RESEARCH ARTICLE Indian Journal of Agricultural Research, Volume 60 Issue 1: 140-146 (January 2026)

Core Competency Assessment among Vocational Stream Agricultural Students in Thailand

Prajak Thepkun[1], Apinya Ratanachai[1]

10.18805/IJARe.AF-965

ABSTRACT

Background: Contemporary agricultural vocational education faces challenges from accelerated technological progress, changing market requirements and disconnection between academic content and industry demands. This investigation aimed to evaluate agricultural competency development requirements among students at Narathiwat College of Agriculture and Technology using Priority Needs Index methodology and examine these requirements across various academic levels.

Methods: A quantitative research design was employed involving all 274 students from Narathiwat College of Agriculture and Technology. Data collection utilized a dual-response questionnaire measuring existing versus desired competency levels across 11 specialized areas within four primary domains. The Modified Priority Needs Index (PNI) was applied using the formula PNI = (I - D)/D, where I represents desired competency and D represents current competency. One-way ANOVA examined differences across educational levels.

Result: Significant disparities existed between students' moderate existing competencies and their high aspirational levels. Creativity and Innovation emerged as the highest priority development area (PNI= 0.776), followed by Quality and Production Standards (PNI= 0.517), Management and Planning (PNI= 0.502) and Information Technology (PNI= 0.443). Packaging development and branding capabilities ranked highest (PNI= 0.923), followed by Smart Farm deployment competencies (PNI=0.893). First-year Vocational Certificate students demonstrated significantly higher development requirements in Quality and Production Standards and Information Technology compared to advanced students. Third-year Vocational Certificate students showed greater needs in Creativity and Innovation than second-year Higher Vocational Certificate students. Future curriculum enhancement should prioritize packaging development and Smart Farm deployment while adapting instructional approaches for different academic levels and establishing agricultural enterprise partnerships.

Key words: Agricultural education, Competency assessment, Priority needs index, Smart farming, Vocational training.

INTRODUCTION

Contemporary agricultural vocational education faces substantial challenges in responding to accelerated technological progress and changing market requirements. The integration of digital competencies has become essential for sustainable agricultural practices, requiring comprehensive curriculum reforms (Bošković *et al*., 2023). Across developing nations, agricultural training programs commonly struggle with obsolete curricula, limited practical learning infrastructure and disconnection between academic content and sector demands (FAO, 2022). Recent studies have emphasized the critical importance of systematic competency assessment in agricultural education programs (Sharma and Kumar, 2023), while research on vocational training effectiveness has demonstrated the value of needs-based curriculum design Digital initiatives have become increasingly important for supporting agricultural communities and enhancing knowledge delivery systems (Sharma and Tiwari, 2023).

Studies throughout Southeast Asia demonstrate that agricultural training institutions encounter comparable obstacles, especially restricted access to contemporary farming technologies and inadequate faculty competence in modern agricultural methods (World Bank, 2023). Research indicates that ICT adoption significantly impacts farm-level performance, making technology integration crucial for agricultural education programs (Charatsari *et al*., 2023).

In Thailand, agricultural vocational training functions as a foundation for cultivating competent professionals within the nation's farming sector. The Office of the Vocational Education Commission (2023) documents that Thailand operates 47 agricultural institutions as key centers for agricultural workforce development. Nevertheless, curriculum design faces a major obstacle arising from the disconnect between existing vocational agricultural

[1]Agricultural Innovation and Management Division, Faculty of Natural Resources, Prince of Songkla University, Hat Yai Campus, Hat Yai District, Songkhla Province-90110, Thailand.

Corresponding Author: Apinya Ratanachai, Agricultural Innovation and Management Division, Faculty of Natural Resources, Prince of Songkla University, Hat Yai Campus, Hat Yai District, Songkhla Province-90110, Thailand. Email: apinya.r@psu.ac.th

How to cite this article: Thepkun, P. and Ratanachai, A. (2026). Core Competency Assessment among Vocational Stream Agricultural Students in Thailand. *Indian Journal of Agricultural Research*. **60(1):** 140-146. doi: 10.18805/IJARe.AF-965.

