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Transition or stick: Practices influencing the sustainability transitions of Taiwan's agricultural system

轉型或固守：影響台灣農業系統永續轉型的實踐因素

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Abstract: Sustainability transition has become a prominent topic for management research, aiming to identify new business models that drive the socio-technical system toward a new regime structure based on sustainable and eco-friendly practices. While existing research has predominantly focused on sectors like energy and transportation, the agri-food system, which plays a significant role in unsustainable production and consumption patterns, has received limited attention. This study aims to investigate the sustainability transition of Taiwan's agricultural system using the combinative lens of the multi-level perspective of transition and social practice approach. Semi-structured interviews were conducted with organic and non-organic farming practitioners, and structural topic modeling was employed to discover the critical practice ingredients influencing the transition of Taiwan's agricultural system toward sustainability. The empirical result indicated that, among the identified nine practice ingredients, "Perception on Environmental Sustainability in Practices" and "Image toward the Return on Practice Option" are particularly critical, as they reflect a pronounced difference in views between

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sustainable and non-sustainable practitioners. Policy implications for building a sustainable agri-food system in Taiwan are therefore elaborated and discussed.

Keywords: Sustainability transition, agricultural system, multi-level perspective, social practice approach, Taiwan.

摘要：永續轉型為管理領域的重要研究議題，旨在探討能推動社會技術系統朝向永續與環境友善實踐的創新商業模式。目前永續轉型研究多集中於能源與交通等領域，而農糧系統中雖然存在許多不永續的生產與消費模式，但相關轉型議題卻較少受到關注。有鑑於此，本研究結合多層次轉型觀點與社會實踐方法之理論視角，透過與有機和非有機農業實踐者的半結構式訪談以及結構主題建模（Structural Topic Modeling），挖掘影響台灣農業系統永續轉型的關鍵實踐因素。研究結果發現，在影響台灣永續農業轉型的九個實踐因素中，「實踐的環境永續性認知」和「實踐選項的報酬預期」尤具關鍵意義，因為永續與非永續農業實踐者對於這兩個因素的認知具有顯著差異，進而影響其實踐取向與轉型動機。基於此發現，本研究進一步針對台灣建構永續農糧系統提供政策建議與討論。

關鍵詞：永續轉型、農業系統、多層次觀點、社會實踐方法、台灣

1. Introduction

Given the increasing concerns over environmental protection, sustainability transition has become a prominent topic among scholars across various fields, engaging them in addressing the challenges posed by the incumbent "oversupply" economic system. This shift has called for new business models to drive the socio-technical system toward a new regime structure in which production and consumption behaviors are sustainable and environmentally friendly. However, the transition process is gradual, requiring a fundamental transformation of artifacts, institutions, actor behaviors, and their interactions (Geels, 2002; Markard *et al.*, 2012).

Research on sustainability transitions has grown steadily over recent decades, but its focus has been limited to specific sectors and geographical areas. According to Geels (2011), sectors with the most urgent need for sustainability transition include transportation, energy, and agri-food. However, existing literature mainly centers on transitions within the energy sector, followed by transportation, with minimal focus on the agri-food sector. While energy and transportation are undoubtedly critical for environmental sustainability, the agri-food system is also deeply involved in unsustainable production and consumption patterns closely linked to environmental issues (Köhler *et al.*, 2017). Moreover, previous studies have emphasized sustainability transitions in Western countries, such as England and the Netherlands, limiting our understanding of alternative transitional pathways and practices in Asian countries, where technical and social contexts differ significantly from those in the West. To address this gap, this study explores the sustainability transition of the agri-food system in Taiwan.

The Taiwanese government has implemented the Organic Agriculture Promotion Act, which promotes concrete standards for organic agricultural product labeling, aiming to guide and encourage farmers toward sustainable agricultural practices. The Act defines organic agricultural products as those produced, processed, packaged, and distributed based on principles of ecological balance and nutrient cycling without the use of chemical fertilizers, chemical pesticides, or genetically modified organisms and their derivatives (Organic Agriculture Promotion Act, 2018). Although the Taiwanese government began promoting organic agriculture in 2007, the proportion of land used for organic farming remains relatively low. In 2017, certified organic farmland accounted for only 0.95% of Taiwan's total agricultural land, whereas the average proportion of organic farmland in European countries was 7.03% (STPI, 2020). This disparity suggests that despite policy interventions aimed at disrupting the socio-technical regime, organic farming practices have not been widely adopted or diffused, resulting in a fragmented transition within Taiwan's agri-food system. This study, therefore, aims to examine the embedded practices that influence the sustainability transition of Taiwan's agricultural system, using a combinative perspective of the

multi-level perspective (MLP) of transition and the social practice approach (SPA). Given that sustainability transition is a complex process wherein policy effects and various embedded practices are challenging to capture, the combined perspectives of MLP and SPA help explain these complexities. While the MLP perspective has been prominent in transition literature by integrating the effects of policy as disruptions to the incumbent regime, SPA complements this by examining the roles of practice ingredients in generating, retaining, and refreshing the social practices that drive the system forward.

In Taiwan's agri-food system, government policy is expected to create windows of opportunity for farmers to shift their practices toward sustainability. However, the fragmented transition suggests that specific practice ingredients influence farmers' decisions to adopt or reject organic practices. Using data from semi-structured interviews with farming practitioners, this study applies the structural topic model to uncover the hidden differences in practice ingredients between organic and non-organic farmers. In doing so, this study contributes to sustainability transition literature by highlighting the transitional challenges facing Taiwan's agri-food system.

The paper is organized as follows. Section 2 introduces the literature on the combined perspectives of MLP and SPA, and the structural topic model. Section 3 outlines the data and methodology of this study. Section 4 presents the practice ingredients of organic and non-organic farming practitioners. Section 5 discusses the critical practice ingredients influencing practitioners' decisions to adopt organic practices.

