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Assessing the Sustainability of Pork Production Systems and Their Effect on Animal Welfare and the Environment

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Abstract
The objective of the study was to evaluating the sustainability of hog production systems and how they affect environmental protection and welfare of animals**.** The Q-PorkChains study evaluated the ecological impacts of 15 pig farming techniques using life cycle analysis. Each of the five states' two conventional and one non-conventional method was analyzed. Evaluations of five to ten farms from each system provided the information for the computations. Conventional (C), adapted conventional (AC), traditional (T), as well as organic (O) were the classifications given to the system under review. Depending on the system, AC systems only slightly enhance meat quality, animal welfare, or environmental effects compared to C systems. The disparities were significantly greater for T systems, which used extremely fat, slow-growing traditional breeds and often raised fattening pigs outside. Environmental effects were estimated and shown at the farm gate for each kg of pig live weight (LW) and each hectare of land used. Climate change, acidification, eutrophication, energy consumption, and land occupancy impacted C systems to 4.7 kg CO_2, 48.3 g SO_2, 29.7 g PO_4, 18.3 and 6.8 m2. AC outperformed C by + 14%, + 6%, 1%, + 3%, and + 17% in equivalent mean values; T by +55%, +77%, +25%, +51%, and +157%, and O by + 5%, 17%, +26%, +12%, and + 122%. In contrast, when stated land use, mean effects for T and O systems were 10% to 60% lower, depending on the impact category. This was mostly caused by increased land use per kilogram of pig produced, which was brought on by feed production and sow or piglet fattening outside. The usage of straw bedding increased the impact of climate change per kilogram. The adoption of traditional local breeds resulted in larger effects per kg for all impact categories, despite lower productivity and feed efficiency. T systems with intensive outdoor pig rearing resulted in a much-reduced effect per hectare of land exploited. The potential for eutrophication per hectare was significantly lower in O systems. Traditional systems have reduced global implications.

Keywords: Q-PorkChains, Green house gas, Organic, Adapted conventional, Live weight.

Introduction

Pig farming techniques contribute to the environmental effects of livestock. Around 700 million tons of CO_2 equivalents of greenhouse gas (GHG) emissions are produced annually due to pig farming worldwide. Growing public knowledge of GHG emissions from farms and rising consumer request for hog meat imply that the ecological effect of its production could not be ignored, even though emissions from the production of pigs were far lower than those from the production of beef and bovine dairy animals. The statistics demonstrate that when evaluating the environmental effects of pig manufacturing processes from a whole farm viewpoint, it is crucial to consider the causes of different direction techniques on every part of the system (1). To meet the increasing demand for animal-derived food among the world's fastest-expanding nations, the livestock sector has seen unprecedented developments during

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the previous fifty years. Over this period, the world's human population expanded by a factor of 3.5, but meat consumption climbed by 5.9. Increased productivity and intensification of animal production systems are the only ways to achieve the anticipated 74 kg rise in global flesh intake per head/year (2). Improving animal welfare may offer extra uses. Improving farm animal well-being nearly always has a positive effect on performance since many welfare concerns have a negative influence on productivity. Improving animal well-being is also one of the techniques and approaches that reduce the need for antibiotics in agricultural animals, which could be beneficial for human health in the long run (3). The pigs and meat have increased their contribution of a 50-year period's worth for total livestock output due to the increased interest for livestock goods, specialization, automation, the creation and sale of inexpensive feedstuffs, market liberalization, inexpensive energy, and enhanced genetics and feeding methods. The increased production of pork has an impact on the utilization of natural resources. On the one hand, pig manufacturing methods have higher N use efficiency (NUE) and better feed conversion ratios (FCRs) than ruminant production systems, resulting in reduced feed consumption and lower N excretion per unit of output. Population increase and also a dietary shift toward more animal protein per capita are driving up demand for pork (4). Pork production necessitates various resources, including the animals themselves, housing facilities, feed, agricultural machinery, skilled farmers and animal caregivers, slaughter facilities, transportation networks, and electricity. Several pork-producing methods are in operation throughout Europe (5).

