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Can Organic Pork Help Achieve Sustainable Development Goals in Thailand?

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Abstract: This paper examines how organic pork (OP) production, marketing and consumption in Thailand contributes to global Sustainable Development Goals (SDGs) that affect food agri-food system sustainability. The paper discusses technical debates and academic literature sources about OP, socioeconomic and environmental impacts of organic agriculture (OA), food security and SDGs. It reflects on theoretical, practical, policy and empirical issues utilizing Thai case study data on willingness to pay (WTP) for OP to illustrate SDG linkages. The study raises broader questions, complications and contradictions about universal access to safe, healthy and affordable organic food. It suggests that WTP as a niche strategy supporting OP producers has responded to consumer demand and has potential for increased farmer incomes. But WTP for OP is an inadequate, problematic priority if it does not better address ecological, social and economic sustainability concerns, cross-cutting SDGs and national policies including inequities among richer and poorer consumers and farmers. It shows how OP may modestly contribute to SDG2 achievement or help realize other interlinked SDGs in Thailand but can also hinder some SDGs. We conclude that the OA movement and governments must better address difficult challenges affecting livestock systems sustainability, meat production, consumption, value chains and socioeconomic equity.

Keywords: organic pork; food security; willingness to pay; Sustainable Development Goals; sustainable livestock systems; sustainable production and consumption; Life Cycle Assessment; Thailand

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1. Introduction

In recent years, pork consumption has increased dramatically in Asia especially due to population growth and growing income per capita. However, rise in pork demand could pose more environmental threats and lead to a number of broader sustainability challenges [1]. At the same time, organic pork has sometimes been characterized as safe meat free from veterinary drug residues and hormones raised in a system that maintains animal welfare. It has also been considered an alternative choice for consumers looking for sustainable meat products. Yet some studies have raised doubts about organic pork sustainability concerning land use, soil conservation, production costs, nitrogen discharge and greenhouse gas (GHG) emissions per kilo of meat potentially larger than in conventional pork production or compared to other meats such as beef or lamb [2].

Similar issues need to be assessed for their relevance or applicability to various countries and specific cases in ecological, social and economic sustainability contexts. This paper builds on related literature sources and debates. It tackles the issue through an interdisciplinary approach and a global Sustainable Development Goals (SDGs) lens. It examines how organic pork (OP) production, marketing and consumption in Thailand contributes to achieving SDGs particularly affecting general food security and agri-food system sustainability.

The paper also builds on broader debates concerning organic agriculture (OA) and questions common assumptions about OA sustainability contributions. OA can be an environmentally friendly way of farming based on the well-known IFOAM core principles

of health, ecology, fairness, and care, which can potentially help achieve some SDGs [3]. Yet scientific debates about environmental impacts of OA remain [4,5]. The OA movement has also acknowledged difficult challenges and debates affecting livestock systems and value chains. Yet IFOAM core principles further suggest that animal health and welfare is essential for environmentally sustainable farm ecosystems [6]. Moreover, IFOAM's Animal Husbandry Alliance has stressed the need to evaluate environmental impacts of livestock production at a system level, not just focus on individual products [7].

This paper looks critically at related OA debates, evidence, complexities and practical challenges utilizing results of a Thai survey about consumer and producer perspectives on OP products. But it filters data using Life Cycle Assessment (LCA) approaches, social and sustainability science perspectives and a SDG lens affecting economic, social and environmental sustainability but especially food security and agri-food system sustainability as a whole.

The paper focuses principally on OP issues in one country. But its themes have relevance to other national contexts or wider, global debates about the roles of livestock and meat consumption in achieving SDG2 and other linked SDGs.

We use an interdisciplinary and cross-sectoral approach with some Thai evidence in response to the main underlying research question that guided our study: "in what ways can organic pork help or hinder achieving SDGs in Thailand?" Our work builds on an earlier unpublished Thai language WTP socioeconomic study borrowing some relevant data. However, the present paper is intended as a broader multidisciplinary response to the limitations and narrow focus of the earlier work, contributing new insights to WTP research, which has so far not adequately addressed broader sustainability concerns. Our working hypothesis for the present paper suggested that OP might contribute better to some SDGs than conventional pork. This assumption was based partly on sustainability claims by OA advocates and by academic studies. We examined related literature sources and summarized data from our Thai WTP case to illustrate the problem. Our preliminary research provided some unexpected results with a more nuanced view. Results suggest that WTP as a largely single, narrow objective mainly benefiting producers, marketers and traders could be a complicating or inhibiting factor in achieving some SDGs in Thailand. We also suggest similar issues should be considered for relevance in other cases and national contexts.

1.1. Sustainable Development Goal Linkages, Organic Food, Food Security and Livestock Sustainability Dilemmas

In 2015, the United Nations General Assembly (UNGA) agreed to 17 interconnected global SDGs intended to "transform our world" by 2030. Its vision (Article 7) stressed the need for a world where "food is sufficient, safe, affordable and nutritious" for all. Agenda 2030 included SDG2, a commitment to end hunger, achieve food security and improved nutrition and promote sustainable agriculture [8].

Some advocates suggest OA could be considered at least "part of the solution" to many cross-cutting issues that SDGs especially aim to address and are as follows: SDG2—Zero Hunger; SDG3—Good Health and Wellbeing; SDG6—Clean Water; SDG 8—Decent Work; SDG 12—Responsible Consumption and Production; SDG 13—Climate Action; SDG 14—Life Below Water; and SDG 15—Life on Land [3]. Some international agencies have also argued OA can support small farmers while helping achieve SDGs [9,10]. But problematically, the SDGs do not mention OA and even less of organic livestock farming or meat products. SDG2, referring to farmed animals and livestock, mainly encourages genetic diversity and gene bank investments to enhance agricultural productive capacity (SDG Targets 2.4 and 2.5). Moreover, as others suggest, more SDG2 work is especially needed to better understand synergies and trade-offs across all SDGs, affecting policies under different scenarios [11].

Meanwhile, international agencies have noted a lack of reliable evidence about some SDG targets related to sustainable agriculture, food security and nutrition with gaps in

available country or global data [12]. Major setbacks also followed the COVID-19 pandemic and war [13].

