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POTENTIAL APPLICATION OF CIRCULAR ECONOMY CONCEPT IN LIVESTOCK PRODUCTION

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Executive Summary

A circular economy (CE) is an economic model that aims to decouple economic growth and the consumption of resources. CE will support the development of a sustainable economy that is competitive; efficient use of resources through design out waste and pollution; keep products, components and materials at their highest value and in use; and regenerate natural system. Discharges and waste are to be reduced from design stage of livestock production, followed by good management practices to eliminate wastage of feed resources and poor feed conversion and losses due to diseases, mortality and inferior products, while optimising production using suitable technologies.

Currently, there has been many ways and innovative initiatives in making the transition from 'linear' to 'circular' in the livestock industry in Malaysia. This publication aims to address the potential application of circular economy in livestock production, thereby allowing farmers to think about sustainability and circularity of their practices in their production and how they are able to move from linear to circular.

About

Malaysia Productivity Corporation (MPC)

MPC Sustainability Project aims to facilitate industries on sustainable practices towards achieving global Sustainable Development Goals (SDGs) through adoption of circular economic model.

More information, please contact: sustainability@mpc.gov.my

KEMENTERIAN
PERDAGANGAN ANTARABANGSA DAN INDUSTRI

Malaysia Department of Veterinary Services (DVS)

DVS aims to provide quality veterinary services as an assurance for public health and sustainable livestock industry for the sake of human welfare. One of DVS objective is to encourage sustainable livestock production and value-added industry.

More information on DVS, please visit website www.dvs.gov.my

KEMENTERIAN
PERTANIAN DAN INDUSTRI MAKANAN

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INTRODUCTION

OVERVIEW OF THE LIVESTOCK INDUSTRY

The livestock sub-sector contributed 14.9% (RM14.8 billion) to the Gross Domestic Product (GDP) of agriculture sector in 2018 (DOSM, 2018).The total ex-farm value of livestock production was RM 22.84 billion in 2018 (DVF, 2020). The poultry industry contributed 74.7% to this value, producing RM11.69 billion meat and RM 5.37 billion eggs while ruminants contributed 8.26% with a combined ex-farm value of RM1.89 billion from beef, mutton, hide and milk.

Ruminant livestock farming is mainly by smallholders. The capital intensive and slow return of ruminant farming are not favoured to be run commercially despite the emphasis and priority given by the Government. The Self-sufficiency Level (SSL) for beef and mutton in 2018 were 22.88% and 10.95% respectively while milk was 61.27%. However, the policy on milk production is to fulfil liquid milk only. The per capita consumption of ruminant products in 2018 were 6.3kg and 1.3kg for beef and mutton respectively while liquid milk was 1.9 litres.

CONCEPT OF SUSTAINABILITY AND CIRCULARITY IN THE LIVESTOCK INDUSTRY

Sustainable development has been defined as "development that meets the environmental, social and economic needs of the present without compromising the ability of future generations to meet their own needs". Most of the current studies on sustainability focus on one albeit important factor, the environment. Equally important factors on sustainability are the need to ensure food and nutritional security for the growing population, in a socially or culturally acceptable manner, that ensures its accessibility, affordability, and safety.

Circular Economy (CE) is an economic tool that works on a closed-loop system of reducing, reuse and recycle (3R) to allow for efficient utilisation of the resources through repair, remanufacturing, refurbishment and recycling. CE develops a sustainable economy that is competitive, efficient resource use through design out waste and pollution; keep products, components and materials at their highest value and in use; and regenerate natural system. Discharges and waste are to be reduced from design stage of livestock production, followed by good management practices to eliminate wastage of feed resources and poor feed conversion and losses due to diseases, mortality and inferior products, while optimising production using suitable technologies.

Circular livestock production is also an ecological concept based on the principle of optimising the use of all biomass, aimed at reducing both resource use and discharges into the environment. Farm animals are to be used for what they are good at, converting by-products and grass resources into valuable food and manure. By converting these feedstuffs, farm animals recycle biomass and nutrients into the food system; they contribute significantly to human food supply, while at the same time reducing the environmental impact.

CE in livestock production system implies reducing the amount of waste generated in the production system, through the utilisation of agriculture and agro-industrial by-products and waste, and nutrient recycling by farmers and processors. Implementation of CE has to be economically beneficial to stakeholders involved. At the same time, circularity could also be improved by changes in diet toward more diverse and resource-efficient food patterns.

LIVESTOCK
INDUSTRY ECO-SYSTEM

VALUE CHAIN AND ACTIVITIES

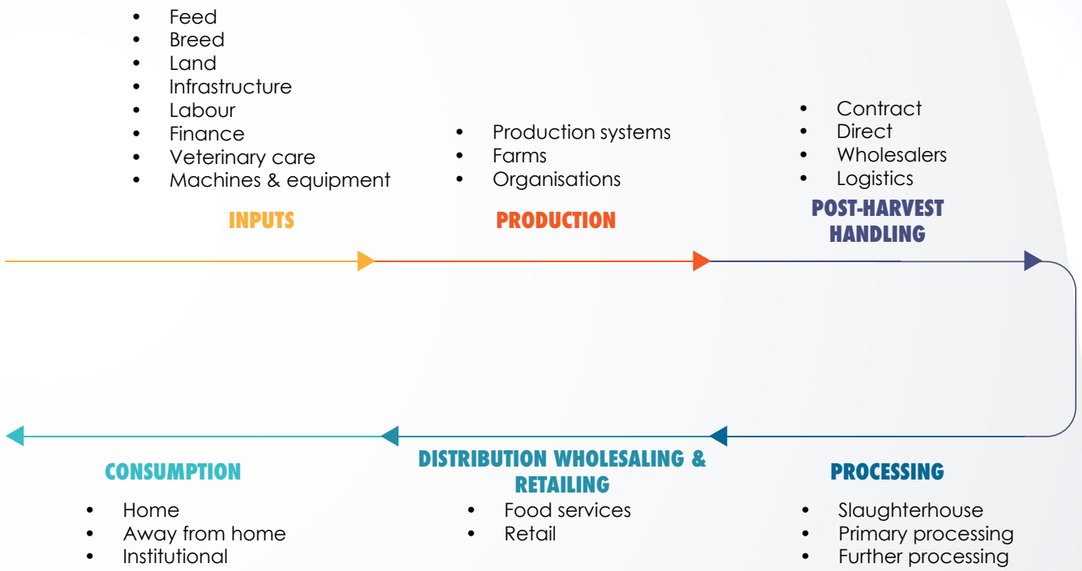


Figure 1: Livestock Value Chain

The conventional livestock value chain in general is linear, starting from provision of farming inputs; livestock farming, harvesting & post harvesting activities; primary processing and further processing; distribution, wholesaling and retailing; and consumption (Figure 1). Livestock products such as milk, beef, and mutton are mainly imported. Some poultry products are also imported for value adding by processors. Thus, the value chain for some of these products begins from the exporting countries. Along the value chain are by-products that may become input to other industries besides wastage and waste that have to be treated or disposed.