Pork production techniques include various approaches, ranging from small-scale agriculture to extensive industrial activities. Each method has its own set of benefits, drawbacks, and implications for animal welfare and the environment. Understanding these elements is critical for developing and executing long-term policies that are consistent with the ideals of animal care, environmental stewardship, and long-term sustainability (6). Demands about pig farming techniques center on animal welfare. Pigs' well-being, including housing conditions, access to space, enough nourishment, and humane treatment, must be carefully examined. Sustainable pork production should prioritize animal welfare by supporting measures that decrease stress, improve animal health, and provide pigs with a natural and full existence (7). The production and distribution of feed, manure management, and greenhouse gas emissions are all important factors impacting the sustainability of pig production methods in terms of the environment. The industry may reduce its ecological footprint and move toward a more sustainable future by implementing innovative technologies, improving resource efficiency, and reducing pollution (8).

Sustainable pig production requires striking a careful balance between animal welfare, environmental protection, and economic viability. They can work towards a future where pork production systems prioritize animal welfare, minimize environmental impact, and ensure the availability of high-quality and sustainable pork products for future generations by promoting responsible practices, fostering innovation, and raising awareness (9). The objective was to assess the risk of unfavorable social effects related to the manufacturing and

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consumption of 1,000 kg of pork from two different pork manufacturing systems: organic and conventional. A literature review and meeting with experts were employed to find pertinent social sustainability problems for pig production methods (10). The study (11) provided food production, and the manufacture of other goods for human use should be feasible. This means that the method must be acceptable both now and later in the future, especially in regard to resource availability, operational implications, and action morality. In this study, the restriction of meat consumption in industrialized countries. They specifically explore various reasons for this regulation regarding environmental, health, and animal welfare problems and the impact of fiscal, informational, and behavioral regulatory tools (12). The research (13) has revealed that highly varied welfare results are frequently observed in facilities that use identical habitats or adhere to the same animal welfare regulations. In the study (14), the animal welfare was mentioned specifically in 6% of initiatives. In 79% of programs, supportive interventions were used, most notably the use of on-site pre-release pens and the provision of supplemental food or water; however, the scope and length of support varied. This research has three objectives. First, to see if they could discriminate between healths, environmental, and animal rights motivations for eating a vegetarian diet using construct validation. Second, they examined whether these incentives were linked to various demographic, behavioral, and personality factors in 3 groups. Third, they examined how people's motives correlated with their responses to vegetarian advocacy materials (15). The study (16) distinguishes the word from other similar ideas, such as species-typical behavior and well-being. It identifies several ways in which naturalness may be employed as: (i) prompts for additional welfare evaluation; (ii) a credible hypothesis for what secures wellbeing; (iii) a threshold for what is acceptable; and (iv) limits on what improvements are undesirable. The study (16) analyzes organic farming in the context settings, paying particular attention to current research findings. It outlines the environmental issues brought on by contemporary farming methods and proposes suitable metrics for gauging their effects. The study's objective was to address market requirements and animal welfare issues. Reliable on-farm monitoring programs and effective welfare improvement strategies are essential for assessing the welfare of the animals and spotting potential dangers (17). The study's goal was to assess the viability of hog production techniques and how they affect animal welfare and safeguard the environment.

Materials and Methods

Description of the system and data gathering

From the 84 systems inventory, 15 pig farming systems were chosen. Each of the five nations had one conventional and two differentiated strategies evaluated. The systems were divided into three categories: conventional, adapted, conventional, and differentiated, which comprised both organic and conventional methods. Surveys of six to ten farms across every system yielded the inventory data required for Life cycle assessment (LCA) calculations. This survey gathered data needed for the global evaluation of numerous sustainability issues. Depending on the system and nation, many types of farms were considered: farms for breeding, farrow-to-finish animals, for fattening animals (18). Information gathered from a

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relevant environmental issue include: (i) Animal performance, includes characteristics crucial for slaughter, such as sow effectiveness, mortality rates, and pig development in conjunction with feed intake after the post-weaning to fattening phases; (ii) metabolizable energy, CP, along with phosphorus (P) contents of the feed, as well as, if available, the feed ingredients' quantities; (iii) housing for animals, comprising the type of housing, floor category, as well as temperature outside; (iv) manure management, such as control inside the structure, during storage, manure treatment, and the kind and extent of distribution. For each agricultural system, an "average" system was constructed based on the data gathered. Performance, nutrient fluxes, and emissions were estimated per every production phase, including sows, piglets up to weaning, piglets after weaning, and fattening pigs (19). The post-weaning along with feeding pig mortality rates, and the annual multiples of weaned piglets per sow, were easy to calculate. The manufacturing of soybean food, rapeseed food, and rapeseed food, as well as the conversion of agricultural goods into feed additives. Additionally, data for monocalcium phosphate were acquired. Information on the emissions and resource use resulting from the production and delivery of various agricultural inputs.