What are the implications for livestock sustainability, organic or otherwise? Recent UN Food and Agriculture Organization (FAO) projections indicate significant growth in global meat demand among low- and middle-income countries, increasing 80 percent by 2030. Growth entails many risks surrounding food and nutrition security, livelihood and equity, health and animal welfare and environmental impacts. Different meat products and value chains can potentially create adverse environmental impacts on soil, water, forests, biodiversity, climate change and more, depending on types or natural resources used, farming approach utilized and relations to the agri-food system as a whole. Environmental impacts of some products can be significant with tensions and trade-offs among livestock management and livelihood and environmental considerations and are not easy to resolve [14].

Agriculture, generally, and some livestock systems, particularly, already contribute to breaching the planet's ecological boundaries. Some studies suggest a sustainable (and healthier) future implies reducing meat consumption [15–17]. At the same time, FAO views the 2030 Agenda for Sustainable Development, as an overarching framework guiding future livestock development [18]. However, even FAO recognizes that the livestock sector needs to transform to address a multitude of interrelated socioeconomic and environmental challenges, in light of the 2015 Paris climate agreement and to meet SDGs [18]. Others have also stressed the importance of understanding roles of livestock systems and value chains in food security provision especially amid increasing urbanization and meat consumption in developing countries [19].

So how can increased consumer demand for meat be sustainable and reconcile with SDGs and especially with food security imperatives? We wrestle with some of these broader questions and contradictions examining OP sustainability issues in Thailand and how these might affect global academics and policy debates.

1.2. Thai Pork Sustainability Issues and Willingness to Pay Affecting Sustainable Development Goals

Across Southeast Asia an increase in domestic pork consumption, averaging 3.6 percent growth annually, has been observed from 1990–2003 [20]. In Thailand, an upper middle-income country, pork is one of the nation's most popular meats. Thailand is one of the largest pig producers in Asia, with 2017 data suggesting more than 19.5 million pigs raised on 180,000 pig farms [21]. Demand for pork among Thai consumers is increasing alongside consumer concerns about safety awareness and certification with market expansion [22–24].

More than 70% of livestock farms in Thailand, based on 2022 data, were poultry farms (mainly chicken) where beef cattle and pig farms were approximately 39 and 4%, respectively [25]. Since one farm can raise more than one type of animals; therefore, one farm-owner can be registered in several types of livestock farm. However, Thai people's domestic consumption rate per year for pork was 1.15 million tons while chicken and beef were 1.88 and 0.25 million tons, respectively [26], which indicated that pork was among the top two types of livestock consumed by Thais. Nonetheless, there are no recent official data or available public reports on actual numbers of organic farms or producers.

Growth in production has mostly been in intensive systems and large operations [27–29]. Yet pork production and consumption can contribute to adverse environmental impacts raising many ecosystem sustainability, socioeconomic and human health concerns. Intensive pig husbandry systems can generate large greenhouse gases emissions (GHGs), affecting climate and health [30]. Antibiotics use is another concern. In Thailand, despite wastewater treatments, antibiotics can remain in pond water with an estimate of 79.3 tons per year [21]. On the other hand, some have argued that organic pig farms are more environmentally friendly and considered safer, at least by many consumers [31].

Meanwhile, Thai organic food buyers have paid more attention to sustainability aspects of food production, including meat products. Strong correlations appear among con-

sumer intentions to buy with environment, animal welfare and local origin attributes [32]. Some consumers have demonstrated a higher willingness to pay (WTP) for organic foods. Recent studies on consumer preferences for pork safety in Thailand particularly suggest WTP premiums for organic products are influenced by a number of factors such as pork product certification and labels for food safety, animal welfare, country of origin and being ractopamine free. But the majority of consumers paid highest attention to drug (ractopamine)-free certified pork [24]. This is consistent with previous findings attributing WTP price premiums for products associated with health benefits as well as ethical and environmental concerns [33].

World production of pork declined from 2017 to 2021 partly due to the African Swine Fever epidemic affecting many pig farmers, especially in China and Southeast Asia. Since 2020, demand for pork consumption also diminished due to preventive measures associated with increased COVID-19 restrictions. To what extent disease, environmental and health crises will impact long-term pork consumption, organic or not, remains to be seen.

But even organically produced pork has not always guaranteed environmental protection or food safety. One recent study suggested Salmonella contamination detected on 11 Thai farms claiming to follow organic principles. Only one farm with official government organic certification appeared Salmonella free [34]. So even labelled organic pork products can pose public health risks.

Meanwhile, Thailand ostensibly remains committed to implementing Agenda 2030 and realizing all SDGs. Thailand's first Voluntary National Review (VNR) report on SDGs to the UN promoted its national Framework on the Promotion of Sustainable Agriculture 2017–2021 affecting SDG3, 12 and other goals [35]. The National Economic and Social Development Plan (NESDP) 2017–2021 also promoted scaling up of organic farming [36]. However, this NEDSP did not prioritize organic livestock farming or OP. This may be partly due to government emphasis on organic produce including some support for vegetable and grain farmers in pilot regions, but not necessarily livestock farmers. The Thai Ministry of Agriculture and Cooperatives (MOAC) is also a huge bureaucracy with different departments or institutes including Rice, Livestock, Extension, Economics, Irrigation and others with different leaderships and lobbyists which complicate management, policy development and political decision-making. In addition, other Ministries or departments including Health, Commerce and Industry can compete for influence in NESDP implementation while cross-cutting national priorities can be ignored. Industrial-scale, chemical approaches and special interests have also long dominated Thai agriculture, which have made scaling-up the organic sector more difficult [37]. This context still reinforces government policies and farmer and public perceptions of organic foods generally as a niche sector compared to chemical–industrial approaches. Moreover, the organic livestock sector is also a subniche with an even smaller and more limited number of OP producers or advocates.

2. Material and Methods

2.1. Theory and Method

This paper draws from multidisciplinary social and sustainability sciences to critically analyze SDG issues affecting OP while utilizing survey data from a Thai consumer study and other relevant data about organic foods. In summary, our paper aims to achieve the following:

1. Discuss Thai organic livestock production, marketing and consumption and the public's willingness to pay (WTP) particularly the one that affects food security for all;
2. Assess how Thai OP may or may not help achieve global SDGs utilizing consumer survey data drawing from and building on LCA approaches;
3. Identify policy issues deserving critical attention while suggesting future research to better understand organic livestock-based meat issues, food security concerns and SDG implementation challenges affecting Thailand and potentially other countries.

Based on social sciences and especially economic-related studies, we draw from and build on WTP approaches discussed elsewhere. WTP could be defined as a maximum price

a buyer is willing to pay for a given number of goods or services [38]. Others have referred to this more explicitly as willingness to pay a premium (WTPP) for organic food [39].