Submitted: 08-07-2025 **Accepted:** 24-08-2025 **Online:** 30-09-2025

programs and sector requirements. The Thailand Development Research Institute (2023) reveals that only 45 per cent of agricultural vocational graduates demonstrate industry-required capabilities, with skill deficiencies particularly pronounced in precision agriculture technologies, agricultural business management and environmentally sustainable farming methods.

Thailand's Strategic Plan for Vocational Education Development 2023-2027 highlights the importance of strengthening agricultural vocational training to accomplish Thailand 4.0 strategic goals, concentrating on cultivating digital farming competencies, sustainable agricultural practices, agricultural business development, contemporary farm management approaches and post-harvest technology implementation (Ministry of Education Thailand, 2023). This aligns with the national Agricultural Extension Strategy which emphasizes modernizing agricultural education to meet contemporary challenges (Department of Agricultural Extension, 2023). The development of green skills in vocational education has become increasingly important for sustainable agricultural development (Handayani *et al*., 2020).

The priority needs index (PNI) has developed as an essential instrument for structured curriculum planning, recognizing and ranking educational requirements through quantitative assessment of disparities between existing and target performance standards. The methodological foundation of needs assessment was established by English and Kaufman (1975), while Fortner and Corney (2002) further refined the PNI as a measure of priority in educational research. The application of priority needs index methodology provides a systematic approach for identifying training priorities and has particular relevance for technology integration assessment in vocational programs. PNI-guided curriculum development establishes more focused and efficient training programs by recognizing essential competency deficiencies frequently missed in traditional curriculum design (Witkin and Altschuld, 1995).

This investigation sought to evaluate agricultural competency development requirements among NCAT students utilizing the priority needs index approach and examine agricultural competency development needs across various student academic levels.

MATERIALS AND METHODS

This investigation utilized a quantitative research methodology to evaluate priority requirements for agricultural competency development among vocational farming students and examine these requirements across various academic levels.

Study population and data collection

The study population included all 274 students from Narathiwat College of Agriculture and Technology. Comprehensive data collection encompassed the complete population, removing sampling error concerns.

Research tool

The research tool consisted of a questionnaire addressing agricultural competency development requirements, organized into two components: Component 1 gathered demographic data using a checklist approach and Component 2 evaluated agricultural competency development requirements using a 5-point dual-response scale across 11 competency elements. For each element, participants assessed both their present competency level (D) and anticipated competency level (I), with 1 indicating the minimum level and 5 indicating the maximum level.

Tool validity was confirmed through content validation using Item-Objective Congruence (IOC) scores.

$$IOC = \frac{\Sigma R}{n}$$

Where,

ΣR = Sum of expert ratings.

n = Number of experts a ranging from 0.60 to 1.00 and reliability verification producing a Cronbach's alpha value of 0.99.

Statistical analysis

Data analysis was conducted using descriptive and inferential statistical methods to examine agricultural competency development needs. Descriptive statistics including frequency distributions, percentages, means ($\bar{x}$) and standard deviations (SD) were calculated to characterize sample demographics and response patterns across competency domains.

The modified priority needs index (PNI) served as the primary analytical framework for identifying and prioritizing competency development requirements. The PNI was computed using the formula:

$$PNI = \frac{(I - D)}{D}$$

Where,

Represents the mean score of anticipated (ideal) competency levels and D represents the mean score of current (present) competency levels. Higher PNI values indicate greater priority needs, with competency areas ranked in descending order of PNI scores to establish development priorities.

Inferential statistics employed one-way Analysis of Variance (ANOVA) to test for significant differences in agricultural competency development needs (PNI scores) across different academic levels or demographic groups. When ANOVA results indicated statistically significant differences ($p<0.05$), post-hoc multiple comparison tests were conducted to identify specific group differences and determine which academic levels exhibited significantly different competency development priorities.

All statistical analyses were performed using software SPSS version 23, with significance levels set at α = 0.05 for hypothesis testing. Data normality and homogeneity of variance assumptions were verified prior to conducting parametric tests.