PRODUCTION INPUTS

Animal feed

Animal feed is the major cost (70-90%) in livestock production. Feed ingredients which are mainly imported ingredients made up about 85% while the remaining about 15% were local ingredients. Feed milling, manufactured animal feed using imported cereals especially corn and soya bean; agro-industrial by-products or co- products such as wheat pollard, soya bean meal, palm kernel meal and rice bran; with addition of minerals, vitamins and additives to complete the nutrient requirement for different categories of livestock.

Breeding and Growing Stocks

An important input in livestock production is breeding and growing stock. In poultry production for eggs and poultry meat, specialisation exists where poultry breeders farmed poultry parent stocks (PS) to produce day-old-chicks (DOC) for broiler or layer farms. Broiler farms usually practise all-in-all-out production system. In dairy, beef cow-calf, goats, sheep and swine farms, initial breeding stock are supplied by local suppliers or importers and become the initial stock for breeding. Dairy heifers, beef cattle, goats and sheep for breeding were imported mainly from Australia and New Zealand.

Land

Traditionally, land naturally populated with native grasses such as riverbanks, road reserves and irrigation bunds are used by smallholders to raise cattle, buffaloes, goats and sheep. In paddy farming areas, cattle and buffaloes are often raised, fed with paddy straw or left out in the fields after harvesting seasons. Rubber and oil palm plantations are also being used as grazing ground for ruminants.

There are also land specially designated as livestock development projects such as Livestock Breeding Centres in Terengganu, Pahang, Johor, Negeri Sembilan and Perak; National Boer Breeding Centre in Perak; National Feedlot Centre (currently inactive) and Pig Farming Area in Sarawak.

Infrastructure

Closed-housed system for poultry, barns for commercial dairy farm and cattle feedlots are designed to last longer, easier to maintain and repair with respect to traditional ones. The design must also meet standards for good husbandry practices including biosecurity measures and animal welfare. Besides providing good animal housing, machines and equipment such evaporative cooling system, tunnel ventilation, automatic feeding and drinking systems are also installed to provide comfort, ease in managing the livestock with high efficiency and productivity level.

Machineries and equipment

An integral part of livestock production is farm machineries and equipment. Some companies provide farm design, supervision of construction, supply of machines and equipment for livestock farm development (Figure 2). Regular maintenance, calibration and repair services are also provided as part of the package. Examples of common machineries used in cattle farms are tractors, forage harvesters, fodder chopper, feed mixer for Total Mixed Ration (TMR), milking machine, milk cooling and bulk storage facilities (Figure 3).

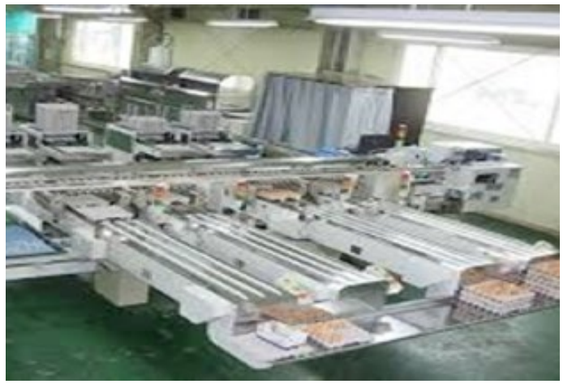


Figure 2: Egg Grading

Figure 3: Feeding with TMR machine

Labour

The livestock industry especially poultry along its value chain is experiencing labour shortage, more so during the current Covid-19 pandemic. Even before this, the industry has been dependent on foreign workers, perhaps due to local workers who have other choices that suit their requirements. The industry has been changing by using technology, not only to increase productivity but also to reduce labour requirement.

This is evident today with the advent of closed-house system and automation in feeding, the requirement of labour has reduced from 1:10,000 birds about 15-20 years ago to 1:20,000 birds or more currently practised in commercial poultry farms.

Services

Animal health and technical services are an important component in livestock production. In an integrated broiler production, integrators provide animal health and technical services to contract farms. Farms are closely monitored and evaluated to ensure standard operating procedures (SOPs) are followed. Farmers especially smallholders are given farm advisory and animal health services by the DVS. For large commercial farms they have their in-house teams that provide veterinary health care and monitoring farm bio-security integrity.

Alternatively, private veterinarians are also engaged by commercial farms to provide such services. Some feed mills also provide after sales advisory services especially to regular and volume purchasers. Other services required in livestock production are common services like other industries such as logistics, financial and marketing services. These services are shared with other farmers in organisations such as cooperatives and associations or provided by companies offering such services.

LIVESTOCK PRODUCTION

The poultry industry is a commercialised and industrialised system of production aiming for high efficiency and productivity. This was achieved through years of development based on science and technology especially in animal breeding and genetics. Systematic breeding commercially started at the level of great grandparent stock (GGPS), producing chicks designated to be grandparent stocks (GPS) that later produce chicks grown to be parent stocks (PS). The PS becomes the commercial producers of day-old chicks (DOC) for final stage of commercial broiler production for human consumption. The same hierarchy is also practised by the poultry layer industry for eggs production.

In a vertical integration system of poultry production, an integrator company supplies DOC, feed and medication to contract farms whose role is to raise the DOC efficiently based on the SOPs provided and monitored by the integrator. The broilers are purchased back and sent for slaughter by the integrator at the end of the rearing period. Currently more than 80% of broiler produced in the country is by this production system. Unlike the integrated system, an independent poultry farmer has to organise his production inputs and marketing the chicken by himself.