In past decades, many studies on organic meat and consumers have focused primarily on their preferences, behaviors and willingness to pay (WTP), which has been used as a marketing tool while creating added value to organic products including meat. WTP is often considered a major contributor or determinant of organic meat market share [40].

Attitude and awareness toward health and environmental concerns also play significant role in influencing consumers' WTP for organic foods [38]. Main financial beneficiaries have been OA producers or retailers who can often make higher profits over conventional foods. Related academic literature on WTP has focused on how to best reap economic advantages of, or decipher ways to better market, specific OA products or commodities. Some OA products also sometimes promote their health and food safety benefits to consumers including broader ethical considerations supporting environmental values or animal welfare [39,41–45]. But related work has only marginally discussed SDG linkages [46].

Core underlying value assumptions about much of the WTP literature and related government policies have been about promoting OA products to consumers, while favoring some producer or retailer groups, but with inadequate discussion about who largely benefits, or should, from higher priced OA products or about making OA products more widely available to those who cannot afford them. So far, the WTP literature also suggests limited examination of complex and contentious sustainability issues. In this light, we question and critique narrow, stand-alone WTP theoretical approaches and value assumptions, since WTP or WTPP can ignore broader sustainability implications, especially social and economic equity dimensions. We use SDGs as an overarching lens to frame this issue for the Thai case and to stimulate a broader global discussion about WTP assumptions and values.

We discuss Life Cycle Assessment (LCA) theory, modeling and empirical evidence affecting pig production. However, we do not attempt any full or detailed LCA study. Instead, the paper utilizes LCA concepts, methods and comparative literature to illustrate broader linkages (as well as disconnections) among OP aspirations or claims and SDG aims, as well as WTP literature with implications for Thai policy, pork sustainability, food security and the organic sector as a whole.

For example, environment, economic and social dimensions of SDGs can complement environmental assessment literature, including LCA, highlighting potential contributions to SDGs and agri-food systems, supply chains or products analysis [47–49]. However, one problem is LCA's limited environmental focus that largely omits economic and social aspects [50]. Others have suggested Life Cycle Sustainability Assessment (LCSA) as an expanded concept to better address economic and social gaps [51]. Moreover, such literature has not yet adequately addressed specific or complex, cross-cutting agri-food sustainability concerns, OA-related issues, or Thai contexts and cases. We concur that LCA is an inadequate assessment tool. Our simplified method highlights SDG-LCA (or LCSA) intersections with OP sustainability for Thailand and problems of discussing WTP alone without including LCSA-related perspectives. We highlight environmental sustainability aspects of pig production [52,53]. But we also discuss broader economic and social sustainability dimensions affecting the pork sector.

2.2. Survey Data

The primary WTP data discussed in our paper is obtained from a Thailand Science Research and Innovation (TSRI)-supported project with unanalyzed findings so far only accessible in a Thai language report. This TSRI study was not conducted with SDGs in mind, but the present paper borrows TSRI research results to discuss broader theoretical issues and SDG policy implications about the intersection of organic livestock management, locally managed organic family farms and consumer demand for OP. Due to an increasing demand for safe meat and a lack of adequate supply to meet growing consumers' needs, the purpose of the survey was to better understand consumers' perception and awareness

regarding OP and its production system including their WTP. The results of the study were intended to help design appropriate consumer outreach, improve sustainable local farm production and promote local food consumption.

Many consumers perceive OP to be safe, healthy and environmentally friendly meat for which they are willing to pay a premium price. But whether or not consumer demand alone is a realistic or sensible measure of sustainability in the context SDGs and especially food security imperatives is moot. This paper utilizes TSRI project survey data to illustrate such implications (and complications) for analyzing OP, WTP and SDG issues together.

A conceptual framework indicating some of the principal issues and relationships discussed is indicated in Figure 1 below.

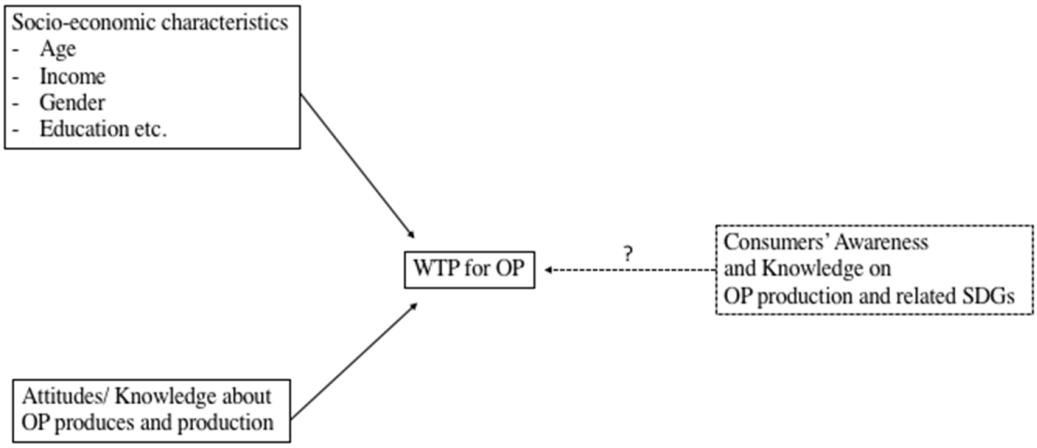

Figure 1. Conceptual framework.

The main aim of our initial survey research during 2019–2020 was to gain a better understanding of consumers' perception, attitudes and valuations of OP that could influence their WTP, especially among those mainly responsible for making purchasing decisions. This study used a multistage sampling technique. In the first stage, the Bangkok Metropolitan area (BMA) was purposefully selected (Figure 2). The purpose was to gather more insightful data and practical information about suitable markets and consumer outreach useful for small-holder producers (farmers) outside the BMA. In the second stage, the study purposefully selected a high population and high purchasing power area for data collection. In the third stage, respondents were selected for interviews using a convenience sampling technique. The survey was conducted at market places, supermarkets and stores where shoppers could purchase pork meat. We collected 400 samples where 309 of 400 respondents were responsible for buying decision in their households. The data collection instrument utilized was a questionnaire. A structured questionnaire was used to study characteristics, behavior of consumers and their higher WTP for OP. The structure of the questionnaire was pretested to check for potential flaws and inconsistencies. Any unclear questions were revised in order to get an acceptable response. The questionnaire was tested for reliability using Cronbach's alpha coefficient, with a value of 0.94.