System divisions and functional components

Pig production, including whole breeding sows, their piglets through weaning, post-weaning piglets, and feeding animals, was submitted to a cradle-to-farm-gate, LCA (Figure 1). The primary resources were used to develop system and subsystem boundaries. The primary component of each system is the pig unit, which produces piglets and raises them till slaughter weight (20). Although this unit is considered landless, it interacts with the usage of land via the import of feed and deposition and the benefit of animal excrement (Figure 1). The system likewise accounted for every piece of land utilized for pig farming outside. The design incorporates herd management, off-farm feed production and delivery, animal emissions, and waste storage. System growth was used to evaluate the environmental effects of manure usage. It was believed that the manure would replace some of the mineral fertilizers.

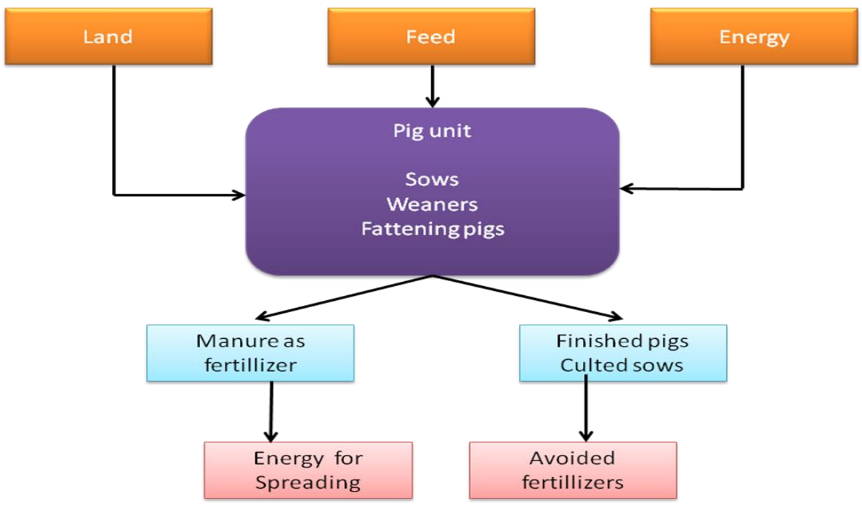

Figure (1): Limits and a simplified overview of the pig production system

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The mineral fertilizer equivalent (MFE) for nitrogen (N) is estimated to be 75%, with an additional 5% loss as nitrate when compared to mineral fertilizer. It was believed that the manure would replace some of the mineral fertilizers (21). The mineral fertilizer equivalent MFE for N was estimated to be 76%, with an additional 5% loss from nitrate when compared to mineral fertilizer. It was supposed that P's MFE was 100%. Animal slaughter and transportation outside of the system were not included. In addition to 1 kg LW of pigs leaving a pig unit, which included slaughtered pigs and selected sows, functional parts were 1 ha of land utilized to grow animals and create feed.

Evaluation of life cycle inventories

Feed and feed ingredient production. Data from surveys were used to determine the quantity and nutritional composition of complete feed consumed by every type of pig. However, because there was typically a dearth of knowledge on the ingredient composition of feed, they were guessed in a manner akin to that performance. Let's assume that a full diet combines grains, protein-rich foods, and minerals. This estimate was done for all of the diets that each pig group used. The approach used for assessing the effects of manufacturing non-organic feed components is described in full in the LCA data for conventionally cultivated feed ingredients (22). It was thought that soybeans were the source of soymeal. LCA is a frequently used technique for assessing a system's or product's surrounding impact over the course of its full life cycle. It evaluates each step of the production process for pork, including the creation of feed, animal care, transportation, and processing. Resource usage, greenhouse gas emissions, land use, and other environmental factors are all revealed by LCA. When examining the creation of seeds for planting, it was believed that the inputs required were the same as those for the comparable crop. Based on data from the LCA Food Database, in organic pig production systems, figures for feed component organic content were used. Estimated air emissions from growing pigs were made for the pollutants NH_3, N_2O, NOx, and CH_4. Calculations were made for the CH_4 emissions caused by enteric fermentation and manure management (23). The amount of NH_3-N released during indoor storage, outdoor storage, and field application of manure was calculated using the type of storage and spreading technique. The structure's energy demand for lighting, heating, and ventilation was considered, but neither the emissions nor the resources used to construct it were. Products for pets and cleaning were also omitted due to a lack of survey data.