Another aspect of integrated farming is the crop-livestock production system. In this system, ruminant livestock are raised in oil palm or rubber plantation. Structured or controlled grazing is practised in designated areas and moved to another area when vegetation under the trees is reduced. With the presence of cattle or goats/sheep the requirement for manual and chemical weeding are much reduced, in addition to the trees getting organic fertiliser from the livestock dung and urine.

Similar to broiler poultry farming, system is intensive beef cattle farming in feedlots. This is the finishing stage of beef cattle production where feeders are purchased for intensive rearing period of around 100 days and then slaughtered. The feeder cattle are purchased from local cow-calf farmers or imported. The feeding rations are mainly crop residues or agro-industrial by-products such as PKM.

The dairy cattle production system involves breeding of dairy cattle, in an intensive system where animals are kept in barns and fed with fodder and concentrates. Milk are produced when cows calved down and cows are milked twice daily for up to 300 days. Cows are rebred to get them pregnant, calved down and be in the next lactation, ideally in a year. The female calves are reared in the farm and selected heifers are used for replacement of old cows or for herd expansion. Other heifers and male calves are sold and moved out of the system.

Swine farming also practises intensive system involving breeding and production of pokers for slaughter as primary products. For goat or sheep production the semi- intensive system is normally practised. The animals are let grazing during the day and kept in house at night, where additional feed is given. Breeding is usually naturally using bucks/ rams.

POST-HARVEST HANDLING

Livestock and livestock products are highly perishable and losses may occur due to poor handling, from farm to processing establishments. In dairy production milk needs to be kept at 0C – 4C to maintain quality especially preventing bacterial multiplication. Thus, milk has to be kept in cold chain from farm to the factory. In some places the government provides cooling tanks for storage at collection centres and insulated tankers for bulk transportation.

For broiler poultry and pig farming, services for harvesting (or catching), loading into crates, transportation to slaughterhouses and unloading are provided by specialised service providers. Eggs produced at farms are graded and packed in trays ready to be collected and delivered to retailers by wholesalers.

Ruminants for slaughter are usually handled by middlemen or butchers who purchase and transport the animals to a holding yard or directly to the abattoirs. Cattle and goats/sheep transportation are not specialised and being carried using normal open cargo trucks.

PROCESSING

Primary processing of meat livestock involves slaughtering at abattoirs. For poultry most slaughterhouses are privately owned by poultry integrator companies. In modern slaughterhouses stringent quality assurance system together with Halal system are practised. For ruminant slaughter, public abattoirs are provided and run by DVS. Products from primary processing of meat are usually sold at markets as whole-bird, carcass or meat or at the most some special cuts. Some are further processed and value added into ready-to-cook products and popular products such as beef patties, sausages and nuggets.

Locally produced milk is mainly processed by processing plants into ready to drink pasteurised and homogenised milk, yoghurt and yoghurt drinks. There are also enterprises that process "dadih" and cheese from fresh milk. Some factories have also started producing UHT milk from local fresh milk to enable them market this long shelve life milk.

DISTRIBUTION, WHOLESALING & RETAILING

Handling of poultry meat and dairy products have to be maintained at low temperature; thus, the distribution, wholesaling and retailing are mainly provided by service providers that have the transport, storage and handling facilities. The wholesalers market the products to retailers and bulk purchasers from institutions or food services. Carcasses from the abattoir are usually marketed by retailers at the wet market, farmers market and night markets.

CONSUMPTION

A local study on beef consumption showed that 90.3% of consumers bought not more than 2 kg of fresh local beef and frozen imported buffalo meat in a month and 48.2% consumed 1 kg to 2 kg monthly per household. 78.5% of the consumers preferred fresh local beef compared to frozen imported buffalo meat and only 66.0% frequently bought the meat. According to OECD, the average consumption of meat per capita worldwide and in Malaysia in 2019 are as in Table 1.

Meat	Malaysia	World	Highest
Poultry meat	48.7	14.8	64.0
Beef	5.3	6.4	38.0
Lamb/mutton	1.0	1.8	8.2

Table 1: Meat Consumption Per Capita kg/yr/capita

The data showed Malaysia was among the highest poultry meat consumer, above the world average while beef and mutton/lamb consumption was below the world average. Consumption of meat occurs not only at home but also a big percentage outside such as food outlets, institutions and gatherings or ceremonies.

WASTE IN THE LIVESTOCK VALUE CHAIN

Waste in the livestock value chain are mainly produce at farms and slaughterhouses. Intensive livestock production produces animal waste, if not properly treated may cause hazards to the environment; emission of gases such as methane and ammonia causing air pollution. A study conducted on 22 selected cattle farms in Peninsular Malaysia has found that, among smallholder farmers, anaerobic lagoon was the most practised (41%), followed by solid storage (27%) and daily spread (23%) (12).

Wastes from slaughterhouses are mainly blood, fatty tissues and intestinal contents. Poultry slaughterhouses also produce feathers, some processed into feather meal for use as animal feed. The volume of by-products from ruminant slaughterhouse are small, the solid waste is generally collected and disposed for composting while the blood goes to waste water treatment.

CIRCULAR ECONOMY PRACTICES IN THE CURRENT VALUE CHAIN

Source	CE Practices/Elements
Pig farms	• Biogas from pig waste and slurry • Use of treated waste water for washing
Poultry farms	• Organic fertiliser from processed poultry litter
Cattle feedlot farms	• Organic fertiliser from composting of dungs & feed waste • Water from washing of barns in dairy farm for watering pasture
Poultry slaughterhouses	• Feather meal from hydrolysis of feathers for animal feed • Internal organs for aqua feed
Dairy farms	• Smart farming to increase efficiency of resource use • Water from washing of barns in dairy farm for watering pasture
Black Soldier Fly (BSF) farm	• Dried BSF for animal feed • Composted feed as fertilisers
Ruminant integration with oil palm or rubber plantation	• Recycling of nutrients • Reduce weedicide & fertiliser • Use of low-cost feed resources
Livestock agroecological (organic) farming	• Use of locally available plant and animal natural resources for feed. • Bird catching and logistics services to transport chicken to slaughterhouse
Poultry farms Dairy Development Centres	• Shared cooling tanks and refrigerated tankers for milk transport to factories

WASTE IN THE LIVESTOCK VALUE CHAIN

POTENTIAL CIRCULAR ECONOMY PRACTICES IN THE LIVESTOCK PRODUCTION VALUE CHAIN

Land
- Land with native grasses
- Paddy areas
- Grazing reserves
- Land under tree-crop plantation
- Land development for livestock
- Agriculture land for livestock