To examine factors affecting WTP in consumers who made purchasing decisions, they were further divided into two groups: regular buyers and non-buyers (with and without OP purchasing experience). ANOVA analysis was used to find the attributes associated with these groups. Factors influencing consumers' higher WTP for OP were age, household income, branding and freshness/cleanliness. In order to examine higher WTP for OP at different prices (five levels), the Ordered Logit Model was used

Figure 2. Map of Bangkok Metropolitan Region, Thailand (the darker area represents Bangkok). Source: Thai Wikipedia (https://th.wikipedia.org/wiki/กรุงเทพมหานครและปริมณฑล) (accessed on 6 September 2023).

$$WTP_i = \alpha_i + \theta_i Age_i + \delta_i Ic_i + \gamma_i Br_i + \partial_i Fac_i + \varepsilon_i$$

That model more specifically refers to the following parameters:

WTP_i = Willingness to pay for OP in consumers;
α_i = Coefficient;
θ_i = Coefficient by factor i;
Age_i = Age;
δ_i = Coefficient of household income;
Ic_i = Household income;
γ_i = Coefficient of branding;
βr_i = Attitudes toward branding;
∂_i = Coefficient of attitudes toward freshness and cleanliness;
Fac_i = Attitudes toward freshness and cleanliness;
$\in_i$ = Error.

3. Results

3.1. Willingness to Pay Survey Analysis (Socioeconomic Characteristics)

Table 1 results' summary indicates that the majority of respondents were female (79%). Ages ranging from 25–54 years accounted for 70% of total respondents while 45% were graduates with a bachelor's degree and higher (21%). Household incomes of most were between 25,001–40,000 THB (23.5%), 10,001–25,000 (20.8%) and higher than 100,000 (17%). The meat most respondents consumed regularly was pork followed by chicken and fish. Ranking for each characteristic indicates sorted items from highest to lowest percentage.

Table 1. Socioeconomic characteristics of respondents (N = 400).

Demographic Characteristics	Items	Proportions (%)	Rank
Gender	Male	21	2
	Female	79	1
Age (Year)	18–24	12	5
	25–34	27.3	1
	35–44	22	2
	45–54	21.3	3
	55–64	14.2	4
	≥65	3.3	6
Education	Elementary school	6.3	5
	Middle school	5.8	6
	High school/vocational school	12.5	3
	Higher vocational certificate	8.8	4
	Bachelor's degree	45.5	1
	Higher than bachelor's degree	21.3	2
Household income (THB)	≤10,000	4.3	8
	10,001–25,000	20.8	2
	25,001–40,000	23.5	1
	40,001–55,000	9.8	5
	55,001–70,000	10.8	4
	70,001–85,000	6.5	7
	85,001–100,000	7.5	6
	≥100,00	17	3
Types of meat consumed regularly	Chicken	14.75	2
	Pork	67	1
	Beef	2.75	5
	Fish	12	3
	Seafood	3.5	4

Note: 1 USD = 34.08 THB; Bank of Thailand, July 2023.

3.2. Knowledge and Awareness of Organic Pork

Figure 3 below illustrates knowledge and awareness among consumers with a history of purchasing and consumption of OP tested using true/false questionnaires classified into five categories: (1) Health and Food Safety; (2) Quality and Value; (3) Animal Welfare; (4) Environment and Social Well-being; and (5) Accessibility. The majority with experience purchasing organic foods had relatively good OP knowledge. More than 90% received high scores for questions about environment and social well-being characteristics of OP. Second and third highest scores were on health and food safety, quality and value and animal welfare (86%, 81% and 76%, respectively). Consumer awareness on accessibility and distribution received the lowest score (65%), implying OP product availability was limited.

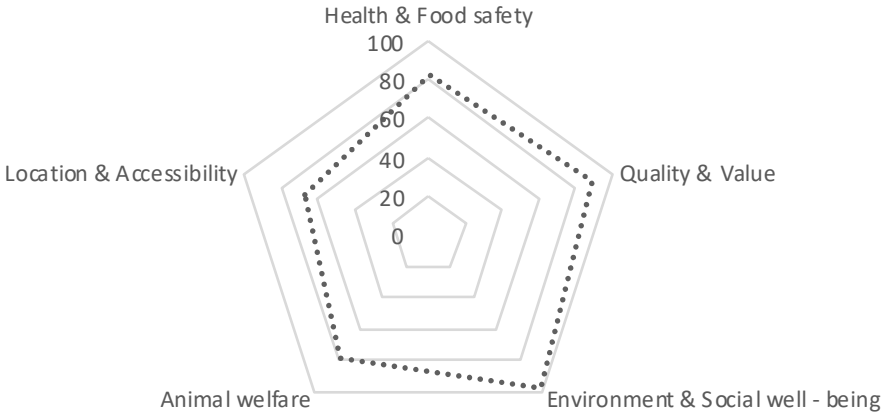

Figure 3. Knowledge or awareness of organic pork among Thai consumers.

3.3. Willingness to Pay for Organic Pork in Bangkok

Table 2 shows main factors contributing to consumers' WTP for OP around Bangkok. They reflect perspectives of 309 consumers who made buying decisions for their households. In particular consumers' characteristics such as age and household incomes (hh-incomes) significantly affected their decision to pay more for OP, i.e., regular buyers with higher age or higher hh-incomes were willing to pay more. Also, a higher WTP for branded or fresh and clean products was a main factor along with age and household income in the regular buyers group, whereas in the non-buyer group, the only factor affecting their decision to pay more for OP was household income. Further, we classified WTP prices into five classes. Each class is represented by the following price ranges: below 10% (Threshold 1), 11–20% (Threshold 2), 21–30% (Threshold 3), 31–40 (Threshold 4), and above 40% (Threshold 5).

Table 2. Factors associated with consumer WTP for OP.