2. Literature review

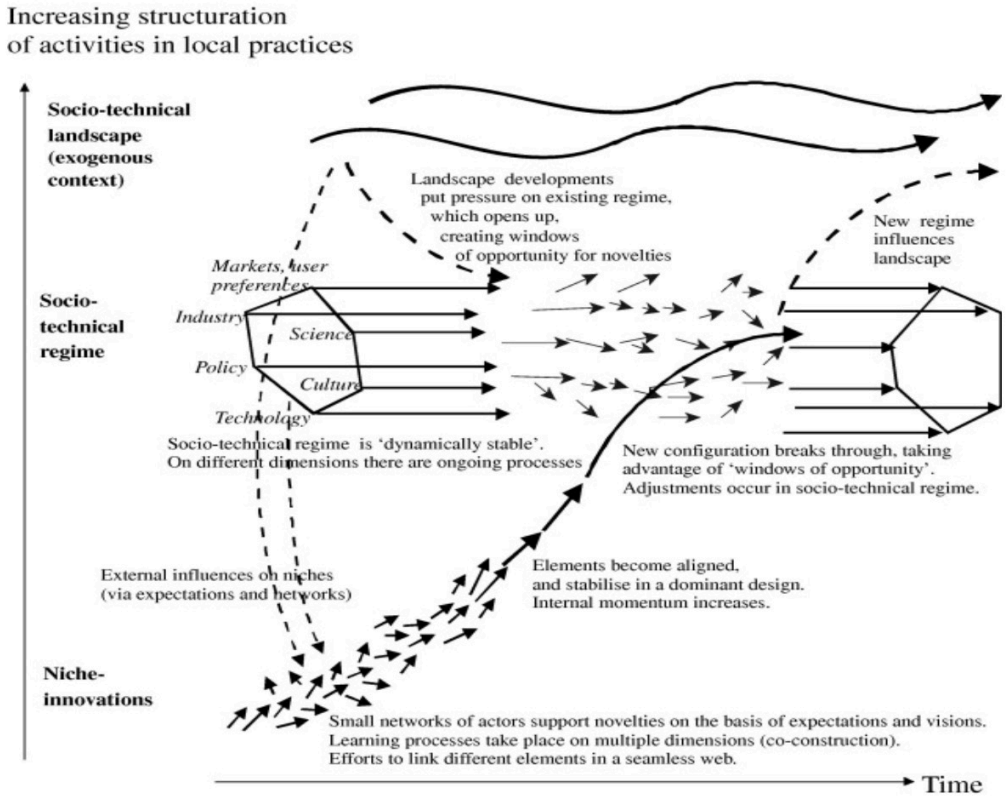
2.1 Combinative perspective of mlp and spa on sustainability transition

Sustainability transition can be conceptualized as an evolutionary process that shifts the incumbent, undesirable socio-technical system toward a more sustainable structure. Alongside this evolutionary process, new technologies, institutions, knowledge, and routines are developed, while the emerging

interaction modes among innovation actors that support sustainable production and consumption become increasingly legitimized (Markard, 2011; Markard *et al.*, 2012). Historically, socio-technical transitions have been widely observed in the energy, transportation, and agri-food sectors worldwide, though they vary in rate and direction due to differences in national contexts. To explain these embedded transitional dynamics, scholars have developed various theoretical perspectives, each with distinct analytical lenses.

The multi-level perspective of transition management has been a leading framework for explaining how transitions occur. It suggests that the socio-technical transition of a sectoral system results from the dynamic interplay between a meso-regime, a macro policy landscape, and micro-level innovation niches (Geels, 2002). The meso-level regime accounts for the deep structure of a socio-technical system, incorporating a coherent set of rules and institutions that guide and coordinate the behaviors of various system actors. Meanwhile, the macro-level landscape plays a critical role in disrupting the evolutionary equilibrium of the regime structure, thereby opening "windows of opportunity" for micro-level niche actors (Lo *et al.*, 2021). These innovative niche actors are equipped with novel approaches to reconfigure the existing regime structure.

However, compared to the MLP, which emphasizes the roles of policy and business activities in transitions by introducing new technology and production networks, research on the social practice approach has highlighted the importance of other social groups (e.g., users and practitioners) in sustainability transitions (Elzen and Wieczorek, 2005). Often overlooked in the MLP perspective, these users and practitioners may generate entrepreneurial ideas, experiment, and gradually improve, ultimately realizing the interactive effects between technical systems and social life. Specifically, the SPA perspective suggests that substantial progress in transition relies on changing social practices, which include three core practice ingredients: image, material, and skill (De Vries *et al.*, 2016). As Pantzar and Shove (2010) suggest, innovation is a continuous process shaped by the interactions between images, materials, and skills. Ongoing reformation and



Source: Geels (2004, p.915)

Figure 1

Multi-level perspective of transition

recombination of these ingredients ultimately lead to new social practices promoting sustainability transitions.

The MLP and SPA perspectives are complementary. While the MLP emphasizes the agency of national policies and market actors in transition but often neglects citizen participation, the SPA provides a lens for understanding the influence of social practices but lacks an explanation of the role of national policy in driving sustainability transitions (Seyfang and Smith, 2007). As a result, there is an increasing effort in integrating the two lenses for analysis of sustainability transition. One influential research in this regard is by Hargreaves *et al.* (2013). In

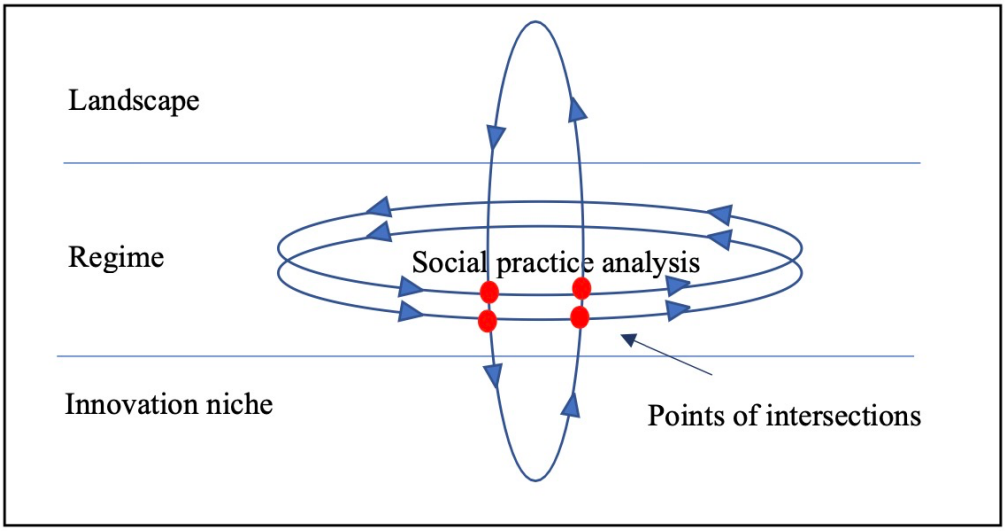
their study for analyzing two sustainability innovations, they found that it is the points of intersection between regimes (as emphasized by the MLP) and practices (as emphasized by the SPA) that facilitate or prevent sustainability transition. This insight has laid the foundation for subsequent researches for understanding how system structures and individual practices interact to shape the transitional trajectory. For example, Seyfang and Gilbert-Squires (2019) adopted a combined regime and practices analysis to the sustainability transition of retail banking sector in the UK, in which they argued that critical interaction points that lead to the lock-in of incumbent system could be transformed into opportunities for change. Focused on theoretical refinement, Keller *et al.* (2022) conducted a critical literature review on sustainability transition and suggested that combining MLP and SPA perspectives helps to connect maro-level system insights with a more nuanced, practice-oriented lens.

This study, therefore, adopts the combined perspectives of MLP and SPA, as suggested by Hargreaves *et al.* (2013), to explore the barriers to sustainability transition in Taiwan's agri-food system. Specifically, this study aims to identify the intersection points between the regime and social practices to examine how these intersections influence the practice ingredients of farmers in Taiwan (see Figure 2).