Labour

Infrastructure
- Accessibility (road)
- Water supply, irrigation
- Energy

Services
- Farm design
- Supply, maintenance & repair of machinery & equipment
- Animal health & production (technical)
- Logistics, accounting, finance & marketing

Animal Feed
- Imported – corn, soya bean
- Rice Bran, CPO, PKC/PKE
- Protein Meals (vegetable protein, animal protein)
- Fats & Oils
- Minerals & Vitamins
- Feed Additives
  Dried Black Soldier Fly Larvae (BSFL)

Breeds & Growing stocks
- Breeders
- Feeder cattle
- Day Old Chick (DOC)

Chemicals & drugs

REUSE WATER	REDUCE WEEDICIDE & FERTILIZER USED	REDUCE ENERGY USED	RECYCLE OF NUTRIENT
Water for washing of barns is used for watering pasture in dairy & beef feedlot farms Use of treated wastewater for washing	Cattle or goats/sheep rearing under tree-crop plantation, the requirement for manual & chemical weeding reduced	Use of renewable energy such as solar, biomass from manure & biogas from farm animal slurry	Ruminant integration with oil palm or rubber plantation Trees get organic fertilizer from dung & urine Livestock waste used to fertilize pasture and crops
1	2	3	4

PRIMARY PROCESSING
- Ruminant carcass and meats cuts
- Beef products (patties, sausages & nuggets)
- Milk drinks (pasteurized, UHT, yoghurt drink)
- Milk products (yoghurt, dadih & cheese)

RECYCLE OF NUTRIENT

REUSE WASTES

DESIGN | INPUTS | LOGISTIC | PRODUCTIONS | POST HARVEST HANDLING | LOGISTIC | PROCESSING | MARKETING | CONSUMER

- Meats
- Milks
- Eggs

- Contract
- Direct
- Wholesalers
- Logistic

- Slaughterhouse
- Primary processing
- Further processing

- Food services/ Institution
- Retail

- Home
- Away from home
- Institutional

MARKET

5	6	7	8
REUSE WASTES	MINIMIZE WASTES	ORGANIC FERTILIZER	RECYCLE OF NUTRIENT

ORGANIC FERTILIZER | RECYCLE OF NUTRIENT

OPTIMIZE INPUTS
- Optimum use of land for food production (ruminant under oil palm & rubber plantation)
- Less herbicide & fertilizer use
- Paddy straw based ration for cattle
- Use of crop residues (corn stover) and agro-industrial by-products (palm kernel meal) as animal feed

OPTIMIZE PRODUCTION
- Integrated Crop- Livestock system
  - Cattle, sheep and goat production under oil palm plantations
  - Crop-livestock-fish farming in a plot of land
- Application of technology in intensive livestock production
  - Knowledge-based management Precision farming
  - Closed- house production system
  - Farm automation & mechanization
- Preventive veterinary medicine & GAHP to reduce wastage from mortality or inferior quality livestock products

Pig farm	Dairy Farm	Poultry farm	Cattle feedlots farms	Ruminant integration with oil palm or rubber plantation
Biogas & slurry Treated waste water for washing	Smart farming to increase efficiency of resources use Water from washing of barns in dairy farm for watering pasture	Organic fertilizer from processed poultry litter	Organic fertilizer from compositing of dungs & feed waste Water from washing of barns in dairy farm for watering pasture	Recycling of nutrients Reduce weedicide & fertilizer Use of low-cost feed resources

INDUSTRY PLAYERS, GOVERNMENT AGENCIES, ACADEMIA AND INDUSTRY ASSOCIATIONS

Farmers

The number of farmers in Peninsular Malaysia in 2018 was 41,885, majority of them (38,856 or 92.8%) are under the Ruminant category. Detail number of farmers is shown in Table 2.

Category	Livestock Type	No of farmers	Total (%)
RUMINANT	Beef cattle	23,965	38,856 (92.8%)
	Dairy cattle	764	
	Buffalo	1,796	
	Goat	10,407	
	Sheep	1,924	
SWINE	Swine	630	630 (1.5%)
POULTRY	Broiler chicken	1,676	2,399 (5.7%)
	Layer chicken	183	
	Meat duck	101	
	Layer duck	227	
	Meat quail	100	
	Layer quail	26	
	Breeder (broiler chicken)	38	
	Breeder (layer chicken)	4	
	Breeder (meat duck)	9	
	Breeder (layer duck)	1	
	Breeder (meat quail)	34	
TOTAL		41,88	

Table 2: Number of livestock farmers in Peninsular Malaysia in 2018

Although majority are ruminant farmers, they are mainly smallholders practising traditional semi-intensive system or subsistence farming while poultry and swine farming are mainly commercialised intensive production system. However, there are also other categories of poultry such as village chicken which are present in almost every rural house and other poultry species reared by the rural folks.

Commercial poultry are mainly run by integrated companies with upstream and downstream activities with contract farming for grow-out broilers. There are five poultry companies listed on Bursa Malaysia. They are CCK Consolidated Holdings Bhd., Teo Seng Capital Bhd., Lay Hong Bhd., Leong Hup International Bhd., and CAB Cakaran Corp Bhd. Major poultry integrators in Malaysia are;

i. Leong Hup Holdings Bhd.
ii. AYAMAS Food Corporation Sdn. Bhd.
iii. Malayan Flour Mills Bhd. (Dindings Poultry)
iv. CAB Cakaran Corporation Bhd.
v. Lay Hong Bhd.
vi. QL Resources Bhd.
vii. PK Agro-Industrial Products (M) (CP) Sdn Bhd
viii. Hyfresh Group (PTS Group)
ix. D.B.E. Gurney Resources Bhd.
x. Chop Cheong Bee Sdn. Bhd.
xi. CCK Consolidated Holdings Bhd
xii. Teo Seng Capital Bhd.
xiii. PWF Consolidated Bhd.
xiv. LTKM Bhd
xv. TPC Plus Bhd

There are government-linked companies or corporation that are involved in livestock production such as RISDA Livestock Sdn Bhd., Felcra Livestock & Agri Product Sdn Bhd., Ladang Rakyat Terengganu Sdn. Bhd., Selangor Agriculture Development Corporation (PKPS), LKPP Corporation Sdn Bhd., National Farmers Organisation (NAFAS), FELDA and FGV Holdings Berhad.