Impact analysis of the life cycle

The following effect categories were taken into account: cumulative energy demand (CED), eutrophication potential (EP), acidification potential (AP), land occupancy (LO), and climatic change (CC). The indicator result has been produced for each effect category by averaging the resources used along with release of each individual item, then a characterization factor for each impact type that it may contribute to, multiplying those numbers. To identify “CC, EP, AP, CED, and LO," the baseline, along with all types, were characterized using the ecoinvent v2.0 database's implementation of these approaches. The following 100-year global warming potential parameters were used to estimate CC: In kilogram CO_2 equivalents, CH_4

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equals 25, N_2O equals 299, and CO_2 equals 1. The general EP factors in kg "PO_4, NH_3: 0.35, NO_3: 0.3, NO_2: 0.13, NOx: 0.13 and PO_4: 1" were used to compute EP. Average parameters in kg "SO_2, NH3: 1.6, NO: 0.5, NO: 0.6, and SO: 1.3" was used to determine AP. The eco-invent v2.1 database's version 1.07 implementation was used to compute CED. LO describes the on- and off-farm space utilized for rear pigs and produces feed. Some authors contend that the functional unit should be altered depending on the effect, comparing localized results measured in hectares of land with global impacts measured in kg of product. While EP as well as AP were taken to be local impacts and declared as a percentage of hectares, CC, AP, CED, along with LO were thought to be global effects and expressed as a percentage of the product.

Examination of several dimensions

They used multivariate Principal Component Analysis (PCA) analysis to look at relationships between the study's variables that were assessed. Piglet production rate, piglet weight per kilogram of the sow or per acre, feed effectiveness, and sow productivity were the factors used to define animal performance and feed CP along with P levels. The environmental effects were displayed in terms of kilograms of LW and hectares of land used. Feed efficiency, and sow productivity, with land productivity, all factors into animal performance and are clearly compared on the first axis of the PCA, with environmental repercussions represented per kg LW, on the other hand. Environmental consequences described per kg LW differ from those expressed per ha. On the graph of individual systems, it is simple to distinguish between three of all three T systems, each of the O systems, and a single AC system. One T system is situated among C and AC systems, despite most of them being next to one another.

Results

Description of the mechanism and animal performance

The farms with a farrowing facility had, on average, 313 sows (Table 1). A mean of 3275 pigs was produced annually on farms with fattening units. The mean farm size per system significantly varied between systems. According to Table 1, group quantity was largest for C and AC methods, lowest for T techniques, and intermediate for the O methods. In general, sows weaned 23.7 piglets every year. The C systems demonstrated the best performance. Performances remained lower in O with T methods, and they were also somewhat lower in AC systems. T and O systems had higher annual feed consumption per sow than C and AC systems because the feed in these systems tended to have higher concentrations of CP and P.

The post-weaning period's average feed-conversion ratio was 1.97 kg/kg growth. In (Table 1) the rate was lower for C methods and highest for T techniques were shown. T systems had a much greater mortality rate compared to the other systems, which varied just a little.

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Table (1): Pig production sow, post-weaning, and fattening pig performance, as well as typical food composition

	Conventional		**Adapted conventional**		**Organic**		**Traditional**	
	Mean	s.d	Mean	s.d	Mean	s.d	Mean	s.d
Number of systems	395	111	475	337	129	111	60	56
Fattening pigs/year per farm	4908	1321	3575	1365	2514	886	519	699
Sows	0	0	0	0	0	0	0	0
Piglets weaned/year	27.9	1.5	25.2	4.8	19.9	1.4	15.2	5.6
Weaning weight/kg	7.31	0.51	7.41	0.47	12.11	0.43	9.29	1.17
Feed/sow (kg/year)	1328	133	1344	237	1596	574	1463	554
Average sow feed composition	0	0	0	0	0	0	0	0
Cp (g/kg)	135	9	135	12	159	11	138	23
Total P(g/kg	4.72	0.30	4.99	0.41	6.99	1.29	5.24	0.45
Post-weaning pigs	0	0	0	0	0	0	0	0
Final weight (kg)	29.1	4.4	27.9	3.4	29.9	0.5	25.5	7.4
Feed-conversion ratio (kg/kg)	1.68	0.06	1.91	0.37	2.21	0.59	2.43	0.62
Mortality rate (%)	2.00	0.9	1.9	0.7	2.2	0.9	7.1	8.4
Average sow feed composition	0	0	0	0	0	0	0	0
Cp (g/kg)	176	12	174	17	194	15	163	35
Total p (g/kg)	5.59	0.45	5.57	0.44	6.37	0.77	5.52	0.79
Fattening pigs								
Slaughter weight (kg)	114.3	7.7	124.9	17.5	119.2	9.7	140.5	14.5
Feed-conversion ratio	2.75	0.09	3.19	0.88	3.04	0.12	5.30	2.23

