertilizer production, and nutrient recycling; (b) clean energy and biogas production and use; and (c) livestock product distribution, marketing, and business planning.

   b. Terms of reference

59. Detailed terms of reference (TOR) for each consultant will be finalized at the start of project implementation. In summary the consultants will collectively do the following:
   (i) Review current and planned PPE systems, practices, and capacity-building needs;
   (ii) For each PPE investment, prepare a fully-costed project LEIP (with bidding documents and milestones as appropriate) to include (i) design, civil works, and equipment specification and procurement; (ii) installation and commissioning; and (iii) capacity building and integration in to the business;
   (iii) Each LEIP to include a capacity building program that clearly provides the business proposition for sustainable and safe biogas production and use and/or organic fertilizer utilization and marketing;
   (iv) Support procurement, installation, and commissioning of the PPE investments, especially for the smaller PPEs, to safeguard expected economic, social, and environmental benefits and sustainability;
Advise AHBs and the PPEs on the design and introduction of appropriate technologies and practices (GAPs) for all aspects of livestock production, including (a) breeding and fattening, (b) balanced feeding for improved productivity and GHG emission reduction, (c) animal health and biosecurity, (d) human and animal welfare, (e) beneficiary farmer and/or farming household and gender participation, and (f) integration of the practices into the PPE business;

Advise AHBs and the PPEs on the design and introduction of appropriate technologies and practices (GAPs) for all aspects of livestock production, including (a) breeding and fattening, (b) balanced feeding for improved productivity and GHG emission reduction, (c) animal health and biosecurity, (d) human and animal welfare, (e) beneficiary farmer and/or farming household and gender participation, and (f) integration of the practices into the PPE business;

Advise AHBs and the PPEs on the design and introduction of appropriate technologies and practices (GMPs) for all aspects of livestock processing, including (a) humane slaughter; (b) meat processing; (c) meat storage, distribution, and marketing; (d) meet quality, safety, and traceability; (e) staff health and safety; and (f) integration of the practices into the PPE business;

Advise AHBs and the PPEs on the design and introduction of appropriate technologies and practices (GMPs) for all aspects of livestock processing, including (a) humane slaughter; (b) meat processing; (c) meat storage, distribution, and marketing; (d) meet quality, safety, and traceability; (e) staff health and safety; and (f) integration of the practices into the PPE business;

Advise AHBs and the PPEs on the design and introduction of appropriate environmental sustainable energy and water saving and soil nutrient recycling technologies and practices (GAPs and GMPs) for (a) livestock manure and waste handing, (b) biogas production and use, (c) organic fertilizer production and use, (d) design and introduction of a performance monitoring program for energy and water saving, and (e) integration of the practices into the PPE business;

Assist the PPEs to operationalize the investments, including developing and/or updating and documenting tailored SOPs for each new enterprise production and processing investment, consistent with adopted GAPs and GMPs, and harmonized with output 1 food safety SOPs;

Develop a tailored capacity building program based on the outline contained in section F-1 above and provide training support and materials; and

Support the PMO to (a) evaluate project results and make recommendations to further advance environmentally sustainable livestock production and processing at each PPE, (b) organize a review meeting for all PPEs and key stakeholders to distill and validate project experiences and learnings, (c) update each PPE’s LEIP based on project learnings, and (d) synthesize the PPE learnings into a resource (knowledge) book to be published in Chinese and English provisionally titled “Environmental sustainable livestock production and processing systems in Henan.”

3. Knowledge Product

During the project, each PPE will introduce and document SOPs tailored to its own livestock production and processing business model and national (and international) regulations, standards GAPs, and GMPs.