Feed mills

Malaysia has 44 feed mills producing 4.99 million metric tons of feed annually and production is dominated by broiler feed (2.701 mil metric tons (54.1%)), layer feed (1.443 mil metric tons (28.9%)), swine feed (0.680 mil metric ton (13.6%)), aqua feed (0.150 mil metric tons (3.0%)) and the remaining 0.020 mil metric tons are ruminant feed. The Malaysian Feedmillers Association has a membership of 15 major feedmillers in the country: -

i. Dindings Soya & Multifeed Sdn Bhd
ii. FFM Bhd
iii. Gold Coin Feedmills (M) Sdn Bhd
iv. Sinmah Multifeed (M) Sdn Bhd
v. Ayamas Integrated Poultry Industry Sdn Bhd
vi. Leong Hup Feedmill Sdn Bhd
vii. PK Agro-Industrial Products (M) Sdn Bhd
viii. PTS GoldKist Industries Sdn Bhd
ix. DBE Poultry Sdn Bhd
x. KL Supreme Feedmill Sdn Bhd
xi. Liang Teik Trading Co Sdn Bhd
xii. MFM Feedmill Sdn Bhd
xiii. Ni-On Marketing System Sdn Bhd
xiv. PW Nutrifeed Sdn Bhd
xv. Sykt Ang Hock Stockfeeds Mfg

Government agencies & Industry Associations

The Ministry of Agriculture and Food Industry (MAFI) is a ministry that is responsible for agriculture and agri-food industries including, agritourism, livestock, veterinary services, fisheries, quarantine, inspection, agricultural research, agricultural development, agricultural marketing, pineapple industry, agribusiness, botanical garden and food security. The Department of Veterinary Services (DVS) is often referred to as the custodian of the livestock industry.

The prevention, control and eradication of animal and zoonotic diseases remain as the principal activities of DVS. The development of the animal industry is dependent on the control of diseases to maintain production and productivity levels and ensure the safety of products for public consumption. DVS addresses the need of sanitary and phytosanitary measures by developing specific programmes covering all fields of the animal industry. The DVS is empowered by laws namely the Animal Act 1953, Veterinary Surgeon Act 1974, Feed Act 2009, and Animal Welfare Act 2015. There are also other acts enforced by other departments that the livestock industry has to comply such as the Poison Act 1952, Environmental Quality Act 1974, Food Act 1983 and Malaysian Quarantine and Inspection Service Act 2011. The DVS of each state is also empowered by various enactments legislated by the state legislative assemblies.

The development of the livestock industry requires close cooperation and networking between Ministries, Departments and Agencies & Industry Associations as in Table 3.

Areas of Cooperation & Networking	Department/Agencies/ Industry Associations
Policy	• MAFI • EPU
Research and Development (R & D)	• DVS • MARDI • MPOB • MOH • Public Universities (UPM, UMK)
Livestock project development	• DVS • LPP • FELDA • FELCRA • RISDA
Marketing support	• FAMA • LPP
Training	• DVS • MARDI • Agriculture College • Vocational College • Public Universities • Cooperative Institute
Financing	• AGROBANK • TEKUN
Compliance to regulation and standards	• MAFI • MOH • KPKT • DVS • JAKIM • DOE • District Land Office • Local Authorities
Farmers' Representation	• FLFAM • MFA • MSAP • VAM

Table 3: Inter-Agency & Industry Associations Cooperation related to the Livestock Industry

IMPLEMENTATION OF
CIRCULAR ECONOMY FOR LIVESTOCK INDUSTRY

CIRCULAR ECONOMY AT MACRO LEVEL

Circular interactions among seven players (wheat millers, feedmillers, feed retailers, insect breeders, livestock farmers, poultry processors and consumers) of the circular economy at macro level are created in order to achieve the goal of "zero waste". Wheat milling is the process of grinding whole wheat grain and is converted into flour. The milling process of wheat produces large amount of wheat bran and pollard as by-products. In general, from wheat milling, these by-products make up 25-40 % and are mainly utilised for animal feed, bioethanol production and succinic acid production.

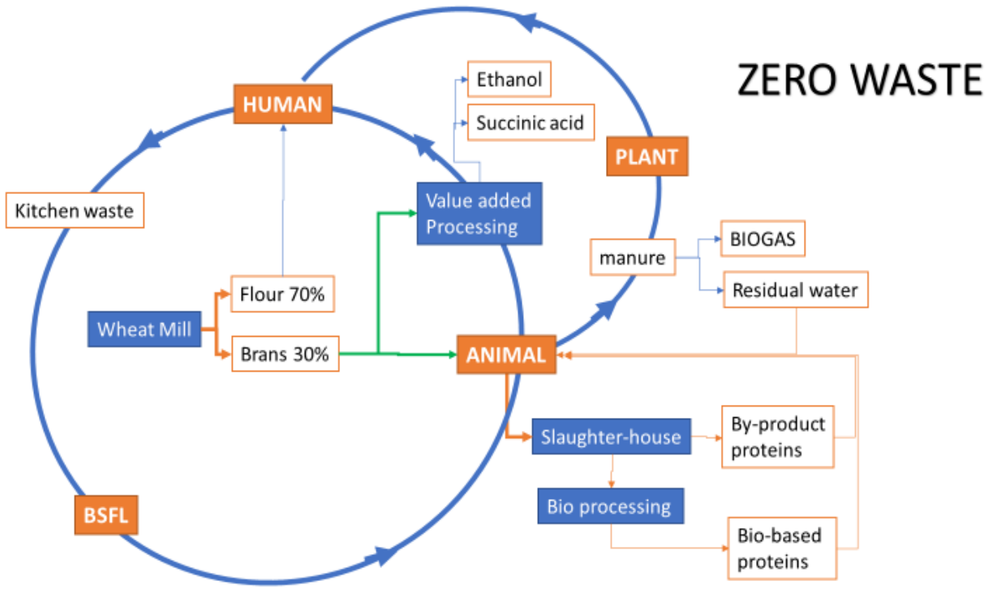


Figure 5: Circular Economy at Macro Level

Another innovation is the use of Black Soldier Fly (BSF) larvae as substitute to protein in broiler feed. Broiler chickens on a diet with black soldier fly larvae may out-perform birds on a commercial feed, and survive longer in the face of a disease. Broiler farmers also enhance the value of poultry dung by composting which becomes much sought-after natural fertiliser for crop farmers. At the consumer end, food waste is one of the suitable materials used as feed for cultivation of BSF.