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(kg/kg)								
Mortality rate (%)	3.5	1.3	3.9	1.3	3.6	1.2	4.6	2.8
Average feed composition	0	0	0	0	0	0	0	0
Cp (g/kg)	156	8	154	8	175	20	146	24
Total P (g/kg)	4.66	0.40	4.51	0.44	5.11	0.57	4.82	0.54
Live weight produced/sow								
Kg/year	2939	176	2849	287	1992	89	1904	651

In post-weaning meals, T systems had the lowest dietary CP content, whereas O systems had the highest rate. With no discernible difference between the other systems, the O systems had the greatest total dietary P level. The average weight of pigs slaughtered in C systems was 114 kg, which was comparable to O systems. In the AC and T systems, it was 13 and 28 kg greater, respectively. During the fattening phase, the average feed conversion ratio was 3.44. It was lower for C methods and higher for T techniques, as shown in (Table 1). T systems had a greater mortality rate than the other systems, which varied just slightly. T systems had the lowest and highest dietary CP content of fattening diets. With no discernible difference among C and AC, O and T methods had the greatest levels of total dietary P. The average amount of pig LW a sow produces per year was 2579 kg.

Table (2): A production system's regularity of housing and manure management

	conventional	Adapted conventional	Organic	Traditional
Sows	0	0	0	0
Housing	0	0	0	0
Indoor	5	5	1	4
Outdoor	1	2	4	3
Indoor with outdoor access	1	1	3	1
Floor (when indoor)	0	0	0	0
Slatted floor	6	5	4	5
Bedding	1	2	3	2
Manure (when floor)	0	0	0	0
Liquid	6	5	4	5
Solid	1	2	3	2
Weaners and fattening pigs	0	0	0	0
Housing	0	0	0	0

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Indoor	6	5	1	2
Outdoor	1	1	1	5
Indoor with outdoor access	1	2	6	1
Floor (when indoor)	0	0	0	0
Slatted floor	6	2	5	3
Bedding	1	2	2	2
Manure treatment	0	0	0	0
Liquid manure	2	0	5	1
Solid manure	1		2	1

Table 2 lists the farms under study's housing and manure management. On slatted flooring, all typical pigs were kept indoors. Only a small portion of the slurry that included their excrement was processed. Slatted floors were common in AC systems, although solid manure was occasionally produced when sows and fattening piglets were kept on straw bedding. Animals were reared in O systems either outside or indoors with access to the outdoors. The most popular method for fattening pigs was the use of slatted floors. Sows might be grown indoors or out in T systems, but fattening pigs were typically kept outside.

Effects of feed and feed additives on the environment

Organic feed ingredients had reduced CC and EP effects on cereals and rapeseed meals than conventional feed components, whereas LO was greater. For C and AC systems, the potential effects of production and distribution of all feed mixes were comparable, whereas those for T systems were 7% to 8% lower. In comparison to conventional feeds, organic feed combinations exhibited reduced CC and EP impacts that were significantly lower but larger AP and LO impacts.

Pig Production's effects on the environment

In (Table 3) the environmental effects of the systems for each kg of pig LW created and displayed, along with each hectare of land utilized over a year. There were significant disparities between the various methods for all effect types stated per kg LW. The mean CC, EP, AP, CE, and LO, respectively, were equivalent to 3.7 kg CO_2, 0.13 kg PO_4, 0.06 kg SO_2, and 7.7 m2/kg LW. For all effects, there were significant variations in the extreme values.