In project year 5, the PMO will organize a meeting for all PPEs and key stakeholders to distill and validate project experience and leaning. A key outputs of the meeting will be a published best practice “Environmental sustainable livestock production and processing systems in Henan” resource book to be produced by HAHB, focusing on animal waste management, energy and water conservation, GHG emission, and animal health and welfare management, in the context of efficient and profitable livestock food chains. The resource book will be used to share the PPE learning and knowledge. The target audience will be other livestock enterprises in Henan Province and further afield in the PRC, aiming to produce environmental sustainable livestock products that are affordable and safe.
### Table 3: Key PPE Project Loan Components—Environmentally Sustainable Livestock Production and Processing

<table>
<thead>
<tr>
<th>#</th>
<th>Enterprise</th>
<th>Present</th>
<th>New</th>
<th>Added Capacity</th>
<th>Main Equipment and Installations</th>
<th>Local Farming Households (HHs) Benefitting and Providing Inputs</th>
</tr>
</thead>
</table>
| (1) | Henan Afanti Food Co., Ltd. | 1. Cattle fattening farm (3,000 head/year)  
2. Live animal marketing | 1. Beef products processing plant  
2. Upgraded animal health, welfare, and biosecurity  
3. Wastewater treatment facilities  
4. Product monitoring and inspection system | 1. 20,000 tons/year (of which halal quick-freeze meat products 10,000 tons/year and beef products 10,000 tons/year) | 1. Beef processing equipment and buildings  
2. A/O waste treatment system | 80 job opportunities  
1,000 to 2,000 HHs |
| (2) | Henan Dadi Animal Husbandry Co., Ltd. | 1. Pig farm (14,000 pigs/year)  
2. Old biogas plant | 1. All in-all out farrow-finished pig system  
2. Pig farm  
3. Existing pig farm converted to sow/nursery  
4. Upgraded animal health, welfare, and biosecurity  
5. Biogas plant  
6. Organic fertilizer plant  
7. Product monitoring and inspection system | 1. 80,000 finished pigs/year  
2. 2 biogas units at 600 m³ capacity each  
3. Organic fertilizer 8,000 tons/year | 1. Pig finishing unit with modern feeding/watering  
2. Climate and/or ventilation control system  
3. Energy-saving boiler  
4. 2 USR biogas fermenters with ancillary kit  
5. 80 kWh bio-generator | 91 job opportunities  
2,140 HHs |
| (3) | Luoyang Donghan Poultry Co., Ltd. | 1. Hatchery (16,000 day)  
2. 33 duck farms  
3. 5 million eggs/year  
4. Organic fertilizer production  
5. Feed mill (60,000 tons/year under construction)  
6. Slaughter and/or packing units (50,000 ducks/day)  
7. Waste treated and discharged to town system | 1. 4 x duck breeding farms  
2. 1 x hatchery  
3. Cold storage plant  
4. Upgraded animal health, welfare, and biosecurity  
5. Waste water treatment facilities  
6. New food processing plant  
7. Product monitoring and inspection system | 1. Annual output of eggs over 55 million  
2. Hatchery capacity 20 million ducklings/year  
3. 3,100 tons of cold storage capacity  
4. Food processing 4,000 tons/year | 1. Modern duck hatchery equipment and/or supplies  
2. Duck finishing with modern feeding and/or watering  
3. Wastewater underground sedimentation (MBR) tank. | 479 job opportunities  
30,000 HHs |
<table>
<thead>
<tr>
<th>#</th>
<th>Enterprise</th>
<th>Present</th>
<th>New</th>
<th>Added Capacity</th>
<th>Main Equipment and Installations</th>
<th>Direct</th>
<th>Indirect</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.</td>
<td>Henan Fenghua Breeding Share Co., Ltd.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>300 job opportunities</td>
<td>20,000 HHS</td>
</tr>
<tr>
<td>6.</td>
<td>Henan Hengtianran Pasture Farming Co., Ltd.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>30 new jobs</td>
<td>30,000 HHS</td>
</tr>
<tr>
<td>7.</td>
<td>Kerchin Cattle Industry Nanyang Co., Ltd.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>80 new jobs</td>
<td>40,000 HHS</td>
</tr>
<tr>
<td>#</td>
<td>Enterprise</td>
<td>Present</td>
<td>New</td>
<td>Added Capacity</td>
<td>Main Equipment and Installations</td>
<td>Local Farming Households (HHs) Benefiting and Providing Inputs</td>