2.2 Structural topic model

The Structural Topic Model (STM) is one method within the family of topic modeling approaches. Topic modeling aims to discover abstract topics from a series of documents, automatically generating a set of descriptive terms for each topic. It assumes that each document contains a limited number of topics, with each topic described by several keywords (Chen *et al.*, 2015). This approach assigns a probability to each document regarding its likelihood of belonging to a particular topic (Beil *et al.*, 2002), making it advantageous for handling collections of documents with highly related topics and for effectively resolving polysemy issues (Pavlinek and Podgorelec, 2017).

Among current topic modeling methods, Latent Dirichlet Allocation (LDA)



Source: the authors

Figure 2
Analytical framework of this study

(Blei *et al.*, 2003) has been widely used to generate topics due to its ability to process large document sets and interpret latent topics (e.g., Erzurumlu and Pachamanova, 2020). The LDA model, introduced by David M. Blei *et al.* (2003), has found various applications. However, the LDA algorithm assumes that all documents in the corpus share the same distribution (i.e., a Dirichlet distribution) for topic proportions per document. For example, in documents recording interview texts, LDA assumes a consistent topic distribution per document, irrespective of document metadata, such as respondents' gender and affiliations. To address this limitation, Roberts *et al.* (2013) proposed the STM, which incorporates relevant document metadata into the prior distributions for document-topic proportions and topic-word distributions.

LDA and STM are Bayesian generative topic models, where each topic is a distribution over words, and each document is a mixture of corpus-wide topics. The probabilities in the topic-word distributions indicate the importance of specific words to the topic (Blei, 2012; Blei *et al.*, 2003; Roberts, *et al.*, 2019).

STM's improvements lie in the generative process, where topical prevalence and topical content can be functions of document metadata. Topical prevalence refers to the extent to which a document is associated with a topic, while topical content reflects the words used within a topic. These enhancements enable researchers to consider metadata effects when generating topics. Mathematically, the generative process for each document d with vocabulary of size V for a STM model with K topics are described as follows.

I. For each document *d*, generate a document's topic distribution θ_d from a logistic-normal generalized linear model based on document covariates X_d, shown as Equation (1).

$$\vec{\theta}|X_d\gamma,\Sigma\sim\text{LogisticNormal}(\mu = X_d\gamma,\Sigma) \quad (1)$$

where X_d is a 1×p vector, γ is a p×(K-1) matrix of coefficients and Σ is a (K-1)×(K-1) covariance matrix.

II. Build the document-specific distribution over words representing each topic (*k*) by the baseline word distribution (*m*), the topic-specific deviation $\kappa_k^{(t)}$, the covariate group deviation $\kappa_{y_d}^{(c)}$, and the interaction between the two $\kappa_{y_d,k}^{(i)}$, given a document-level content covariate y_d. And,

$$\beta_{d,k} \propto \exp\left(m + \kappa_k^{(t)} + \kappa_{y_d}^{(c)} + \kappa_{y_d,k}^{(i)}\right) \quad (2)$$

where m, and each $\kappa_k^{(t)}$, $\kappa_{y_d}^{(c)}$ and $\kappa_{y_d,k}^{(i)}$ are V-length vectors containing one entry per word in the vocabulary.

III. Assign words in each document to topics based on a document-specific distribution over topics as Equation (3).

$$z_{d,n}|\vec{\theta}_d\sim\text{Multinomial}(\vec{\theta}_d) \quad (3)$$

Conditional on the topic selected, determine an observed word from the topic as Equation (4).

$$w_{d,n}|z_{d,n},\beta_{d,k=z_{d,n}}\sim\text{Multinomial}(\beta_{d,k=z_{d,n}}) \quad (4)$$

Given the advantage of STM, it is increasingly applied to understanding organizational phenomena. For example, Hu *et al.* (2019) applied STM to hotel

reviews in New York City to reveal the aspects of hotel consumers' dissatisfaction. Similarly, Schmiedel *et al.* (2019) quantified employees' perception on organizational culture by using STM to analyze employee reviews from Fortune 500 companies. Applications of STM also include exploring leader challenges (Tonidandel *et al.*, 2022), extracting consumers' perceived service quality, and identifying emerging technological trends (Choi and Woo, 2022), etc. These studies have demonstrated the growing potential of STM in exploring complex organizational phenomena through textual data analysis.

3. Methodology

3.1 Data collection

This study first collected Taiwan's organic policies and regulations to identify the landscape pressures exerted by the government to shift farmers' practices toward organic methods. After that, this study conducted semi-structured interviews with farmers, including those practicing organic and non-organic farming. A total of 10 farmers participated, primarily cultivating leafy vegetables and short-term crops like gourds and melons.

Grounded in the MLP, this study examines how vertical cycles of government policy—such as changes before and after implementing organic farming regulations—affect practitioners. A horizontal cycle framework based on Pantzar and Shove's (2010) three elements (image, material, and skill) was used to develop the interview guide. For the skill element, the guide covered questions on access to cultivation techniques, improvement strategies, crop marketing, and relationships with distribution channels. The image element addressed views on farming practices and attitudes toward environmental sustainability, while the material element included questions on aspects like the farm environment and support from intermediary organizations, such as agricultural research stations and farmers' associations. All interviewees consented to recording, and the interviews were transcribed verbatim.

Interview lengths ranged from 1 to 3.5 hours, depending on participants'

willingness and the depth of their responses. The interviews were conducted between June and September 2021 at each participant's farm. Table 1 provides information about the practitioners and their farms.

3.2 Data analysis

Data analysis includes four main tasks, explained as follows.

3.2.1 Text preprocessing

Before analyzing interview transcripts with STM, it was necessary to conduct text preprocessing. Since Chinese words are not separated by spaces as they are in English, preprocessing included appropriate word segmentation for Chinese text. This study used the R package Jieba for Chinese word segmentation. After segmentation, additional preprocessing tasks included removing punctuation, Jieba's default stopwords, and numbers, resulting in a dataset of 3,238 words.

Table 1
Information of interviewed practitioners

Practi-tioner	Location	Years of Farming	Interview length	Initial practice	Current practice
A	Tainan	> 20 years	1 hour	Organic	Organic
B	Nantou	2 years	2 hours	Organic	Organic
C	Yunlin	14 years	2.5 hours	Non-organic	Organic
D	Chiayi	> 20 years	2.5 hours	Organic	Non-organic
E	Chiayi	6 years	3 hours	Non-organic	Non-organic
F & G	Chiayi	3 years	3.5 hours	Non-organic	Non-organic
H	Yunlin	> 20 years	2 hours	Non-organic	Organic
I	Chiayi	7 years	2 hours	Organic	Organic
J	Tainan	3 years	2 hours	Organic	Organic
K	Chiayi	3 years	2 hours	Non-organic	Non-organic

This study further refined the vocabulary by developing a custom Chinese stopword list, which included units of measurement (e.g., “once,” “two years”), temporal references (e.g., “yesterday,” “someday”), and modal particles (e.g., “otherwise,” “based on”). Synonyms were standardized; for instance, terms like “cucumber,” “bok choy,” and “cabbage” were labeled uniformly as “vegetable,” while “pineapple,” “melon,” and “honeydew” were categorized as “melon and fruit.” Additionally, words mentioned by only one practitioner were considered specific to that individual and removed from analysis. After preprocessing, the final word count for analysis was reduced to 858.