At poultry slaughterhouses large volumes of waste are generated. These are important resource of industrial protein that could potentially be utilised in various value-added applications, currently either underutilised or being used for relatively low-value products such as animal feed and pet food. However, with advanced processing technology, protein is extracted from proteinaceous waste which is then incorporated into industrial processes to produce value-added bio-based products such as protein-based wood adhesives.

CIRCULAR ECONOMY AT MESO LEVEL (INDUSTRY SYMBIOSIS)

Industrial symbiosis is the process by which wastes or by-products on an industry or industrial process become the raw materials for another as illustrated in the production of animal feed. The milling of grains and oil extraction industry produced by-products or co-products such as rice bran and palm kernel meal, which are good ingredients for animal feed. These are sought by feed mills because of their cheaper prices and good nutrient content.

Currently, large poultry slaughterhouses process feathers into feather meal. The inedible offal is sometimes collected, heat treated and used as fish feed. The unutilised wastes are often discarded along with municipal solid waste.

Although the volume of by-products from scattered ruminant and poultry SME slaughterhouses are not significantly large to generate symbiosis with other industries, there are potentials to be highlighted which may be useful in future. Some of the by-products and waste such as bones, fat, tissues and feathers could be processed as pet foods, gelatine, adhesive and fertilizer industries or further processed for pharmaceutical and cosmetic industries.

CIRCULAR ECONOMY AT MICRO LEVEL

An example of CE at micro level is an integrated crop-livestock system, as in rearing of cattle under oil palm plantation. This system promotes interaction of animals and plants in an agroecology situation that reconciles natural resource management, food production and ecosystem services in the long term.

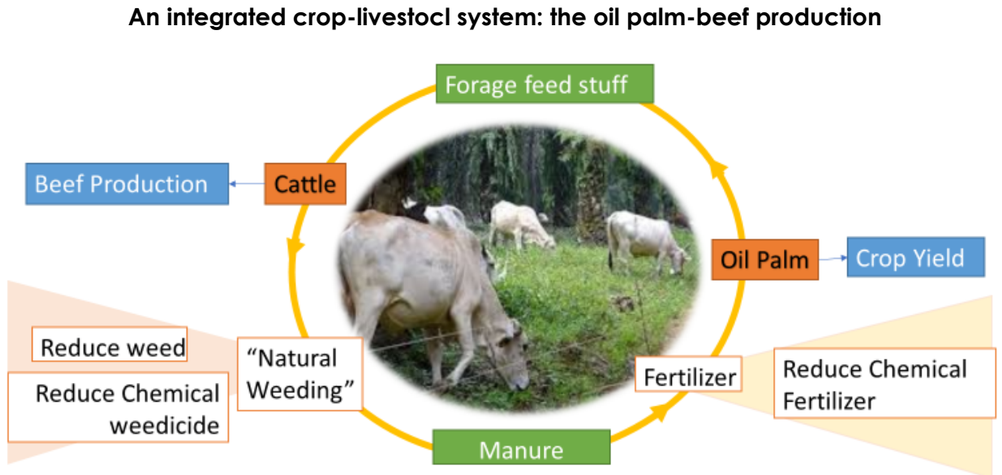


Figure 6: Circular Economy at Micro Level

A number of ecological functions and benefits (recycling of nutrients, crop yield, reduce weed invasion, beef production) are closely linked to maintaining biological diversity in agro ecosystems. Under this system, the competition for land for feed or food would be minimised.

THE FRAMEWORK OF CIRCULAR ECONOMY IMPLEMENTATION

Central to circular economy implementation framework is to develop a sustainable livestock industry that is competitive, reduction of waste and pollution, efficient resource utilisation at the same time revitalise natural system. Sustainable livestock farming systems are characterised by economically viable livestock production along the value chain, while accomplishing social and ecological goals.

Enablers and Barriers

At production level, a lack of knowledge about new products among potential clients, time-consuming processes to get the circular model right are among the challenges. At the system level, closing a relatively unimportant cycle may achieve minimal economic or environmental benefits, while other linear processes, including their waste streams, still continue, amongst others because pricing in the current system does not give benefits to circular practitioners. Another system risk is that the use of organic waste may circulate toxic materials or pathogens in the feed and food systems.

Some common barriers for CE implementation in the livestock industry are summarised in Table 4. These barriers can become enablers if positive measures are taken.

TECHNOLOGICAL

Barriers	*Enablers*
1. Lack of information and knowledge 2. Lack of technologies and skills 3. High cost and lack of financial capabilities to acquire technologies 4. Lack economy of scale for recycling 5. Lack funding for R&D	1. Increase information sharing 2. Improve transfer of technology 3. Financing of CE technologies made available 4. R&D to develop technology for SME 5. Funds for R&D made available

GOVERNANCE

Barriers	*Enablers*
1. Complex or overlapping regulations 2. Industry regulated by many agencies 3. Lack of CE knowledge among leaders and agencies 4. Lack of financial support and incentives for CE 5. Lack of standard, criteria and tools, to measure benefits of CE projects	1. Strong CE governance by lead agency using "single window" concept dealing with policy, implementation, monitoring and evaluation and promotion 2. Harmonised regulation pertaining to livestock industry 3. Supportive funds, taxation and incentives available 4. Standard, criteria and tools for evaluating CE projects developed.

RELATIONSHIP

Barriers	*Enablers*
1. Lack of awareness and support from consumers and society 2. Lack of support and partners 3. Conflict with existing businesses that focus on linear models	1. Nationwide awareness promotion 2. Strong industry-community partnership 3. Circularity incorporated in organisational strategy

Table 4: Barriers and Enablers in Livestock Industry

The proposed framework to circular economy is based on three dimensions namely Technological (technology & innovation); Governance (policy & support instruments);and Relationship (collaboration and partnership).