Factor	Total		Regular Buyers		Non-Buyers	
	Coefficient	***p*-Value**	**Coefficient**	***p*-Value**	**Coefficient**	***p*-Value**
Age	−0.019	0.023 **	−0.036	0.015 **	−0.013	0.199
Household income (monthly)	−0.000	0.000 ***	−0.000	0.017 **	−0.000	0.000 ***
Producers' branding	−0.286	0.016 **	−0.447	0.038 **	−0.241	0.102
Freshness/cleanliness	−0.158	0.242	−0.486	0.088 *	−0.006	0.977
Threshold 1	−6.726	0.000 ***	−8.301	0.000 ***	−6.69	0.000 ***
Threshold 2	−5.857	0.000 ***	−7.364	0.000 ***	−5.809	0.000 ***
Threshold 3	−5.082	0.000 ***	−7.017	0.000 ***	−4.549	0.000 ***
Threshold 4	−3.702	0.000 ***	−5.583	0.000 ***	−3.174	0.000 ***
Threshold 5	−1.961	0.001 ***	−4.114	0.003 ***	−1.295	0.081 *
Log likelihood	−425.516		−146.128		−272.439	
Prob > chi2	0.000 ***		0.000 ***		0.000 ***	
Pseudo R2	0.049		0.071		0.040	
Total respondents	309		102		207	

*** *p*-value < 0.01, ** *p*-value < 0.05, * *p*-value < 0.1.

3.4. Life Cycle Assessment Applied to Organic Pork Sustainability in Production Systems

Pig production is a complex process and system requiring large inputs resulting in adverse environmental impacts affecting various supply chains. Evaluating pig production's environmental impacts alone is not an adequate determinant for measuring sustainability. Economic and social sustainability elements are also essential contributors [54]. Building on LCSA conceptualization, we below compare sustainability contributions of two systems, i.e., conventional and organic pig production. Conventional production that we generally refer to is a system that primarily uses agrochemical inputs in feed and where animal welfare is not a significant concern; hormones or antibiotics are used to manage animal growth

and disease; and industrial-scale approaches and large corporations dominate farmers' decisions. Evidence from various studies suggests, despite good intentions, organic foods may not always yield best results, depending on specific cases and contexts.

3.5. Pig Production Systems, Life Cycle Assessment and Sustainability Goals

Table 3 shows comparative impacts of two pig production systems (conventional and organic) on different sustainability dimensions and how each system contributes differently according to LCA- or LCSA-related indicators. This also illustrates which stakeholders could be affected or benefit from these husbandry systems. LCA indicators can partly explain pig husbandry system's environmental impacts due to its production processes. Building on LCSA, we use broader or more inclusive sustainability indicators, resources, environment/ecosystems, societal/economic and animal welfare.

Resources. Impacts of land use and occupation on conventional and organic pig production systems can be different. Some studies suggest organic systems have higher land occupation due to need for organic feed ingredients and potentially greater environmental impact expressed per Kg pig live weight produced. Moreover, despite limited data on water use or water use efficiency (WUE) in organic pig farms, some evidence suggests industrial pig farms may have highest WUE followed by traditional farms. This (some authors argue) could imply that industrial farms are more sustainable, in terms of water use, compared to other farm types such as organic or traditional farms [55].

Environment and Ecosystems. Table 3 suggests that both production systems contribute to global warming and climate change whereas conventional systems could lead to land toxicity compared to organic farming systems as per Tantasuparuk and Kunavongkrit [27,55,56].

Social and economic. Table 3 shows that even organic pork production systems may not significantly help achieve SDG2 (i.e., according to intended targets in Table 4). We also cannot rely on environment-related LCA indicators only. However, building on LCSA conceptualization, social and economic considerations can intersect with relevant SDGs.

Animal welfare. Organic production systems generally have higher concern for animal welfare, health and well-being more than conventional (industrial) production systems [57,58].

Table 3. Impact of pig production systems on different sustainability elements.

Elements	Conventional	Organic	Stakeholder	Related Source
Resource:				Dourmad, Ryschawy [55], Huong, Takahashi [59], Tuomisto, Hodge [60]
Land use	+	++		
Water use	+	++		
Environment and Ecosystem:				
Global warming (GHG emissions)	+	+		Thanapongtharm, Linard [28], Dourmad, Ryschawy [55], Tuomisto, Hodge [60], Karlsson and Röös [61]
Toxicity	++	?		
Biodiversity	−	+		
Social and Economic:				
Incomes	+	+	Producer	Lekagul, Tangcharoensathien [57], Delsart, Pol [58], Boogaard, Boekhorst [62], Lai, Wang [63], Qiao, Martin [64], Rauw, Rydhmer [65], Andretta, Hickman [66], Bastounis, Buckell [67]
Contribution to economic development	++	+		
Delocalization/migration	++	+	Producer/Community	
Well-being and living condition	−	+	Producer	
Health and safety	−	+	Consumer	
Affordability	++	+	Consumer	
Animal Welfare:	−	++		Delsart, Pol [58], Spoolder [68]

(++ greater impact; + moderate (fair) impact; − negative impact; ? no supporting evidence/unknown).

Table 4. Organic pork contribution to SDG2 or other SDGs in Thailand (authors' analysis of linkages to consumers/producers—August 2023).

SDG2 Target	SDG2 Cross-Cutting Themes	Intended Outcome	Perceived Value of OP		Related SDGs
			Consumer	Producer	
2.1	Food security	End hunger (with Safe and Nutritious Food)	Yes	Yes	SDG3: Good Health/Well-being
	Hunger		No	No	
	Safe food		Yes	Yes	SDG6: Clean Water/Sanitation
2.2	Malnutrition	End malnutrition	Yes	Yes	SDG3: Good Health/Well-being
2.3	Agricultural productivity and income;	Improve agricultural productivity and income	Yes (Mainly income)	Yes (Mainly income)	SDG1: No Poverty SDG8: Decent Work/Eco Growth SDG10: Reduced Inequality
	Marginalized groups (e.g., women; indigenous people; family farmers; pastoralists; and fishermen)		No (No evidence /rarely addressed)	No (No evidence /rarely addressed)	SDG5: Gender Equality (for women farmers)
2.4	• Sustainable food (production) systems; • Climate/disaster resilience	Promote (ecologically) sustainable food production	Yes	Yes	SDG6: Clean Water/Sanitation SDG12: Responsible Consump-tion/Production SDG13: Climate Action SDG14: Life Below Water SDG15: Life on Land
2.5	• Genetic diversity (seeds, plants, livestock, and breeds) • Traditional knowledge (preservation, utilization and promotion)	Protect genetic resources (agrobiodiversity)	No (No evidence /rarely addressed)	No (No evidence/ rarely addressed)	SDG4: Quality Education SDG14: Life below Water SDG15: Life on Land
2.a	• Agricultural research • Farmer extension	Increase agricultural research and extension investments	Not clear (Mainly focus on promoting food safety)	Not clear (Mainly focus on production)	SDG4: Quality Education SDG17: Partnerships