3.2.2 Covariates setting

Including metadata, or covariates, is an advantage of STM within the family of topic modeling methods. STM integrates metadata covariates in two primary forms: topical prevalence and topical content. Topical prevalence allows observed metadata to influence the frequency with which a topic is discussed, while topical content enables observed metadata to affect the word distribution within a specific topic. This study focuses on the practice of organic farming; thus, covariates were set according to whether a farmer was an organic or non-organic practitioner at the time of the interview. Furthermore, the study aims to identify the elements influencing practitioners’ behaviors within the MLP and SPA frameworks. Interview questions were tailored to ensure relevance to MLP-related policy aspects and SPA’s three core elements, suggesting that interview responses align with consistent topics. However, this study assumes that organic and non-organic farmers may express different views on the same topics. Accordingly, metadata was incorporated into the model as topical content rather than topical prevalence.

3.2.3 Number of topics evaluation

Based on the structured text data post-preprocessing, this study used the R package stm to conduct analyses. When fitting an STM model, users must specify the number of topics. Previous studies frequently relied on semantic coherence and exclusivity indicators to evaluate the ideal number of topics. However, this study could not apply these indicators, as they are intended for models without

content covariates. Instead, this study used two indicators—held-out log-likelihood and residual—to help determine the topic number. The held-out log-likelihood indicator assesses the model's prediction performance, while the residual indicator evaluates the variance dispersion level within STM's data-generating process (Roberts *et al.*, 2019). Higher log-likelihood and lower residual values indicate optimal solutions (Weston *et al.*, 2023).

This study anticipated that the number of topics would not be significant, as farmers focused their responses on perspectives related to MLP and SPA. After examining the held-out log-likelihood and residuals for models with 5 to 15 topics, this study selected the 9-topic solution, as it yielded the lowest residuals and high log-likelihood.

3.2.4 Labeling topics

Labeling the estimated topics was necessary to interpret success and failure cases during the sustainability transition process. This study identified and labeled each topic by examining four metrics provided by the stm package. These metrics included PROB, which measures the words most likely generated from a given topic, and FREX, which identifies frequent words within a topic yet unlikely to appear in others. Based on the meanings of the topics, this study assigned each topic to either skill, image, or material from the SPA perspective. These topics represent the practice ingredients affecting farmers' sustainability transitions.

Through STM, this study identified the ingredients discussed by interviewed farmers as they encountered an unstable regime influenced by Taiwan's organic policy. Additionally, this study distinguished the discussions and concerns around the same ingredients between organic and non-organic farmers.

4. Results

4.1 Unstable regime driven by Taiwan's organic policy

Taiwan has introduced the "Enforcement Rules of the Agricultural Production and Certification Act" and the "Organic Agriculture Promotion Act" to promote sustainable practices in the agricultural sector. The "Enforcement Rules

of the Agricultural Production and Certification Act," launched in 2007, is considered a critical milestone in Taiwan's sustainable agricultural development. Furthermore, the "Organic Agriculture Promotion Act," introduced in 2018, promotes environmentally friendly agriculture and the sustainable use of resources. This Act defines organic agriculture as the production of agricultural products—including crops, forests, aquaculture, and livestock—based on principles of ecological balance and nutrient cycling, prohibiting the use of chemical fertilizers, pesticides, and genetically modified organisms in these products. Despite the government's introduction of organic farming and TAP (Traceable Agricultural Product) practices in 2007, the certified agricultural acreage for these practices remains low, accounting for less than 4% of total agricultural land.

Guided by the perspectives of the MLP, this study examines policies promoted by the Taiwanese government for organic agriculture, which may contribute to instability in the socio-technical regime of the agri-food system. Based on viewpoints from the SPA, various factors influence changes in practice. Consequently, this study categorizes organic agriculture policies into three phases based on the timeline of relevant organic legislation in Taiwan: the pilot phase of organic practices (1997–2003), the development phase (2003–2018), and the promotion phase (post-2018), with relevant legislation summarized in Table 2.

4.2 Number of topics determination

This study posits that the number of topics should be limited, given that the farmers' responses primarily concentrate on aspects of the MLP and SPA. Figure 3 displays the held-out log-likelihood and residuals for models encompassing 5 to 15 topics. Upon reviewing these results, this study adopts the 9-topic solution, which presents the lowest residual and a satisfactorily high log-likelihood.

4.3 Practice ingredients of Taiwan's agri-food system

Table 3 displays the results of implementing the STM. The second column details the mean proportion of each topic within the document, with Topic 6 appearing most frequently at 16%, followed by Topic 7 at 12%. However, the proportions of the nine topics are relatively similar, indicating that each topic holds

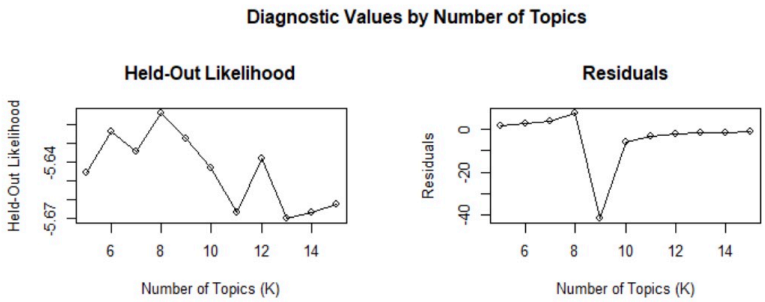


Figure 3

The diagrams of held-out log-likelihood and residual

Table 2

Legislation stages of organic agriculture practice in Taiwan

Period	1997-2003	2003-2018	After 2018
Stage	Pilot	Development	Promotion
Objective of stage	Establish production and labeling guidelines for organic agricultural products	Establish a clear legal basis for the regulatory management of organic agricultural production	Enhance the overall quality and safety of organic agricultural products
Example of key regulation	1999/3/15: Regulations Governing the Standards for Productions of Organic Agricultural Products 1997/1/22: Regulations Governing the Trial Operation for Labeling Organic Agricultural products	2003/9/15: Regulations Governing the Management of Organic Agricultural Products 2007/7/6: Regulations Governing the Management of Organic Agricultural Product Production and Certification	2018/5/30: Organic Agriculture Promotion Act 2019/5/14: Organic Agriculture Incentives and Subsidy Regulations

comparable significance within the corpus.