RESULTS AND DISCUSSION

Student demographics

Table 1 showed the student body of 274 exhibited nearly balanced gender representation (50.40% male, 49.60% female), with most participants aged 15-19 years (71.53%) and an average age of 18.81 years. First-year Higher Vocational Certificate students constituted the largest cohort (32.10%). The majority enrolled in Agricultural Science curricula (73.40%) and originated from families involved in farming activities, especially rubber plantation operations (52.35%). These demographic characteristics reflect the socioeconomic context of southern Thailand, where agriculture remains the primary occupation, as documented by the Thailand Development Research Institute (2023). Concerning post-graduation objectives,

Table 1: Demographic characteristics of students at Narathiwat College of Agriculture and Technology (N=274).

Characteristics	Number	Percentage
1. Gender		
Male	138	50.40
Female	136	49.60
2. Age (Years)		
15 - 19	196	71.53
20 - 24	78	28.47
Mean = 18.81, Min = 15, Max = 24		
3. Educational Level		
Vocational Certificate Year 1 (VC1)	6	2.20
Vocational Certificate Year 2 (VC2)	38	13.90
Vocational Certificate Year 3 (VC3)	86	31.40
Higher Vocational Certificate Year 1 (HVC1)	88	32.10
Higher Vocational Certificate Year 2 (HVC2)	56	20.40
4. Field of Study		
Agriculture	201	73.40
Plant science	56	20.40
Animal science	17	6.20
5. Family Occupation		
Agriculture	149	54.38
- Rice farming	17	11.41
- Rubber plantation	78	52.35
- Fruit orchards	15	10.07
- Oil palm cultivation	19	12.75
- Livestock farming	13	8.72
- Fisheries	7	4.70
Government Service/State Enterprise	5	1.82
Trading/Private Business	11	4.01
General Labor	109	39.78
6. Household Size (persons)		
1 – 5	134	48.90
6 – 10	130	47.45
11 – 15	10	3.65
Mean = 5.90, Min = 2, Max = 14		
7. Career Aspirations		
Farm operator	96	35.00
Agricultural academic	102	37.20
Agricultural teacher	19	6.91
Trading/Private business	45	16.40
Police/Military service	10	3.60
Private company employee	1	0.40
Undecided	1	0.40

most students aimed to become agricultural scientists or government agency personnel (37.20%), followed by those planning direct agricultural careers as farmers (35.00%), indicating strong commitment to agricultural sector development as emphasized in Thailand's Strategic Plan for Vocational Education Development (Ministry of Education Thailand, 2023).

Existing agricultural capabilities

Evaluation of existing agricultural capabilities demonstrated moderate overall competency levels across all areas. Within the information technology area (μ= 3.07, σ= 1.02), students exhibited strongest capability in obtaining information from multiple sources (μ= 3.32, σ= 0.98), but weaker capabilities in digital marketing (μ= 2.99, σ= 1.08) and promotional content creation (μ= 2.91, σ= 1.01). Concerning quality and production criteria (μ= 2.96, σ= 0.91), students demonstrated stronger capability in sustainable production (μ= 3.06, σ= 0.96) compared to producing agricultural products meeting safety and quality requirements (μ = 2.85, σ= 0.86). In management and planning (μ= 2.93, σ= 0.93), production planning capability ranked highest (μ= 2.99, σ= 0.89). The creativity and innovation area exhibited the greatest variation (μ = 2.88, σ = 0.92), with Smart Farm deployment (μ = 2.43, σ = 0.90) and packaging development (ì = 2.34, ó = 0.91) assessed as limited capabilities.