Table (3): Potential environmental effect estimated as per kg of pig live weight (LW) of land utilized

	conventional		Adapted conventional		Organic		Traditional	
	Mean	s.d	Mean	s.d	Mean	s.d	Mean	s.d
Number of systems	6		6		4		3	
Impact/kg LW	0	0	0	0	0	0	0	0

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Climate change (kg CO_2-eq)	2.252	0.086	2.567	0.603	2.433	0.229	3.481	1.087
Eutrophication (kg PO_4-eq	0.020	0.003	0.021	0.007	0.017	0.006	0.035	0.013
Acidification (kg SO_2-eq)	0.045	0.007	0.045	0.017	0.057	0.015	0.055	0.005
Energy demand (MJ)	17.23	0.54	16.51	2.67	18.09	2.52	24.29	7.71
Land occupation (m^2)	4.128	0.230	4.799	1.039	9.149	1.724	11.581	5.472
Impact per ha of land used	0	0	0	0	0	0	0	0
Climate change (kg CO_2-eq)	5468	392	5358	297	2686	258	3673	1167
Eutrophication (kg PO_4-eq	46.4	3.6	42.5	4.6	18.4	2.3	36.3	9.6
Acidification (kg SO_2-eq)	106.2	13.8	90.9	17.3	62.6	3.7	63.9	39.3
Energy demand (MJ)	39.5	2.60	35.9	1.96	19.9	10.1	26.7	8.4
Pig produced (kg LW	2430	141	2163	416	1115	211	1239	841

The mean CC/kg LW was lower for C systems as well as greatest for T methods, with AC and O methods being in the center. Similar EP per kg LW values for C and AC methods were found. However, T system values were higher, and O system values were lower. Between the C and AC methods and the T and O methods, there were significant disparities in the amount of LW generated per ha of land occupied. The three variables had the most effects on CC across all systems: animal housing, manure preservation, and spreading (Figure 2).

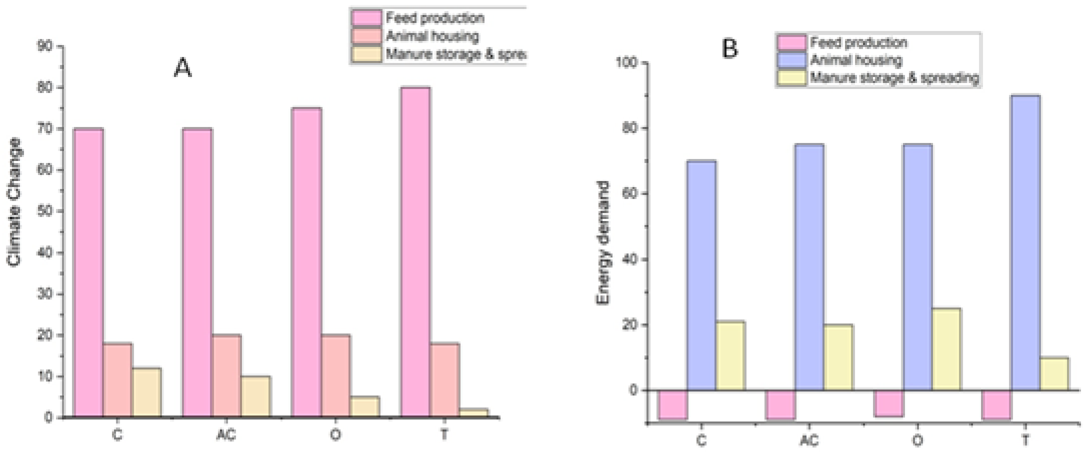

Figure (2): The four pig production techniques in light of energy use and climate change, **[A]:** The four pig production techniques in light of climate change, **[B]:** Production techniques in light of Energy demand

In comparison to C and AC methods, O and T methods tended to have smaller relative contributions from housing and manure. Similarly, (Figure 2) shows that feed output was a major factor in CED. For T systems, the contribution of animal housing was the smallest. Manure spreading replaced fertilizer applications; hence its impact on CED was negative. In comparison to CC or CED, the proportionate contribution of feed production to AP was much lower (Figure 3), with animal housing accounting for between 50% and 60% of AP. With the exception of O systems, feed production accounted for the bulk of EP (Figure 3). T and O

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systems tended to produce marginally bigger global effects compared to C systems, whereas AC systems likely to have marginally smaller local impacts (Figure 4). O methods have a significantly lower EP.