This study configured the covariate to influence the topical content when designing the STM model. This configuration enables the STM model to reveal topics where organic and non-organic practitioners discuss the same themes using

Table 3
Keywords and labels of the topics derived by structural topic model

ID	Prop.	Keywords measured by FREX			SPA
		Non-organic	Organic	Topic Label	Element
1	10.8%	Greenhouse, market, output, subsidy	Greenhouse, land, regulation, subsidy	Practice Asset	Material
2	10.4%	Too poor, hard, subsidy, young people	pest, serious, subsidy, income	Practitioners' image toward the return on practice option	Image
3	10.0%	Soil, herbicide, pest, leaves	farm, soil, organic fertilizer, ok	Internal and external environments for practice	Material
4	9.8%	Non-toxic, cooperation, consumer, deliver	Dealer, Cooperation, non-toxic, subsidy	Sales capability	Skill
5	10.1%	Consumer, traceability, using pesticide, TARI*	Fan club, traceability, methods, TARI*	Ability to build a consulting network	Skill
6	16.4%	Agriculture, assistance, help, environment	Customer, association group, concept, protect	Practitioners' perceptions of environmental sustainability in practices	Image
7	12.1%	Pesticide store, farmer association, crop, wholesaler	Supply product, dealer, accreditation company, capability	Supply capacity	Skill
8	10.0%	Solve, production, fertilizer, plant	production, solve, problem, method	Cultivation technique	Skill
9	10.3%	Market, transformation, agriculture, government	Small farmer, market, subsidy, group meal	Supporting system	Material

* TARI is the abbreviation of Taiwan Agricultural Research Institute, Ministry of Agriculture.

different vocabularies. The third column of Table 3 displays the four keywords, measured by the FREX metric, for non-organic and organic practitioners. Based on the vocabulary used by practitioners and the interview transcripts, this study names the topics, with the names listed in the fourth column. By referencing the topical contents and the perspectives of the SPA, this study classifies each topic into one of the SPA elements: skill, image, or material, thereby treating the topics as ingredients of these elements.

Figures A-E are diagrams depicting the topical perspectives of organic and non-organic practitioners regarding the derived topics. These figures present the top 40 words discussed by both types of practitioners for each topic, with the importance of each word measured using the PROB metric. The font size reflects the probability value's magnitude, with words positioned more centrally indicating vocabularies commonly discussed by both types of practitioners. The following paragraphs use Figures A-E and the keywords identified by the FREX metric in Table 3 to elucidate each topic and its corresponding SPA ingredients, supplemented by statements from the interviewees.

4.3.1 Topic 1: Practice asset

Table 3 and Figure A illustrate that the keywords associated with Topic 1 include “greenhouse,” “agricultural product,” “land,” “regulation,” and “subsidy.” This topic pertains to the resources, materials, and assets required by farmers in their practices. Consequently, this study names Topic 1 “practice assets,” corresponding to the Material element of the SPA.

Both organic and non-organic practitioners emphasize the importance of owning or leasing land to engage in agricultural practices. While a minority of practitioners inherit land from their parents for farming, most must lease land from others. When leasing, practitioners must negotiate with landowners for any additions or modifications to structures or greenhouses, which can limit their willingness to invest. Additionally, the time-bound nature of lease contracts often leaves agricultural practitioners uncertain about making long-term investments in their practices. The sustainability transition process frequently involves substantial

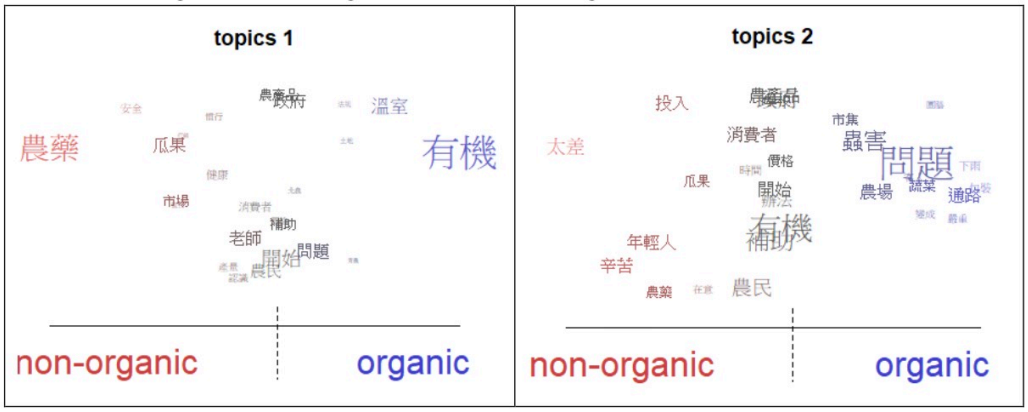


Figure A
Topical perspectives between organic and non-organic practitioners on topics 1 and 2

reforms and expenditures, such as changes in materials and expansions of greenhouse facilities. Therefore, securing the necessary resources and managing cash flows are critical for sustaining these practices.

4.3.2 Topic 2: Practitioners' image toward the return on practice option

According to Table 3 and Figure A, keywords associated with Topic 2 include "subsidy," "input," and "price." The typical definition of return rate is the ratio of revenue to cost. Practitioners choose agricultural practices offering higher returns after considering benefits and costs. However, different types of practitioners perceive the scope of costs and benefits differently, leading them to adopt distinct practices.

Regarding costs, most organic practitioners actively use methods compliant with organic standards for pest and disease management; however, some practitioners opt for more passive methods to reduce costs. For instance, Practitioner C stated, "*If we plant a whole field, the crops have some pests to some extent. Nevertheless, I choose not to treat them because, indeed, ... treatment is also a cost burden.*"

Regarding revenue, organic practitioners consider tangible monetary gains

and intangible benefits, such as health and food safety. Practitioner I noted, "*Farming is, of course, to make money, but if you can achieve health, safety, environmental friendliness, and profitability, these are certainly the best goals.*"

In addition to current earnings, organic practitioners hold a more optimistic view regarding the prospects of the organic agriculture industry. They believe that increasing consumer awareness of food safety, the absence of pesticides in organic produce, third-party auditing mechanisms, and certification standards will reassure consumers and gradually lead to a thriving organic market. These perceptions bolster organic producers' confidence to continue their practices. As Practitioner H mentioned, "*The demand for organic products is gradually increasing, and consumer awareness of organic matters, food safety, and sustainable agriculture is also on the rise, which leads to greater recognition of these products.*"

Non-organic practitioners recognize the advantages of organic practices but perceive that the time, labor, and costs required for organic farming are considerable. In comparison, their practices reduce time and minimize uncertainties. Although non-organic products do not command the same market prices as organic ones, practitioners believe they are still responsible to consumers and society. They refrain from using chemicals and ensure agricultural products pass pesticide residue tests before entering the market. For example, Practitioner G stated: "*Organic control relies on the workforce or uses materials, hormones, or other things, which can sometimes be more expensive than pesticides. ... Regarding labor, I believe organic practices require at least two to three times more effort... I think it's fine to keep pesticide use within safe levels. Pursuing organic standards is just too exhausting.*"