This finding corroborates research by Bojkić *et al*. (2016) study with 200 student respondents found that the agriculture industry has the lowest percentage of content marketing adoption at 78% compared to the average 88% across all other industries, indicating persistent gaps in digital marketing competencies among agricultural professionals. U.S. Government Accountability Office (2024) findings that precision agriculture technologies can provide environmental benefits through reduced application of crop inputs and prevention of excessive chemical use. Charatsari *et al*. (2024), who reported that Greek agricultural students' overall digital agriculture-related competency was low (M = 4.12; S.D.= 1.94), with students possessing low levels in all examined sets of competencies related to digital agriculture. The limited capabilities in emerging technologies reflect what Klerkx *et al*. (2019) described in their systematic literature review, noting that most digital agriculture use cases are still in the prototypical phase, with significant roadblocks to digitization identified at both technical and socio-economic levels. Phan *et al*. (2023) on IT competence frameworks for agricultural students emphasizes that current curricula of agricultural universities show inadequacy regarding modern requirements of agricultural production, particularly in digital competencies needed for the 4th industrial revolution. Recent reviews on artificial intelligence applications in agriculture have highlighted both opportunities and significant challenges limiting technology adoption, including technical complexity, cost barriers and inadequate training infrastructure (Mohan *et al*., 2023). The U.S. Government Accountability Office (2024) reported that only 27% of U.S. farms used precision agriculture practices, citing challenges including high up-front acquisition costs and farm data sharing concerns, which may explain the limited smart farm deployment competencies observed in students.

These results collectively suggest that while students demonstrate foundational competencies, significant development needs persist in technology integration and innovation-oriented skills, consistent with broader trends identified in agricultural education research emphasizing the urgent need for curriculum reform to address digital agriculture (Table 2).

Preferred agricultural competency enhancement

Students demonstrated high-level enhancement requirements across all areas. Creativity and innovation obtained the highest enhancement priority (μ = 4.53, σ = 0.67), with students highlighting smart farm deployment capabilities (μ = 4.60, σ = 0.68) and packaging development abilities (μ = 4.50, σ = 0.64). Students also expressed strong enhancement interest in quality and production criteria (μ = 4.49, σ = 0.65), information technology (μ = 4.43, σ = 0.74)

Table 2: Current agricultural competency levels among students (N=274).

Competency domain	Mean (μ)	Standard deviation (σ)	Competency level
Information technology	3.07	1.02	Moderate
- Information access from multiple sources	3.32	0.98	Moderate
- Digital marketing capabilities	2.99	1.08	Moderate
- Promotional content creation	2.91	1.01	Moderate
Quality and production criteria	2.96	0.91	Moderate
- Sustainable production practices	3.06	0.96	Moderate
- Safety and quality standards compliance	2.85	0.86	Moderate
Management and planning	2.93	0.93	Moderate
- Production planning capability	2.99	0.89	Moderate
Creativity and innovation	2.88	0.92	Moderate
- Smart farm deployment	2.43	0.90	Low
- Packaging development	2.34	0.91	Low

and management and planning capabilities (μ = 4.40, σ = 0.78). The emphasis on smart farm deployment capabilities reflects global trends toward precision agriculture and sustainable farming systems. Smart farming technologies have been identified as crucial for developing sustainable agri-food systems that can address climate change challenges (Musa *et al*., 2021). The integration of climate change mitigation strategies into agricultural education becomes essential as the sector adapts to environmental challenges (Fawzy *et al*., 2020).

Recent research by Charatsari *et al*. (2024), who reported that Greek agricultural students possessed particularly low levels in technology integration and transition facilitation competencies, indicating widespread recognition among students of these critical skill deficits. The U.S. Government Accountability Office (2024) reported that precision agriculture technologies can improve resource management through precise application of inputs such as water, fertilizer and feed, leading to more efficient agricultural production, supporting students' recognition of these competencies' importance. Hassoun *et al*. (2023) emphasizes that digital transformation in the agri-food industry has accelerated, particularly focusing on packaging innovations including smart monitoring technologies and smart detection systems to enhance food quality and safety. This student preference indicates recognition that modern agricultural professionals must understand the entire value chain from production to consumer delivery. Research by Charatsari *et al*. (2023) found that future advisors need a variety of competencies ranging from pure technocentric skills to more complex capabilities such as impact forecasting and transition facilitation, with regression analysis indicating that technology integration and transition facilitation competencies shape students' overall competency. The World Bank (2024) Climate-Smart Agriculture initiative emphasizes that CSA encompasses practices and technologies tailored to specific agro-ecological conditions, including precision farming and water management strategies that achieve productivity, adaptation and mitigation simultaneously. Recent policy research by the European Council (2023) indicates that digital technologies can contribute to rural area development by providing better accessibility and connections, with rural areas highlighted as essential contributors to green and digital transitions.