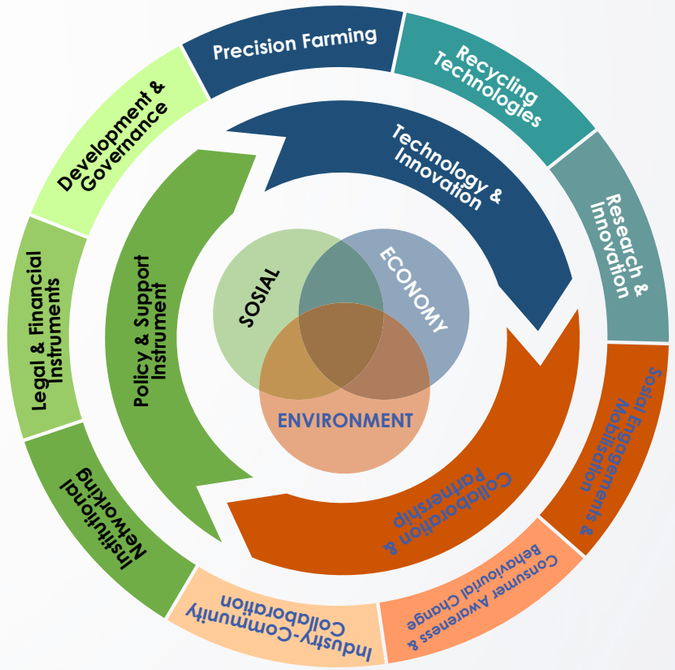


Figure 7: Framework of Circular Economy Implementation for Livestock Production

Technology & Innovation

Technology in livestock production is crucial towards transition to circularity and sustainability. Technology can enhance level of control over the application of breeding, nutrition, environmental management and good husbandry practices, the key factors in animal production. Precision Livestock Farming (PLF) is knowledge- based, that utilises the capabilities of information technology systems to optimise the application of livestock inputs, thereby ensuring that the minimum resources needed are used at the production stage in order to achieve optimum performance with minimal environmental impact.

In poultry production, PLF mainly involves the use of sensors, cameras and microphones that measure temperature, ambient dust, relative humidity, vibration, ammonia concentration, carbon dioxide concentration and a thickness and crack sensor for eggs. In dairy cattle farming, the use of Radio Frequency Identification Device (RFID) system allows farmers to monitor individual animal feed consumption, weight gain, movement, temperature, lameness, milk production and milk composition, often without any human intervention or presence. The ultimate goal is to employ PLF as the farmer's aid to automatic management of livestock production.

Smart technologies and data-driven business models generated by Web of Things (WoT) which is a superset of the IoT represents the integration of digital technology in precision livestock farming. WoT will help to use satellite position data, remote sensing devices and proximal data gathering technologies, enabling an information-based decision-making approach to farm management towards optimising returns on inputs.

Technological innovations in animal production should cope with increases in production while reducing carbon footprint and ensure sustainability of livestock production. Mitigation strategies such as dietary manipulation and biotechnologies can be used to reduce greenhouse gas (GHG) emissions per animal. Emissions from manure storage can also be reduced using biological and thermochemical conversion technologies with added benefit of producing bio-energy while treating livestock wastes. The development of technologies for GHG and nutrient reduction offers the opportunity for environmental sustainability.

Recycling technologies is an area that needs to be emphasised and enhanced such as at slaughterhouses. Livestock slaughtering and processing require recovering solutions to deal with the enormous waste material such as feathers, bones, blood, visceral organs and faecal material. New technologies are available in recycling of waste for example using animal bones as a source of nutritionally valuable natural collagen protein and other vital minerals, that could make full use as ingredients for nutritious foods, pharmaceuticals and cosmetics.

Knowledge generation through research and innovation is a continuous process of improvement and change. The involvement of MARDI, DVS and universities in research will ensure continuity across different research projects. The importance of building a solid evidence and knowledge base are necessary to outline and tackle the technological issues faced when managing multiple approaches to sustainability of livestock production.

Policy and Support Instruments

The proposed general policy and governance on CE implementation for all sectors, including the livestock industry are;

i. Development Policy
a. Link CE with long term agro-food development plan
b. Incorporate 3R elements in development programs and projects.
c. Harmonise with concurrent

ii. Implement in Public Procurement
a. Circular design standards and norms for projects
b. Registration of suppliers and contractors with CE initiatives.
c. Resource efficiency as a criterion for selection of contractors or suppliers.

iii. Strengthening secondary resource markets
a. Development of circular trading platforms
b. Creation of industrial parks for promoting industry symbiosis
c. Rename waste as secondary raw material for processing

iv. Human Capital Development
a. Train the "CE generation" from young at school.
b. Mapping of future jobs and skills.
c. Foster in-house or community training on CE.

v. Promotion of CE
a. Promote 3R practices through guidelines for players of industries.
b. Promote CE business through certifications, labels and recognition.
c. Promote 3R culture at all levels of society.

In order to practise good governance, the government may establish or appoint a lead agency to spearhead CE implementation as a "single window" concept. The functions of the lead agency among others are:

i. Develop masterplan for CE policy implementation.
ii. Establish connections across different sectors, agencies and industries.
iii. Mapping of CE initiatives among players of different sectors
iv. Develop strategies on CE involving all actors of the industry value chain
v. Harmonise different requirements of parties involved, public and private, at federal and state levels.
vi. Promote, coordinate, and provide fund for Research & Innovation in CE
vii. Joint public-private marketing and promotion campaigns
viii. Develop and implement a monitoring and evaluation framework

Financial instruments are important as incentives for industry to get along with the CE bandwagon. Some proposals are;

i. Reduce taxes on CE-based products and increase tax on linear-based products
ii. Support across sectors and link with fiscal policy
iii. Targeting specific sectors within the CE that have highest impact first.
iv. Incentives for companies at CE-industrial parks
v. Tax incentives to encourage nutrient recovery and bio-energy production.

Legal Instruments are required to give power and authority to the government officials in executing laws, rules and procedures required to govern the implementation CE matters in the country. Thus, it is proposed that the lead agency;

i. Develop specific and enforceable standards for all sectors.
ii. Harmonise existing laws and regulations to incorporate all initiatives based on the new CE policy.

Institutional networking involving public and private institutions needs to be strengthened, harmonised and coordinated. These institutions have their own functions and agenda but working together as a team would enhance the nation's capability in a common mission of capitalising the benefits of CE.