4.3.3 Topic 3: Internal and external environments for practice

As shown in Table 3 and Figure B, the keywords for Topic 3 include "soil," "farm," and "pest and disease." These keywords suggest that Topic 3 pertains to the internal and external environments of farms, such as soil quality, farm climate, and activities at neighboring farms, all of which impact practitioners' production activities. Based on the SPA perspective, this study categorizes this topic as the

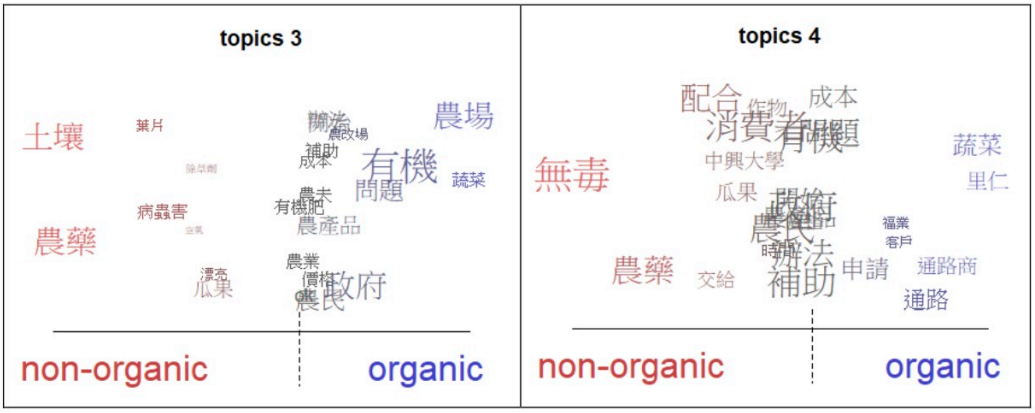


Figure B
Topical perspectives between organic and non-organic practitioners on topics 3 and 4

Material element and names it as “internal and external environments for practice”.

To prevent pests, diseases, and external influences from neighboring fields, most organic practitioners opt for greenhouse cultivation and strive to maintain good relations with neighbors. As Practitioner H mentioned, “*Poor relations can lead to problems, such as neighbors spraying pesticides without notice, which then drift into your field*.” However, Practitioner B’s farm is situated at a higher elevation with fertile soil, fewer pest issues, and no nearby farms, making open-air cultivation feasible. By following the principles of “*right time, right place, right crop (choosing the appropriate variety)*,” the farm achieves high yields.

For non-organic practitioners, the influence of nearby farms presents challenges to their sustainability transition efforts. Practitioner E feels unable to manage the uncertainties associated with the surrounding farmland. Practitioner J's farm, located downstream from a river, frequently suffers from soil contamination due to upstream farms following heavy rains. Consequently, unresolved external environmental conditions have led them to abandon plans for organic certification.

4.3.4 Topic 4: Sales capability

Table 3 and Figure B illustrate that the keywords for Topic 4 include consumer, dealer, and channel. These keywords relate to the distribution channels for agricultural products, leading this study to name Topic 4 as "sales capability" and categorize it under the Skill element of the SPA. The distribution channels and expertise differ between organic and non-organic practitioners.

Organic practitioners typically have diverse distribution channels. Some organic practitioners benefit from local government regulations requiring junior high and elementary school nutrition lunches to include organic leafy vegetables. This administrative order has created a market for organic leafy vegetables, making school meal services a primary channel for many organic practitioners, like Practitioners A and G. Other common channels include signing supply contracts with organic produce distributors, collaborating with e-commerce platforms, selling organic vegetables to major retailers such as PX Mart, Costco, and Carrefour, and participating in weekend farmers' markets. Substandard agricultural products are typically sold directly through traditional non-organic markets. To establish a variety of channels, organic practitioners must be proactive. Practitioner C recalls entering agriculture over a decade ago, initially contacting Leezen distributors by phone and later actively participating in weekend farmers' markets, setting up a personal website, and eventually having distributors reach out online.

Most non-organic practitioners primarily utilize wholesale fruit and vegetable markets and dealers as their sales channels. Practitioner F explained, "*The former involves transporting agricultural products to wholesale markets where they are auctioned at a shouted price*, while the latter involves selling the produce to dealers, with prices determined by these dealers and subject to significant fluctuation."

4.3.5 Topic 5: Ability to build a consulting network

Table 3 and Figure C reveal that the keywords for Topic 5 include "Taiwan Agricultural Research Institute (TARI)," "teachers," "government," "planting," and "pesticide use." These keywords suggest that farmers inevitably encounter

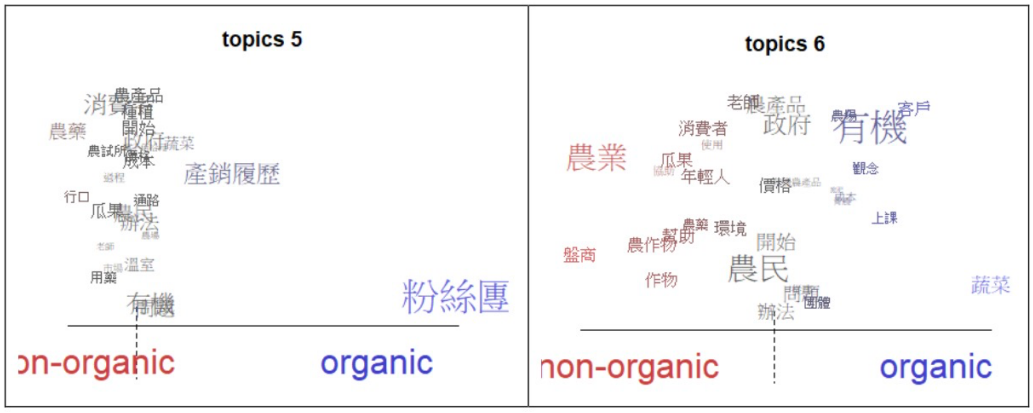


Figure C
Topical perspectives between organic and non-organic practitioners on topics 5 and 6

challenges in planting or sales. At such times, finding relevant resources to address these issues becomes an essential skill for practitioners. Therefore, this study names Topic 5 the "ability to build a consulting network" and categorizes it under the Skill element of the SPA.

Regarding planting, organic Practitioner I explained, "*If there is a problem with plant growth and I do not know how to solve it, I will ask friends. After that, I will ask teachers if I still cannot solve the problem. I used to attend classes at the Tainan Agricultural Research and Extension Station (ARES), so I know quite a few teachers there.*" Non-organic Practitioner G stated, "*When a problem arises in my fields, I ask my teachers directly. I go wherever my connections are. For us, the quickest solution is to ask teachers at the TARI.*"

In addition to cultivation issues, practitioners often encounter challenges with sales. Organic Practitioner C mentioned, "*Friends I met in classes at the ARES introduced me to the school cafeteria at Fuzhi Junior High School, which needed organic produce. We started cooperating directly with Fuzhi Junior High School and gradually expanded to other channels.*" Non-organic Practitioner D stated, "*In the early days of farming, product sales relied on introductions from a relative's contacts, followed by online connections.*" These examples highlight the

importance of establishing a supportive network for agricultural practice.