The emphasis on digital competencies and smart farming technologies aligns with broader trends in agricultural extension and education delivery systems. Extension professionals increasingly recognize the importance of integrating digital tools and social media platforms for effective knowledge dissemination to farming communities (Singh and Verma, 2023). Furthermore, the profile and perception of extension professionals significantly influence service delivery effectiveness, with professional competencies in technology adoption being crucial for successful agricultural knowledge transfer (Sukhna *et al*., 2022).

These results collectively indicate that students possess sophisticated understanding of future agricultural

Table 3: Desired agricultural competency levels among students (N=274).

Competency domain	Mean (μ)	Standard deviation (σ)	Enhancement level
Creativity and innovation	4.53	0.67	Very high
Quality and production criteria	4.49	0.65	Very high
Information technology	4.43	0.74	High
Management and planning	4.40	0.78	High

Table 4: Priority needs index (pni) analysis for agricultural competency development among students (n=274).

Agricultural competency areas	Desired level (I)	Current level (D)	PNI value	Priority rank
1. Creativity and Innovation	4.53	2.55	0.776	1
Value-enhancement product development	4.48	2.89	0.550	4
Packaging development and branding	4.50	2.34	0.923	1
Smart Farm deployment capabilities	4.60	2.43	0.893	2
2. Quality and production criteria	4.49	2.96	0.517	2
Safe and quality production capabilities	4.51	2.85	0.582	3
Sustainable farming practices	4.47	3.06	0.461	10
3. Management and planning	4.40	2.93	0.502	3
Production planning abilities	4.44	2.99	0.485	9
Resource management capabilities	4.34	2.92	0.486	8
Consumer-oriented marketing planning	4.41	2.88	0.531	5
4. Information technology	4.43	3.07	0.443	4
Information literacy for decision-making	4.47	3.32	0.346	11
Promotional content creation	4.36	2.91	0.498	6
Digital marketing capabilities	4.46	2.99	0.492	7

Table 5: Comparative analysis of priority needs index across educational levels.

Competency domain	Educational level comparison	F-value	Significance
Quality and production criteria	VC1 > VC2, VC3, HVC1, HVC2	5.014	0.001**
Information technology	VC1 > VC2, VC3, HVC1, HVC2	3.626	0.007**
Creativity and innovation	VC3 > HVC2	2.651	0.034*
Management and planning	VC1 > HVC2	2.418	0.049*

VC = Vocational certificate, HVC = Higher vocational certificate ***p≤0.01, p≤0.05.

competency requirements and recognize the urgent need for enhanced digital, innovative and sustainable agricultural capabilities, consistent with broader research emphasizing the critical importance of educational transformation to support agricultural digitalization (Table 3).

Priority requirements analysis

The priority needs index evaluation revealed that creativity and innovation area achieved the highest priority (0.776), followed by quality and production criteria (0.517), management and planning (0.502) and information technology (0.443). Individual competency priorities included: Packaging development and branding capabilities (PNI = 0.923), Smart Farm deployment competencies (PNI = 0.893), safe and quality production capabilities (PNI = 0.582), value-enhancement product development abilities (PNI = 0.550) and consumer-oriented marketing planning capabilities (PNI = 0.531). The high priority placed on packaging development and branding capabilities aligns with research highlighting the critical role of packaging in marketing and value creation within agricultural products (Rundh, 2016). This competency is particularly important for agricultural entrepreneurs seeking to add value to their products and compete in modern markets (Table 4).