Collaboration & Partnership

Collaboration and partnerships are important for successful start of the transition process. Fostering industry-community collaboration, particularly in small and remote local communities would bring people together creating common understanding and ownership of CE initiatives. In such collaboration, the ownership of the initiative by local people, farms and businesses is important for accepting the presence of the industry and for its long-term viability.

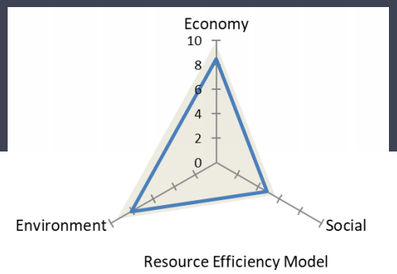
Diverse partners help to bring new ideas and knowledge to the collaboration, such as universities and research institutes together with consumers and livestock producers can be an integral and successful part of the livestock business. This kind of collaboration in the long run would not only create awareness but also assist in changing the behaviour of consumers towards preferring livestock products from farms implementing CE initiatives.

Society engagement and mobilisation are the process of bringing together all societal and personal influences to raise awareness and understanding of CE initiatives and cultivate continued support from individuals and community. It is an important means to formulate CE policy by making it more responsive and accountable to people's needs and demands. Showing strong public support for an issue would encourage political support at the highest level to create an enabling environment for national policy formulation and implementation plan.

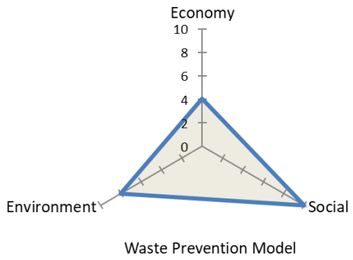
CIRCULAR ECONOMY BUSINESS MODEL
IN THE CURRENT VALUE CHAIN

i. **Resource Efficiency Model.** This model requires using natural resources more efficiently for livestock production through high application of technology. Advanced technology such as smart technology, precision farming, together with knowledge-based management system prevent wastage resulting in less input such as feedstuffs, chemicals and antibiotics used. Decreasing the inputs needed for production is also a viable approach to reduce inputs towards reciprocal outcome of reducing waste.

Improving the efficiency of nutrient utilisation by the animals can help reducing the import of nutrients from outside the farm. By using fewer resources, in a more efficient manner, the business can retain its competitive edge, create green growth, sustainable jobs and better protect the environment.



Resource Efficiency Model

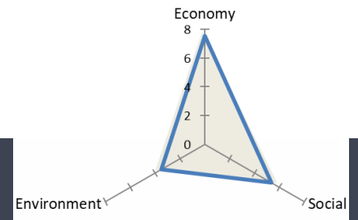


Waste Prevention Model

ii. **Waste Prevention Model.** This model focuses on extending the use of materials recycle and reuse. An example is in a case of a dairy farm providing manure and compost to corn farmers who in return offers corn stover to the farm to make silage as feed to the cows. Other examples are using biogas as energy source, the solid waste as compost for fertiliser and waste water recycled for barn washing and watering of plants.

Besides aiming at achieving zero waste from the livestock farming, this model also advocates reducing wastage from mortality or inferior quality livestock products such as meat, milk and egg. This can be achieved through, for example, good husbandry practices, by preventing and controlling animal diseases, and by promoting the responsible use of veterinary medicines, including antimicrobials.

ii. Crop-Livestock Integration Model. This model aims at optimum use of land for food production. By integrating crop with livestock such as rearing cattle, goats or sheep in oil palm or rubber plantation, natural vegetation under the tree crop is utilised as feed for the ruminants. At the same time, manure from dungs naturally adds nutrient to the soil and used by the plants. Other benefits include less herbicide and labour being required to clear the land of unwanted undergrowth.



Crop-Livestock Integrated Model

CONCLUSION

THE WAY FORWARD

ADOPTION OF CE CONCEPT IN LIVESTOCK INDUSTRY

The livestock industry in Malaysia is experiencing continued growth in demand largely driven by human population growth, increase in income and urbanisation. The industry has been responding dynamically, aided by use of science and technology to increase production especially in broiler and eggs with specialisation, commercialisation and industrialised system. However, the linear economic model of production system which is often equated to wasteful, unfriendly to the environment and causing social uneasiness have to change by incorporating the circular economy model which is geared towards sustainable livestock production. Many circular economy initiatives such as using crop residues and agro-industrial by-products as animal feed, waste reducing resource utilisation via precision livestock farming, recycling of farm waste for biogas production, crop-livestock integrated farming and industrial symbiosis of feather meal production using slaughterhouse waste (feathers) as raw material have been practised but need to be implemented on a larger scale to give meaningful impact.

The potential economic benefits of circular economy are enormous and waiting to be tapped. The proposed framework of circular economy implementation for the livestock industry is aimed towards sustainable livestock production. The framework is based on 3 dimensions namely, Technological (technology& innovation); Governance (policy & support instruments); and Relationship (collaboration and partnership). The drivers in each dimension are identified in this framework.

The proposed business models are resource efficiency model, waste recovery model and crop-livestock integration model. These models aim at achieving sustainability in livestock production but have varying impacts on the economy, social and environmental factors. The proposed framework and business models will help to accelerate the implementation of circular economy in livestock production.

Awareness and support

Circular economy concept and application need to be made known not only to players and stakeholders of the livestock industry but also to the politicians, leaders, civil societies, consumers and the public at large. The purpose of creating awareness with wide coverage is to gain the backing, understanding and behavioural change towards supporting CE initiatives.

Mapping of CE initiatives

It is envisaged that there are CE initiatives that are being practised by the livestock industry players. They should be identified, evaluated and case studies be written to document the initiatives. Best practices from these initiatives should be used as examples for others to emulate. Later, progresses should be made based on studies by researchers so that the models and initiatives can be improved.

Governance

Governing mechanism of CE implementation and coordination should be strengthened by legislation, structure and financial support. There are many roles and functions of a governing body that needs to be put in place. Having strong administrative instruments and coordinating mechanism would enable the agency to execute its roles and functions effectively.

Strategic Plan

A strategic plan of circular economy is important as a guide for the successful implementation of Circular Economy in Malaysia, encompassing all industries. This will help in streamlining the direction and focus towards achieving a particular goal.

Blueprint for CE implementation

This blueprint details out the implementation plan, as each industry has its own blueprint. This serves as the tactical plan of operation for the industry.

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