<td></td>
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</tr>
<tr>
<td>8</td>
<td>Muyuan Foodstuff Co., Ltd.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Pig sow, farrowing, adn finishing farms (11 million pigs/year)</td>
<td>1. Sow breeding farm</td>
<td>1. 10,000 breeding sows</td>
<td></td>
<td>82 new jobs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Feed mills</td>
<td>2. Pig finishing farms</td>
<td>2. 50,000 finished pigs/year</td>
<td>1. Sow breeding and pig finishing units with modern feeding and watering</td>
<td>30,000 HHs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Slaughter and/or processing units (1 million pigs/year)</td>
<td>3. Upgraded animal health, welfare, and biosecurity</td>
<td>3. Three biogas units</td>
<td>2 x 800 m³ USAB digesters</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Biogas production</td>
<td>4. Five new biogas plants</td>
<td>4. 12,000 tons/year of organic fertilizer</td>
<td>1 x 1000 m³ USAB digester</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Organic fertilizer production</td>
<td>5. New organic fertilizer processing plant</td>
<td></td>
<td>40 kWh bio-generator</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Product testing and basic traceability system</td>
<td>6. Product monitoring and inspection system</td>
<td></td>
<td>5. 30,000 m³ oxidation pond</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Henan Niuniu Animal Husbandry Co., Ltd.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Cattle fattening farm (4,000 heads/year)</td>
<td>1. Cattle fattening</td>
<td>1. 5,000 cattle inventory/year</td>
<td></td>
<td>75 job opportunities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Live animal marketing</td>
<td>2. Upgraded animal health, welfare, and biosecurity</td>
<td>2. 2 biodigesters, each 600 m³ capacity</td>
<td>1. Farm equipment and buildings with fattening sheds</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td>3. Manure treatment facility, including biogas and organic fertilizer</td>
<td>3. 15,000 tons/year of organic fertilizer</td>
<td>2. Feed processing unit with silage silos, chaff cutter, TMR mobile mixer, water storage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td>4. Greenhouse facilities</td>
<td></td>
<td>3. Plug flow 700 m³ digester</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td>5. Product monitoring and inspection system</td>
<td></td>
<td>4. 40 kWh bio-generator</td>
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</tr>
<tr>
<td>6.</td>
<td></td>
<td></td>
<td></td>
<td>5. 500 m² solar array</td>
<td></td>
<td></td>
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<tr>
<td>7.</td>
<td></td>
<td></td>
<td></td>
<td>6. Greenhouse</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>8.</td>
<td></td>
<td></td>
<td></td>
<td>7. Organic fertilizer processing equipment and civil works</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Hatchery unit (33 million chicks/year)</td>
<td>1. Chicken breeding farm</td>
<td>1. Breeding chicken inventory of 300,000</td>
<td></td>
<td>220 job opportunities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>3 breeding farms (280,000 birds)</td>
<td>2. Feed mill plant</td>
<td>2. Annual sales of fertilized eggs 56.4 million</td>
<td>1. New hatchery equipment and buildings</td>
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</tr>
<tr>
<td>3.</td>
<td>Layer units (5 million eggs/year)</td>
<td>3. Upgraded animal health, welfare, and biosecurity</td>
<td>3. Feed mill capacity 200,000 tons/year</td>
<td>2. Feed mill equipment and building</td>
<td></td>
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</tr>
<tr>
<td>5.</td>
<td>Feed mill (80,000 tons/year)</td>
<td>5. Product monitoring and inspection system</td>
<td>5. Wastewater treatment system</td>
<td>4. Underground fertilizer equipment</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>6.</td>
<td>Product testing and basic traceability system</td>
<td></td>
<td></td>
<td>1. Underground sedimentation (MBR) tank</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* See Appendix 14 for details.
* Funded separately.