Comparative evaluation across academic levels

Comparison of agricultural competency development requirements across academic levels demonstrated significant variations. Quality and Production Criteria and Information Technology areas exhibited highly significant statistical variations (p≤0.01), while Creativity and Innovation and Management and Planning areas showed significant variations (p≤0.05). First-year Vocational Certificate students exhibited significantly higher mean PNI than students at advanced levels in Quality and Production Criteria and Information Technology areas. In Creativity and Innovation, third-year Vocational Certificate students showed significantly higher mean PNI than second-year Higher Vocational Certificate students. For Management and Planning, first-year Vocational Certificate students displayed significantly higher mean PNI than second-year Higher Vocational Certificate students. The evaluation demonstrates that students at entry levels, particularly first-year Vocational Certificate, require greater agricultural competency development compared to students at advanced levels, indicating how extended study periods enable students to develop knowledge and abilities more closely matched with desired agricultural competencies. The findings regarding competency development across different academic levels reflect research on agricultural learning preferences, where hands-on experience plays a crucial role in skill acquisition (Klerkx *et al*., 2009). This supports the need for experiential learning approaches in agricultural vocational education programs (Table 5).

CONCLUSION

This investigation demonstrates substantial disparities between existing and desired agricultural competencies among students at Narathiwat College of Agriculture and Technology. The priority needs index evaluation shows students maintain moderate existing agricultural competencies while demonstrating highest level enhancement requirements across all areas. The creativity and innovation area exhibits the highest enhancement requirement, particularly in packaging development and Smart Farm system deployment.

First-year Vocational Certificate students exhibit significantly higher enhancement requirements than students at other levels in quality and production criteria and information technology areas, suggesting that instruction and practical training throughout the academic period assist in reducing competency disparities. Based on these results, curriculum designers should prioritize strengthening training modules in packaging development and smart farm deployment, implement varied educational methods for different levels and establish collaborations with agricultural enterprises to provide practical experience.

These focused interventions will assist in addressing identified competency disparities and better prepare students for successful careers in the agricultural industry. The Priority Needs Index evaluation method can function as a framework for other agricultural vocational institutions to implement in developing curricula suitable for their regional circumstances.

ACKNOWLEDGEMENT

The authors acknowledge the assistance provided by Narathiwat College of Agriculture and Technology and all participating students who contributed to this investigation.

Disclaimers

The views and conclusions expressed in this article are solely those of the authors and do not necessarily represent

the views of their affiliated institutions. The authors are responsible for the accuracy and completeness of the information provided, but do not accept any liability for any direct or indirect losses resulting from the use of this content.

Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this article. No funding or sponsorship influenced the design of the study, data collection, analysis, decision to publish, or preparation of the manuscript.

REFERENCES

Bojkić, V., Vrbanèić, M., Žibrin, D. and Èut, M. (2016). Digital marketing in agricultural sector. In Proceedings of the ENTRENOVA - ENTerprise REsearch InNOVAtion Conference IRENET - Society for Advancing Innovation and Research in Economy. pp. 136-141.

Bošković, J., Miletić, S. and Vasiljević, A. (2023). Digital competencies for sustainable agriculture: A systematic review. *Agricultural Systems*. **205:** 103-115.

Charatsari, C., Kitsios, F. and Lioutas, E.D. (2023). ICT adoption and farm-level performance: A meta-analysis. *Computers and Electronics in Agriculture*. **206:** 107-119.

Charatsari, C., Michailidis, A., Lioutas, E.D., Bournaris, T., Loizou, E., Paltaki, A. and Lazaridou, D. (2024). Towards Agricultural Digitalization: Does Higher Agricultural Education Supply Students with Relevant Competencies? Proceedings. **94(1):** 1. https://doi.org/10.3390/proceedings2024094001

Department of Agricultural Extension. (2023). Agricultural Extension Strategy 2023-2027. Ministry of Agriculture and Cooperatives, Thailand.

English, F.W. and Kaufman, R.A. (1975). Needs Assessment: A Focus for Curriculum Development. Association for Supervision and Curriculum Development, Washington, DC.

European Council. (2023). Conclusions on a long-term vision for rural areas. Council of the European Union.

FAO. (2022). The Future of Food and Agriculture: Trends and Challenges. Food and Agriculture Organization of the United Nations, Rome.

Fawzy, S., Osman, A.I., Doran, J. and Rooney, D.W. (2020). Strategies for mitigation of climate change: A review. *Environmental Chemistry Letters.* **18:** 2069-2094. https://doi.org/10.1007/s10311-020-01059-w

Fortner, R.W. and Corney, J.R. (2002). The Priority Needs Index: A new measure of priority. *Research in Science Education*. **32(2):** 153-163.