Table 4. *Cont.*

SDG2 Target	SDG2 Cross-Cutting Themes	Intended Outcome	Perceived Value of OP		Related SDGs
			Consumer	Producer	
2.b	Agriculture markets and trade	Prevent agriculture markets and trade distortions	No	No	SDG1: No Poverty SDG8: Decent Work/Economic Growth SDG12: Resp Consumption Prod
2.c	Food prices and commodity markets	Limit food price volatility (can exacerbate hunger/food insecurity)	No	No	SDG1: No Poverty SDG3: Good Health/Well-being, SDG8: Decent Work/Economic Growth

3.6. Organic Pork Sustainability and Sustainable Development Goals in Thailand

Although TSRI survey data was not collected with SDGs in mind (i.e., gathered from or suggested by survey participants), actual or potential OP linkages and disconnections with SDG2 and associated SDGs seemed evident. Some SDG-related issues or themes were apparent from TSRI project interviews and survey data. However, the TSRI project design and methodology did not focus specifically on asking SDG-related questions or assessing SDG linkages. So, Table 4 below presents our interpretation from our survey data and interview that provide evidence on WTP, illustrating possible OP contributions to various SDG2 targets or aims and how other SDGs are affected, inferred from Thai consumers' and producers' perspectives.

For example, improving intended outcomes for safe food, nutrition and ending hunger (SDG 2.1) with OP could help achieve some SDG3 (Good Health/Well-being) and SDG6 (Clean Water/Sanitation) aims. Thai consumers perceived OP mainly as a source of safe food according to its ostensibly toxin-free husbandry system. The majority of both consumers and producers also believed that OP contained higher nutritional value than conventional products. Yet, although OP may (but not always as it is dependent on monitoring, certification guarantees, etc.) contribute to food safety, its contribution to food security is less clear due to irregular and unstable supply and higher price (SDG target 2.1–2.2). On the other hand, for Thai producers and associated businesses, OP price premiums contribute to profitability and income generation (affecting SDG1: No Poverty, and SDG8: Decent Work/Economic Growth) especially for small-holder farmers.

In addition, OP can potentially help achieve SDG5: Gender Equality (especially for women farmers and their families in rural communities); SDG8: Decent Work/Economic Growth; and SDG10: Reduced Inequality. But only if agricultural productivity and incomes improve for all peoples (not only the few consumers who can afford higher value meats or producers and sellers getting price premiums). OP is part of a larger value chain involving many possible stakeholders and activities. To better achieve more SDGs, those stakeholders should include small-holder farmers in rural areas where poverty and inequality can be reduced and where women's roles in farming and their local economies are better valued and enhanced.

Moreover, a sustainable production system for OP can especially affect SDG 6: Clean Water/Sanitation; SDG12: Responsible Consumption/Production; SDG13: Climate Action; SDG14: Life Below Water; and SDG15: Life on Land. As such OP production could enhance or promote sustainable use of water, sustainable consumption, protect life on land and under water, protection or increase of biodiversity and its sustainable use or support climate change mitigation. But it does not necessarily depend on what LCA or LCSA or other indicators or measurement tools are used to assess and verify sustainability throughout the entire OP production system and value chain from farm to fork. Future research could use

LCA- or LCSA-related modeling more fully applied to OP in Thailand, on a case-by-case basis, at farm level and across the value chain. Additional surveys related to SDGs would also be useful. But such additional and critical analyses for particular regions, farms, local communities, markets, etc., go beyond the scope of the present paper.

4. Discussion

The organic sector in Thailand is relatively small compared to some countries or regions. Recent publicly available data indicates that Thailand so far has just 0.8% of land area used for certified organic production [69]. By comparison, Europe, as a whole, averages to around 3.6 percent while Oceania has 9.7 percent. Some individual countries, Austria for example, are at 26.5 percent, well above average [69]. But data on Thai organic livestock and meat is not systemically collected by government or reported in global organic statistics.

However, Section 1.2 above provides a general overview including some data about livestock share and different meat consumption rates of Thai peoples. Limited available sources also suggest that the share of organic livestock farms in Thailand is very low when compared to conventional (industrial) farms. The latest available number noting organic livestock farms certified by governmental offices was approximately 189 [70] with only about 6–7 organic pig farms. There may also be more small community organic farms that are not certified or registered by government, but there is no official data available regarding those. This requires further investigation in future research beyond the scope of the present paper.

Nonetheless, pork is still one of the highest consumed meats in Thailand, while some consumers view OP as a safer, more environmentally friendly choice. But even organic pig products may not always be environmentally, economically or socially sustainable.

Various drivers such as health awareness, product characteristics, quality and its nutritional value could influence WTP for any organic food including organic pork [38,71]. Previous studies have also shown that environmental awareness and ecological consumption behavior could be driven by consumer knowledge and attitudes [38]. Moreover, information concerning organic farming may be a major contributor or determinant influencing consumers' WTP [40]. Increasing consumer knowledge about environmental impacts of organic meat production could also lead to more sustainable food consumption [72].

However, our study suggests that WTP for OP is still largely a niche strategy supporting OP producers mainly in response to urban middle-class consumer demands as well as potential for increased incomes for some farmers or retailers. Nonetheless, we suggest that assessing this niche strategy alone cannot be a sufficient measure of multiple sustainability dimensions viewed through SDGs. In this respect, as Section 3.6's summary analysis complemented with Table 4 above suggest that OP can contribute modestly to some SDG2 targets, as well as potentially several other SDGs, but in limited ways, at least in Thailand. This raises many questions, concerns and research recommendations that are discussed below.

4.1. Willingness to Pay and Organic Pork Awareness among Thai Consumers

In Thailand and elsewhere, some studies on consumer WTP have been about price affecting consumers' purchasing behavior [33,38]. There also appears to be increasing consumer concern about food safety and personal health. Others suggest a majority would pay premium prices for organic and other sustainable food products that meet animal welfare standards [33,46]. Food safety label marketing also influenced Bangkok consumers to pay more for both government-led and private brands [73]. On the other hand, conventionally produced pork was considered more affordable and accessible.

But previous research on WTP for OP among Thai consumers suggests that most findings have emphasized WTP for price premium, certification, marketing, animal welfare and profitable investment in OP production [23,24,33]. Marketing for organically produced pork has been geared toward price premiums mainly affordable for middle and higher classes. Some studies report that WTP research for price premiums of OP could also help

producers make up for higher production costs, safety audits and labelling [74]. But most WTP research has focused on organic product marketing, branding, communication and economic value to encourage more producers to adopt sustainable farming and production practices or to influence policy making and government support.