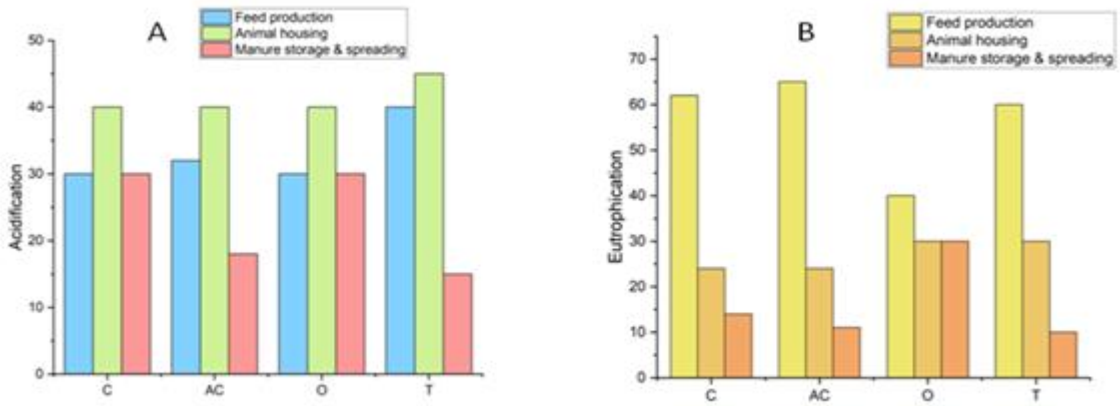

Figure (3): The effects of acidification and eutrophication on feed output **[A]** The effect of pig production in acidification **[B]** The effect of pig production in Eutrophication

Comparing T and O methods to C methods, it was found that they tended to have somewhat larger global effects, whereas AC systems tended to produce slightly smaller local effects (Figure 4). O techniques have an EP that is much lower. The values are given as a percentage of the mean for the traditional system using either kg living weight as the functional unit (CC = climatic change; AC = acidification; LO = land occupation; CED = cumulative energy demand) or ha of land utilized as the functional unit (EU = eutrophication; AC = acidification). Dark grey for LO relates to the land for growing livestock outside, and light gray to the land used for producing feed.

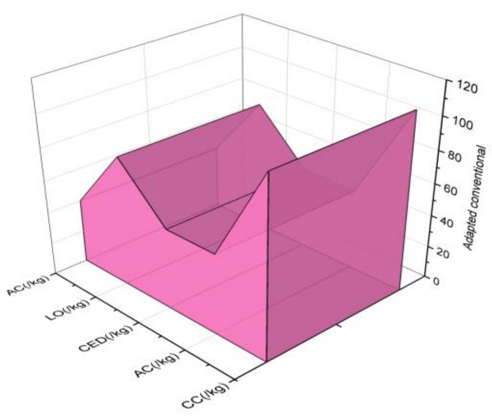

Figure (4): Using modified conventional values, compare the four different system effects on the environment

Examination of several dimensions

Comparing animal performance, such as feed effectiveness, sow productivity, and land productivity, is made obvious on the PCA's first axis, with environmental repercussions

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represented per kg LW, on the other hand. Environmental consequences described per kg LW differ from those expressed per ha. On the graph of individual systems, both O systems, 2 of 3 T methods and one AC technique are all easily distinguished. One T system is situated among C and AC systems, despite most of them being next to one another. examining the influence of the organic approach's surroundings (Figure 5). The values are given as a percentage of the mean for the traditional system using either kg living weight as the functional measure or ha of land utilized as the functional unit. For LO, light grey represents outdoor rearing acreage and dark grey represents land used to produce feed.

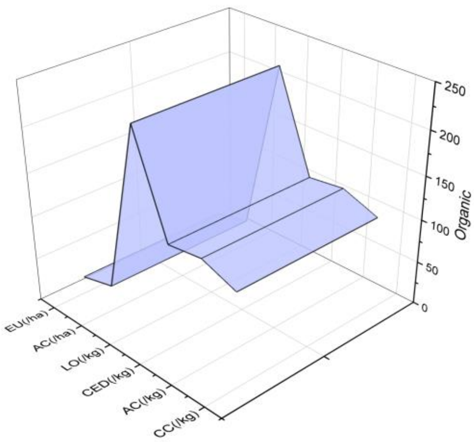

Figure (5): Evaluating the effects of the organic technique type on the environment

The contrast of the method types traditional in terms of their environmental implications. The values are given as a percentage of the mean for the traditional system using either kg living weight as the functional unit or ha of land utilized as the operational unit. Below (Figure 6) represents the analyzing the various impacts of traditional method type.Dark grey for LO relates to the land for growing livestock outside, and light gray to the land used for producing feed.