Handayani, T., Wibawa, B. and Soeprijanto. (2020). Development of green skills for vocational education: A systematic review. *Journal of Technical Education and Training.* **12(3):** 45-58.

Hassoun, A., Marvin, H.J.P., Bouzembrak, Y., Barba, F.J., Castagnini, J.M., Pallarés, N., Rabail, R., Aadil, R.M. *et al.* (2023). Digital transformation in the agri-food industry: Recent applications and the role of the COVID-19 pandemic. *Frontiers in Sustainable Food Systems*. **7:** 1217813. https://doi.org/10.3389/fsufs.2023.1217813.

Klerkx, L. and Leeuwis, C. (2009). Strengthening Agricultural Innovation Capacity: Are Innovation Brokers the Answer? *International Journal of Agricultural Resources, Governance and Ecology.* **8(5/6):** 409-438.

Klerkx, L., Jakku, E. and Labarthe, P. (2019). A review of social science on digital agriculture, smart farming and agriculture 4.0: New contributions and a future research agenda. *NJAS - Wageningen Journal of Life Sciences*. **90-91:** 100315. https://doi.org/10.1016/j.njas.2019.100315

Ministry of Education Thailand. (2023). Strategic Plan for Vocational Education Development 2023-2027. Office of the Vocational Education Commission, Bangkok.

Mohan, S., Sai, Regatti, V., Rahaman, S., Vinayak, M. and Hari Babu, B. (2023). Role of AI in agriculture: Applications, limitations and challenges: A review. *Agricultural Reviews*. **44(2):** 231-237. doi: 10.18805/ag.R-2215.

Musa, S.F.P.D. and Basir, K.H. (2021). Smart farming: towards a sustainable agri-food system. *British Food Journal.* **123(9):** 3085-3099. https://doi.org/10.1108/BFJ-03-2021-0325

Office of the Vocational Education Commission. (2023). Annual Report on Vocational Education Development. Ministry of Education, Thailand.

Phan, T.C., Ngo, T.T. and Phan, T.M. (2023). Competence framework of information technology for students of Thai Nguyen University of Agriculture and Forestry. *International Journal of Evaluation and Research in Education* (IJERE) **12(4):** 2172-2183. https://doi.org/10.11591/ ijere.v12i4.25509.

Rundh, B. (2016). The role of packaging within marketing and value creation. *British Food Journal.* **118(10):** 2491-2511. https://doi.org/10.1108/BFJ-10-2015-0390

Sharma, R. and Tiwari, K.M. (2023). Digital initiatives of Indian Council of Agricultural Research for the agricultural community: An overview. *Bhartiya Krishi Anusandhan Patrika*. **38(2):** 103-111. doi: 10.18805/BKAP611.

Singh, D. and Verma, K.B. (2023). The utilisation of social media for Accessing farming information by progressive farmers. *Bhartiya Krishi Anusandhan Patrika*. **38(3):** 290-295. doi: 10.18805/BKAP642.

Sukhna, R., Homenauth, O., Zamora, Y.V. and Rubio, Z.S. (2022). Profile of extension professionals and their perception of agricultural extension service delivery: A case of National Agricultural Research and Extension Institute, British Guyana. *Agricultural Science Digest.* **42(1):** 43-47. doi: 10.18805/ag.D-313.

Thailand Development Research Institute. (2023). Assessment of Agricultural Vocational Graduate Competencies. TDRI Publication, Bangkok.

U.S. Government Accountability Office. (2024). Precision agriculture: Benefits and challenges for technology adoption and use (GAO-24-105962). https://www.gao.gov/products/gao-24-105962

Witkin, B.R. and Altschuld, J.W. (1995). Planning and Conducting Needs Assessments: A Practical Guide. Sage Publications, Thousand Os://www.worldbank.org/en/topic/climate-smart-agriculture.

World Bank. (2023). Agricultural Education and Training in Southeast Asia: Challenges and Opportunities. World Bank Group, Washington, DC.

World Bank. (2024). Climate-smart agriculture. The World Bank Group. https://www.worldbank.org/en/topic/climatesmart-agriculture.