Although both organic and non-organic practitioners build consulting networks, the nature of their inquiries differs. Non-organic practitioners often seek information about pesticides, as exemplified by Practitioner F: "*Government organizations, the ARES, and the Toxicology Institute provide pesticide usage charts. This one was given to me by a professor from National Taiwan University, who teaches pesticide use.*"

4.3.6 Topic 6: Practitioners' perceptions of environmental sustainability in practices

This topic has the highest mention rate. The presence of keywords such as "protect," "assistance," "environment," and "concepts" indicates that this topic involves practitioners' perceptions of the impact of various farming practices on environmental sustainability. This awareness, in turn, influences their actions. This study names the topic "practitioners' perceptions of environmental sustainability in practices" and classifies it under the Image element of the SPA.

Most organic practitioners express that their actions are not merely routine production activities but also efforts to minimize damage to the land and protect the surrounding ecological environment. They believe that overreliance on pesticides will lead to increasing difficulties in managing pests and diseases in the future. Practitioner J stated, "*Our environment is deteriorating… with excessive fertilization, which is why I choose to grow organically.*" Practitioner I commented, "*If you spray, there will be pesticide residues. Some say it's fine if the residues are minimal, but what if they cannot be eliminated? What about long-term accumulation?*" Practitioner H described, "*Organic [farming] is friendly to both ourselves and the environment... that is the way forward.*"

The non-organic practitioners interviewed acknowledged that while pesticides can be effective and yield quick results, they also pose risks when improperly applied, leading to soil and environmental pollution and the development of pest and disease resistance. Therefore, they emphasized the importance of understanding proper pesticide use and the effects of chemicals. They strive to balance environmental considerations with production, adhering to

reasonable and safe pesticide use principles to support sustainable, continuous production.

4.3.7 Topic 7: Supply capacity

Table 3 and Figure D demonstrate that the keywords for this topic include "supply," "distribution," and "agricultural products." These keywords indicate that agricultural practitioners in Taiwan are predominantly small-scale farmers with relatively low production volumes, resulting in weaker bargaining power with downstream distributors or packaging factories. Consequently, enhancing production capacity and ensuring a stable supply have become critical skills for practitioners to focus on and develop. Therefore, this study names Topic 7 "Supply Capacity" and classifies it under the Skill element.

Organic Practitioner H explained that during cultivation, "*There are many uncontrollable factors, such as the weather, which make it impossible to predict the yield of organic crops.*" To increase yield, Practitioner I adopts farming methods that save labor and time and are easy to manage, aiming to "*modify approaches to achieve the highest yield possible for me.*" *Constrained by limited production, Practitioner J hesitates to accept more customer orders.*

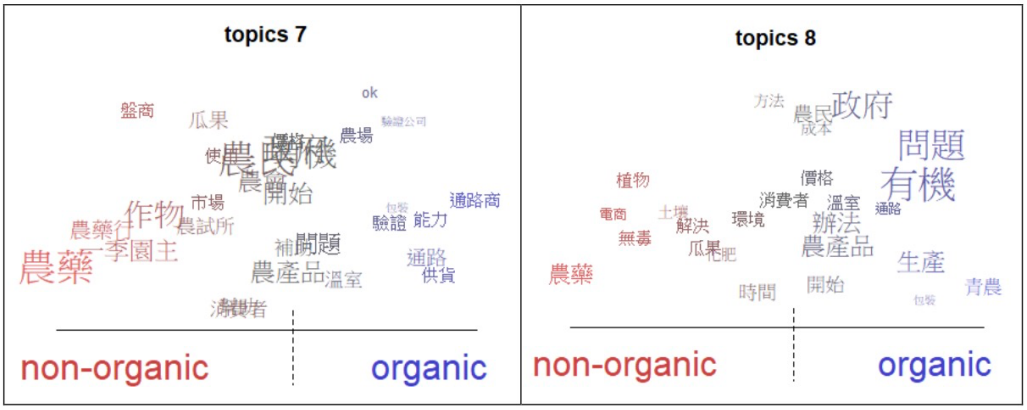


Figure D
Topical perspectives between organic and non-organic practitioners on topics 7 and 8

Non-organic Practitioner F discussed the dilemma of low yield: "*Selling agricultural products through lesser-known online platforms, small farmers receive few orders, leading to overripe and spoiled products; whereas, selling through well-known e-commerce sites, small farmers cannot handle large orders due to insufficient production.*" Practitioner E is indifferent to whether e-commerce platforms market their products, as the amount of produce they can sell remains limited.

4.3.8 Topic 8: Cultivation technique

Regarding Topic 8, keywords such as "resolution," "fertilizers," "problems," "methods," and "plants" indicate that this topic relates to plant cultivation techniques. Therefore, this study names Topic 8 "cultivation technique," categorizing it under the Skill element. Both organic and non-organic practitioners express that cultivation techniques require continual improvement and are a matter of accumulated experience. They also emphasize the importance of proactively observing and recording processes to address pests and diseases with targeted treatments.

In organic farming, obtaining certification requires the prohibition of pesticides and chemical fertilizers, which leads farmers to face challenges such as pests, diseases, and weeds by relying on available organic materials or employing biological techniques. These methods help control issues and supplement plant nutrition to ensure healthy growth. Practitioner G, who studied agriculture in college and university, utilizes his professional knowledge to address crop growth problems, stating, "*I can solve issues by searching for information online.*" Practitioner C, aiming to meet retail needs by cultivating a diverse range of crops, has accumulated extensive cultivation techniques for various agricultural products, practicing seed saving and seedling raising.

Non-organic practitioners, permitted to use chemical fertilizers and pesticides, strive to achieve zero detectable residues in their crops. They employ various methods to address plant pests and diseases. For instance, Practitioner J's approach involves "*cutting off leaves affected by pests or diseases and consulting with a pesticide shop to identify the problem*," followed by purchasing pesticides to

resolve the issue. Some farmers also actively reduce pesticide use through biological control techniques. Practitioner E explained, "*I only use low-toxicity chemical pesticides during the early stages of plant growth… A little chemical prevention for the seedlings can prevent virus transmission from pests or production anomalies caused by diseases.*" In the later stages of plant growth, "*I look for natural predators of the pests as a form of control.*" However, Practitioner D does not fully endorse organic fertilizers, stating that "*crops are not as healthy without chemical fertilizers to assist them, as organic fertilizers do not provide a complete range of nutrients.*"

4.3.9 Topic 9: Supporting system

Table 3 and Figure E reveal that the keywords for Topic 9 include "transformation," "government," "small farmer," "subsidy," and "group meal." This topic pertains to the government's support system available to farmers engaged in agriculture, and this study classifies it under the Material element.