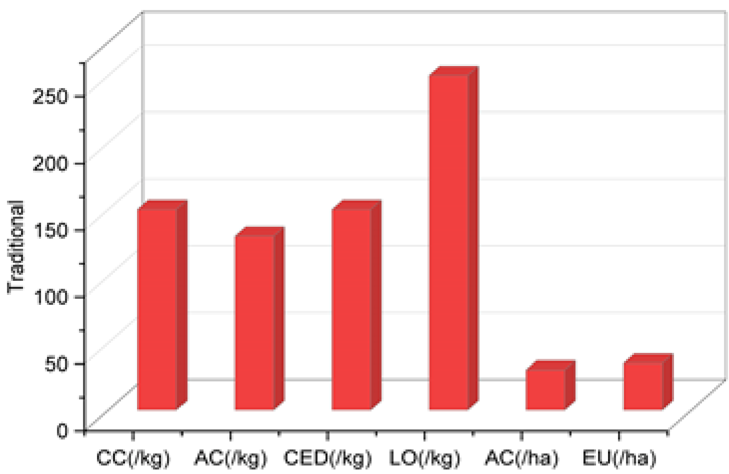

Figure (6): Analyzing the environmental various impacts of traditional method type

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Discussion

Recent LCA estimates of the environmental effects of pig farming place the CC values reported in the current study within a larger range. For O systems, the mean CC is lower (24). The better animal performance in their research and higher N2O emissions are most likely to blame for the disparities in O systems, the usage of straw bedding, and higher N2O emissions. On the other hand, the calculation of CC values for systems C and O that support our findings. The lower feed efficiency of T systems, which is connected to the outdoor growing of traditional breeds, is the primary cause of their larger CC effect per kg LW. Since animals are raised outside, the CC impact from feed production is greater, and the reduction in CH4 emissions only partially offsets this. Because AC systems utilize straw bedding more often and with poorer animal performance than C systems, they have a somewhat larger CC effect. In the current study, the mean EP for O systems is lower than for most of the superior animal performance. O and C systems were compared in the study. The production of feed components without the use of mineral fertilizers results in O systems having the lowest EP among the analyzed systems, whereas T methods have the greatest EP mostly due to their poorer feed effectiveness. The larger range of values also encompasses the AP values found in the current investigation. The mean AP for C and AC systems is substantially the same as that found for comparable systems (25). CED values that span a larger range of values were obtained in the current investigation. The average CED for C and AC systems is comparable to that of other systems. For O systems, the mean CED is a little lower. Since T and also O systems have high LO values, the LO values found in the current study partially fall beyond the acceptable range of values. For T systems, outdoor pig fattening provides about 60% of LO/kg LW, which results in greater LO.

In contrast, increased LO in O systems is mostly caused by higher LO of feed production due to lower organic crop yields. According to (26), a multidimensional study that produces fewer animals per sow, a kilogram of feed, or hectares has greater environmental consequences per kg LW but lower effects per hectare. Feed CP along with P contents appear to have just a little impact on the outcomes and mostly distinguish the O system (27). Although it is frequently used in agricultural LCAs, the utilization of numerous functional units is still up for dispute (28). As functional units for dairy production, for instance, researchers have employed land area, animal units, and milk output.

Similarly, it used 1 hectare and 1 kilogram of pig LW as functional units for raising pigs. The environmental effect represented in terms of kilograms is negatively correlated with the degree of intensification, but the converse is true for impacts reported in terms of hectares. The study (29) shows that neither widespread nor intensive agricultural practices naturally have reduced environmental effects. For instance, EP per kg LW is lower for C methods, which were typically found in areas from major eutrophication issues and large densities of animal production.

Conclusion

The type of impact and the functional unit utilized, however, determine how well the systems rank. This study finds significant variation in every component of the environment after taking into account the variety of pig raising techniques. When the impact is represented in terms of the amount of land utilized rather than the amount of LW generated, the relationship between the degree of intensification and the surrounding effect per ha land usage is reversed. According to the sort of influence taken into consideration, there is a major difference between the types of systems. This would suggest that local conditions, particularly how sensitive heavily influence the ideal system selection of the ecosystem is to regional influences. The results of this study indicate that LCA, as detailed in a companion work, is appropriate for evaluating the environmental effects of pig production systems and can help with the evaluation of sustainability in general.

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