Yet despite good intentions to support small-holder farmers and create value-added OP products, lower- to middle-class income families may have less access to safe or healthier food including OP. Previous WTP research for organic producers has tended to be more focused on profit generation with less attention to other dimensions such as contributions to ecosystem or social aspects, including small-holder farmers' well-being, rural development and equity. To date, research on WTP has also largely ignored environment, social well-being or broader food security considerations. Thus, so far, OP has not contributed much to most SDG2 targets specifically, or to some broader social, economic or environmental aims associated with other SDGs.

4.2. Organic Pork Production Systems and Life Cycle Assessment Application Limits

Some research has reported that both conventional and organic pig farms cause equally adverse environmental impacts especially for climate change, eutrophication and energy demand [55]. In contrast, some organic pig farms can even leave worse environmental impacts than conventional farms in terms of land occupation and acidification [55,75]. On the other hand, some organic pig operations have reduced environmental toxicity better than conventional farms [60,65,66]. Yet some studies suggest that conventional pig farms may contribute more to land and water use sustainability than organic farms, despite their environmentally friendly intention [59]. But no clear evidence demonstrates whether all organic pig farm husbandry positively increases biodiversity. This may depend on farm size and types, e.g., backyard, family farm or commercial farm [57,58]. But most organic or traditional pig farms have open pigpens with more space per pig or outdoor free ranges using more land than conventional farms due to higher animal welfare concerns. In addition, feed for organic pig farms requires more land [52,55,60].

LCA is one tool to assess environmental performance of pig production systems in both organic and conventional systems. Viewed through LCA, some organic livestock production systems may show more environment impacts than conventional systems due to resource efficiency [55]. However, LCA studies also have many limitations, rarely considering land degradation, biodiversity loss, pesticides or toxicity effects and animal welfare [76].

Actual practices on Thai rural community farms show organic pig farms may use 50–70% less water compared to conventional farm systems. Also, free-range pigs cannot compare with deep-bedded system regarding soil pollution since pig waste is normally absorbed into rice straw bedding. In addition, phosphorus shedding pollution in deep-bedded organic livestock system is less than other systems (Tantasuparuk, 12 February 2023, personal communication). So LCA can fail to accurately capture key characteristics of each farming system, i.e., organic and conventional farming in its analytical model, e.g., modelling organic fertilizers flows could lead to misleading interpretations of environmental performance impacts of organic agriculture. On the other hand, a broader approach including social and environmental considerations, such as LCSA, may address some limitations [51].

At the same time, both systems (organic and conventional) could contribute to income generation differently. Organic systems have increased small-holder farms wages and incomes supporting localization and migration reduction, while promoting better rural lives and community well-being [64,77,78]. Moreover, organic production systems have promoted safer practices and better living conditions for farmers offering food safety with better consumer health and well-being. Yet many find it difficult to afford or access organic products. Large-scale conventional pig farms, on the other hand, may contribute to some economic development and income generation while harming ecological systems [28,29,79].

4.3. Organic Pork Production System's Implications for SDG2 and Related Sustainable Development Goals

So how can we determine different system contributions to SDGs? One way is to examine various factors, e.g., animal welfare, water treatment system, land erosion or degradation, i.e., non-LCA indicators [76]. We should examine not only environment but societal and economic dimensions as well.

Agriculture is naturally associated with SDG2, but as seen from Table 4 above, it affects various other SDGs. OP could potentially help mitigate hunger, nutrition and food security concerns and be a good food option to improve or maintain health and well-being for some people (SDG2.1, SDG2.2, and SDG3). Also, OP could contribute to income generation and be an important source of protein while supporting poverty reduction (SDG 1), especially in rural communities. OP production systems could (if designed and managed properly) also promote life on land (SDG15) such as restoration and sustainable use of land.

At the same time, commercialized industrial OP production may not support genetic or livestock breed diversity (SDG2.5) as the majority use conventional breeds. Native breeds have normally been raised in small-scale backyard farms (5–10 pigs) for household consumption. Therefore, organic pig farming may not be the best model for large commercialization, but more suitable for rural village or community level farms, contributing to local food safety and security. Yet one major contributing factor to a drastic reduction in natural breed varieties has been growth and expansion of industrial farming.

Gender issues have also not been adequately investigated so far, especially female roles in organic meat purchasing. Our survey data, for example, indicated that the majority of shoppers were female (about 80%) while women play important roles in family food purchasing and decision-making. Other research on consumers' WTP about food safety and organic products also reported that majority (more than 75%) of buyers are women [24,33,73]. So how does gender, especially role of women in food purchasing decisions, affects SDG5 (gender equality) or other SDGs? This issue deserves further study.

Finally, OP can contribute to wider economic prosperity, reducing inequality. But OP acts as a means to gain price premiums for producers and resolve consumers' WTP conflicts with other SDG2 themes such as universal access to safe and nutritious food. Higher food prices could limit general consumer access if lack of supply and price controls are not well addressed (e.g., SDG2, Target 2.3). There is still little evidence that illustrates how OP has yet substantively contributed to economic sustainability among women or indigenous peoples. OP production systems can also promote ecosystem well-being and benefit environment or human health, which aligns with most consumers' perceptions about organic benefits [23,32,74]. Whether or how organic livestock husbandry systems can reduce GHGs and mitigate global warming (SDG13—Climate Action) while not threatening food production (Target 13.2) also requires further investigation.

5. Future Research and Recommendations

5.1. Lack of Research or Data on Pig Production System's Socioeconomic and Environmental Impacts

In Thailand, there is still insufficient data on how organic pig production systems contribute to food security and how different SDG2 dimensions are linked to other SDGs, under what contexts or circumstances and in different cases, i.e., local communities, ecosystems, provinces, or districts, affecting different kinds of consumers and producers. More research on LCA- and LCSA-related approaches is especially needed on OP climate change linkages and how such environmental contexts can affect propensities toward human or animal epidemics, or new livestock diseases.

So far, most Thai OP research and promotion policy has been narrowly about niche economic development, marketing and consumers' behavior with little attention to broader contexts or impacts of organic pig production, whether negative and positive. For example, more study is needed about impacts of different organic pig production on environment and ecosystem that include social aspects, local community and economic impacts, rural

migration, gender issues, etc. Further research should particularly examine how OP affects food security and agri-food sustainability as a whole in Thailand and elsewhere. In addition, large-scale farms and their economic dominance (collaborating with large supermarkets and other food value chain actors) remain controversial. Emerging swine diseases' effects on small-holder farmers also deserve further investigation, as well as whether or how OP production may help or hinder health promotion or disease prevention.