The government has established numerous measures in Taiwan to support farmers' agricultural endeavors. Agencies affiliated with the Ministry of Agriculture, such as the Agricultural Research and Extension Stations (ARESs) and TARI, are responsible for national agricultural research. These agencies routinely offer training courses on crop cultivation and management techniques, enabling farmers to improve their skills. Many practitioners interviewed entered

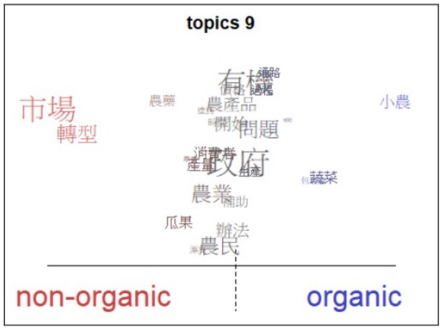


Figure E

Topical perspectives between organic and non-organic practitioners on topics 9

agriculture after training at these affiliated institutions, and they continue to return for further education and consultations on agricultural issues. These examples demonstrate that technical support institutions are crucial for practitioners to initiate and sustain agricultural practices.

In addition to technical training provided through the ARESs and TARIs, the government supports practitioners in sales by establishing farmers' associations. Even more significant, however, are the associations spontaneously formed by the farmers themselves. Practitioner E explains that these farmers' associations create "*a large team where members support and learn from each other*," while facilitating connections with online sales platforms.

The support systems mentioned above benefit both organic and non-organic practitioners. The government's support system for organic practitioners also includes direct subsidies and the creation of organic markets. Direct subsidies encompass substantial grants for constructing greenhouses and associated facilities, providing significant assistance to practitioners. Smaller subsidies are also available for items such as fertilizers and certification fees. However, existing organic practitioners consider these merely minor aids and not sufficient to attract new entrants to organic farming.

Since 2013, New Taipei City has mandated that all elementary and junior high schools serve organic vegetables in school lunches at least once per week. In 2016, Taiwan implemented a nationwide policy requiring school nutrition lunches to use locally produced, traceable ingredients. These policies have ensured a consistent demand for organic leafy vegetables. Organic Practitioner I noted that this policy "*rescued organic leafy vegetables from near extinction*," allowing organic practitioners to persist. The policy also serves an educational purpose by raising students' awareness of organic agriculture. Creating new organic markets is perhaps the government's most robust and effective support system for organic practitioners on the sales front.

5. Disscussion and conclusion

Based on the combined perspectives of the MLP and the SPA, this study

examines the intersection points created by government organic policies that exert pressure on the regime and how these intersections influence shifts in farming practices. To explore this, the study identifies embedded practice ingredients within Taiwan's agri-food system, focusing on the similarities and differences between organic and non-organic practitioners. Among the nine ingredients revealed by the topic model method, as summarized in Table 4, "Perception on Environmental Sustainability in Practices" (Image 1) and "Image toward the Return on Practice Option" (Image 2) are found to differ significantly between organic and non-organic practitioners.

For Image 1, organic practitioners view organic farming as eco-friendly for both the environment and consumers, which drives their practice transformation. Non-organic practitioners, while acknowledging the potential damage and pollution from pesticides, continue with traditional practices and strive to balance environmental protection with production. This difference may stem from divergent views between organic and non-organic practitioners on expected returns from practice options (Image 2). According to interviews, organic practitioners are optimistic about the long-term market demand for organic agri-foods, whereas non-organic practitioners perceive organic farming as risky and potentially costly.

These differing perspectives reveal underlying motivations that shape practitioners' choices and imply potential barriers to sustainable transitions within Taiwan's agri-food system. Organic practitioners, driven by long-term market demand and environmental responsibility, are more inclined to invest in sustainable practices despite initial costs. In contrast, non-organic practitioners, wary of the perceived financial risks associated with organic farming, often prioritize balancing environmental impact with production output. These insights suggest that policy interventions could be tailored to address specific concerns of non-organic practitioners, such as by offering subsidies or training to mitigate perceived risks and costs, thereby facilitating a smoother transition to sustainable practices across the sector. For example, the government can provide targeted subsidies and low-interest loans to sustainable practitioner for relieving financial

Table 4
Summary of the practice ingredients

Practice Ingredients	Descriptions
Skill	
Skill 1: Cultivation Technique	Techniques essential for cultivating crop, including crop management, pest and disease control, and product storage, etc.
Skill 2: Ability to Build a Consulting Network	Practitioner's ability to create a network of resources and information to support practices. This includes connections with universities, research institutions, farmer associations, and market outlets.
Skill 3: Sales Capability	The capacity to generate sustained income through effective product sales, including direct sales, online platforms, home delivery, and distributors.
Skill 4: Supply Capacity	The ability to increase production and maintain a stable supply to the market by expanding farm size or increasing yield per unit area.
Image	
Image 1: Practitioners' Perceptions of Environmental Sustainability in Practices	Practitioners' awareness of the environmental impact of their practices, which guides their actions. For instance, organic practitioners see their work as environmentally protective and has a symbiotic relationship with nature, while conventional practitioners believe environmental impacts are manageable.
Image 2: Practitioners' image toward the return on practice option	Perceptions regarding the return on various practice choices. Practitioners often choose methods with higher anticipated returns, though the scope of their cost-benefit considerations, including food safety, market outlook for organic products, and the time

	and financial costs of pest control, may differ, leading to diverse approaches.
Material	
Material 1: Practice Assets	Essential resources for practice, such as funding, greenhouses, and equipment
Material 2: Internal and External Environments for Practice	Environmental factors that impact practices, including soil and climate conditions on the farm and nearby agricultural activities that influence production
Material 3: Supporting Systems	Social-technical systems that sustain practices, including (1) government technical support, such as regulations, support agencies, training programs, and practitioner subsidies; (2) government initiatives for market development, such as establishing new markets and promoting agricultural education; and (3) mutual support associations for practitioners.

pressures and reducing initial investment risks. Additionally, creating stable market demand through government procurement policies, such as prioritizing organic products in school lunches, could further incentivize market expansion of organic products.

In addition to these differences, it is worth noting that both organic and non-organic practitioners indicated the importance of securing stable internal and external environments (Material 2) for production. Farming practitioners, whether adopting organic or non-organic approaches, recognize that consistent internal conditions, such as soil health and efficient irrigation systems, alongside stable external environments that protect against pest and pesticide contamination, are essential for sustaining productive practices. To address these needs, policies can focus on supporting small-scale farmers in monitoring and managing

environmental fluctuations, along with grants for infrastructure improvements such as greenhouses and irrigation systems to mitigate environmental risks. Furthermore, fostering a mutual support network among regional farmers would be highly beneficial for overcoming common barriers to sustainability by promoting organic education and enabling knowledge sharing on environmental challenges.

The limitation of this study, using STM, is that descriptions of practice ingredients are relatively static and unable to capture the dynamic processes and interactions between practice ingredients. With this in mind, we have carefully elucidated the challenges of sustainability transition in Taiwan's agri-food system by examining the practice ingredients that prevent practitioners from adopting organic farming. Future research could consider conducting case analyses to explore the interactive patterns of practice ingredients among organic and non-organic practitioners, providing a more dynamic understanding of sustainability transition in the agri-food system within an Asian context.

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