5.2. Agri-Food Systems, Food Security and Sustainable Development Goals Are Multi-Dimensional: Research Must Better Address Cross-Cutting Sustainability Issues and Be Interdisciplinary

Sustainable agri-food systems can potentially help reduce or eliminate hunger while promoting food security for all (the core aim of SDG2) and potentially contribute to other SDGs. Agriculture is not only about food production systems but also affects rural development, farmer well-being, socioeconomic equity, health, environment and more. Multiple factors must be assessed when measuring sustainability and how food systems or value chains, including OP can help achieve SDGs.

Further research should study SDG linkages, including how OP and organic livestock systems contribute to, or impede, sustainability in many dimensions, such as environmental, social and economic. Future WTP studies in Thailand and elsewhere could also be more useful if they revise their aims and scope to address broader sustainability concerns and metrics using SDGs and other tools. We hope our paper can stimulate a broader discussion about related concerns.

6. Conclusions and Policy Implications

In summary, OP can be viewed as a safe nutritional protein source. Yet our findings show that OP may only partially or modestly contribute to SDG2 achievement or help realize other interlinked SDGs in Thailand. This is because organic livestock promotion including pig farming has largely focused on consumer WTP and producer economic benefits but less on environmental or social aspects, food security, or reducing socioeconomic inequities. More broadly our paper, using a Thai case, has also shown that environmental concerns about pork products may influence consumers' purchasing decision and their WTP. Our study also attempted to link LCA analysis about OP with WTP approaches to highlight some issues not well addressed in other literature. But given our limited scope, and lack of other related studies, more research about OP production impacts on ecosystems and value chains through LCA, or LCSA more broadly, would be useful for Thailand or elsewhere.

6.1. Competing Interests: Poor Consumers, Small Producers or Large Companies?

OP as a high-end or premium product to help raise small-producers' incomes and encourage more investment in organic livestock businesses can be a double-edged sword. It could benefit small producers but may, depending on specific contexts or circumstances, negatively impact food security for all. Some consumers, especially lower- to middle-income people may have less access to safe food products, especially in times of volatile or rising food prices (note SDG2, 2.c).

The majority of pig farms in Thailand have also historically been small-holders raising less than 50 pigs [27]. Less than 1% have been large scale (>5000 pigs) while more than 46% of breeder pigs were owned by two large private companies. Approximately 6% have been native or indigenous breeds, normally raised by small backyard farmers in rural areas [27].

But with industrial farm production upscaling, small- and medium-sized farms are decreasing. In Thailand, approximately 70% of the country's total pig production and market share has been dominated by large-scale farms or companies while 50% belongs to only three large companies with small holder farms having only 30% share of total pig production [80].

This reflects a not so genuinely free or competitive market. Large companies are advantaged over small-holder farmers through consumer marketing, which can exploit

price premiums. When OP prices' increase and commercialized organic products such as pork grow (e.g., through large supermarket chains or branding), this can attract more investment from larger corporations as part of their "food safety" business portfolios. In some cases, small-holder farmers may not be able to compete and be forced out of business [27,81,82]. Policy makers and government agencies must design better supports for small-holder organic production in ways that simultaneously improve broader food security enhancement for all consumers while also addressing other environmental and socioeconomic concerns reflected in various SDGs.

6.2. Thailand's Inconsistent Organic Agriculture Policy

Since 2018 the Thai MOAC livestock department has promoted organic livestock farming nationally aligned with government-supported policy and OA promotion strategies [83]. They have focused mainly on poultry, dairy and deep-bedded swine organic farms, as well as organic feed. The National Development Strategy for Organic Agriculture promoted organic agricultural products to meet safety standards and increase farmer revenues [36]. However, the MOAC Organic Strategy ended in 2021 while a new national OA draft implementation plan, ostensibly initiated for 2022–2027, has never been officially launched. Instead, the MOAC livestock department has adopted the "Bio Circular Green Economy" approach complementing Thailand's government strategy linked to SDGs.

Meanwhile, the latest National Economic and Social Development Plan (2023–2027), still promotes organic livestock farming as small part of an environmentally friendly farming and high-value agricultural products strategy [84]. But it is not clear, yet, if or how OP will be considered in this plan, much less how OP can support in Thailand. Nonetheless, the Thai government so far seems to be aware of OA's potential importance to the national economy and how OA can support local food security and social well-being especially for rural communities. Following recent national elections in mid-2023, it also remains to be seen how support for OA-, OP- or SDG-related policies and programmes will continue or change. Further study is needed to monitor and assess new developments.

6.3. Summary Reflections

Our preliminary research results suggest that WTP as a largely single, narrow objective mainly benefiting producers, marketers and traders could be a complicating or inhibiting factor in achieving some SDGs in Thailand. It shows how OP may modestly contribute to SDG2 achievement or help realize other interlinked SDGs in Thailand but can also hinder some SDGs.

At the same time, to conclude, the SDGs say nothing about how livestock farming or meat production, marketing or consumption can help achieve zero hunger amid climate change or other environmental concerns. But we still suggest WTP for OP is an especially problematic priority if it does not better address broader sustainability concerns, cross-cutting SDGs and especially food security. This raises many questions and concerns about what research, policy incentives and technical supports are needed to make OP production more sustainable. If it can be, how so? The SDGs are also full of gaps and uncertainties about what roles OA generally, OP specifically, or sustainable livestock or meat products more broadly, should play in achieving SDG2 of zero hunger while eliminating poverty and addressing environmental, socioeconomic and health concerns linked to other SDGs. Future research must address such issues better in Thailand and elsewhere.

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Data Availability Statement: As our research is based on qualitative data with partial quantitative analysis, specific data regarding our survey findings is available upon request.

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Abbreviations List Summary

BMA	Bangkok Metropolitan Area
FAO	Food and Agriculture Organization of the United Nations
GHGs	greenhouse gases emissions
LCA	Life Cycle Assessment
LCSA	Life Cycle Sustainability Assessment
MOAC	Ministry of Agriculture and Cooperatives
NESDP	National Economic and Social Development Plan
OA	organic agriculture
OP	organic pork
TSRI	Thailand Science Research and Innovation
SDGs	Sustainable Development Goals
UNGA	United Nations General Assembly
VNR	Voluntary National Review
WUE	water use efficiency
WTP	willingness to pay
WTPP	willingness to pay a premium

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