



Health Analysis for Ergonomic Risk Assessment among Rice and Sugarcane Farmers Using LINE Chatbot Application

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Abstract: Farmers are at risk of exposure to a variety of health hazards, particularly unnatural and strenuous working postures in the fields. This study aimed to develop and evaluate a LINE-based ergonomic risk assessment application integrated with a chatbot recommendation system. Specifically, the study evaluated the application's validity, compared time efficiency between paper-based and application-based assessments, and assessed user satisfaction among health personnel and farmers. The sample consisted of 30 application users, including subdistrict health promotion hospital staff/public health officers, village health volunteers or farmer leaders, and research assistants, and 125 farmers as assessors. The tools used included the Rapid Entire Body Assessment (REBA), the application, and a questionnaire. Data were analyzed using descriptive statistics, a one-sample t-test, and a paired t-test ($p < 0.05$). The study found that the chatbot application passed expert evaluation and passed the test. It performed the following functions: login, assessment based on observation images, selection of images for assessment, introduction of risk in the chatbot, and accurate recording of results. Experts assessed its suitability with an average score of 4.87 ± 0.11 (out of a full 5.00), which is considered the highest level. The application's effectiveness, when used with farmers, was significantly reduced in time compared to the traditional assessment ($p < 0.05$). Scores obtained from the traditional and application methods were not significantly different. The results of the satisfaction assessment of the application among farmers showed that users were most satisfied with the benefits and application, with an average score of 4.80 ± 0.36 . In terms of ergonomics, farmers had a prevalence of right shoulder and neck pain of 17.6% (95% CI=12.0-24.8) and 16.8% (95% CI=9.9-24.5), respectively. The application can be easily used to assess ergonomic risks and takes less time than the previous format. Moreover, the results of the assessment are of the same quality as those assessed by experts using the previous format. Recommendations: The application should be expanded to farmers to obtain a comprehensive picture of the country. High-risk groups should be followed up with to reduce their risk levels.

Keywords: Chatbot; ergonomic risk; farmers; REBA; mobile health

1. Introduction

Agricultural productivity has a positive impact on the national economy. Thailand is the second-largest rice exporter [1] and the third-largest sugar exporter [2]. Thailand has the largest agricultural sector, accounting for 31.2 percent of the total population [3]. However, in the production process,

farmers are more physically demanding than in other occupations, and their work is carried out in uncontrolled environmental conditions. Occupational illnesses can have both health and economic impacts. Farmers are exposed to physical (heat and natural light), chemical (pesticides), and ergonomic (unnatural and physically demanding work postures) threats [4]. Ergonomic problems affect farmers' health and agricultural productivity, most commonly associated with unnatural working postures (e.g., bending, twisting), excessive force (e.g., digging, lifting heavy sacks), and the use of inappropriate tools (e.g., heavy, loose hoes, large, or vibrating machinery) [5]. This results in pain and musculoskeletal diseases. Sugarcane farmers have been reported to experience neck and back pain at higher rates than other body parts. Furthermore, thin operators are more likely to experience pain and discomfort in certain body parts [6]. Working hours have a statistically significant effect on wrist and low back pain [7]. Various ergonomic control measures have been implemented to reduce musculoskeletal risks among farmers in Thailand, including the use of ergonomic tools, modification of working postures, and training programs to improve work techniques. Previous studies have demonstrated that ergonomic interventions, such as modified agricultural tools and posture training, can significantly reduce physical workload and musculoskeletal symptoms among rice farmers [8]. However, these interventions often require trained personnel and structured implementation, which may not be feasible in all rural settings. Therefore, alternative approaches such as digital assessment tools may provide practical support for identifying ergonomic risks and guiding preventive actions.

Currently, ergonomic surveillance approaches have standardized assessment tools for preventive measures, such as the Rapid Entire Body Assessment (REBA) and Physical workload (%CVL). These assessments were applied to rice farmers in northern Thailand. The REBA assessment and %CVL were measured before and after the farmers experimented with the rice planting innovation. The results showed that REBA scores while planting rice with ergonomic tools were significantly lower than those while planting with assisted tools and traditional rice planting. Furthermore, the physical workload during rice planting with ergonomic tools was significantly lower than that with assisted tools and traditional rice planting [8]. However, the REBA assessment process is complex, requiring measurement of the entire body's working posture and scoring comparisons with multiple tables. Therefore, the analysis primarily relies on occupational health experts. In practice, in farmland areas, health personnel or village health volunteers are unable to conduct the assessment themselves. Ergonomic risk assessment is a complex and multi-step process. However, in today's world, it can be addressed with information technology, depending on the type of data being analyzed and processed. The present study aimed to assess, record, analyze, and interpret results quickly. This approach was designed as a LINE chatbot application that uses images of farmers' working postures adapted from REBA, reducing the need to read text or perform manual calculations. Furthermore, it can be accessed via the LINE app, a popular app in Thailand that can be installed on smartphones. A National Statistical Office [9] survey found that 95.4% of people aged 6 and above use smartphones, and 98.6% use the internet via smartphones, spending an average of 5 hours and 2 minutes per day. This demonstrates the important role of easily accessible technology. This research has been applied to health analysis by defining working postures in degrees of different organs using the standard REBA tool. The resulting scores provide immediate risk levels and recommendations, responding quickly to needs. Chatbots have previously been used for health awareness [10].

Several digital ergonomic assessment tools and health chatbot systems have been developed to improve occupational health surveillance. Traditional ergonomic assessment methods, such as Rapid Upper Limb Assessment (RULA) and the Ovako Working Posture Analysis System (OWAS), have been widely used to evaluate musculoskeletal risk and have later been adapted into digital formats to improve usability and reduce calculation errors [11, 12]. In recent years, information technology and conversational agents have increasingly been applied in healthcare and occupational health settings to support data analysis, improve accessibility to health information, and enhance risk communication among users [10, 13, 14]. These digital approaches enable faster interpretation of complex ergonomic data and provide practical solutions for use in rural agricultural settings where trained personnel may be limited. However, many existing systems primarily focus on health education or basic risk communication rather than integrating standardized ergonomic risk assessment tools with automated scoring and real-time feedback. Therefore, this study extends previous work by integrating the Rapid Entire Body Assessment (REBA) method into a LINE-based chatbot system, enabling

rapid ergonomic risk assessment and immediate personalized recommendations in real field conditions. Despite these technological advancements, the application of standardized ergonomic assessment tools in rural agricultural settings remains limited due to the complexity of assessment procedures and the shortage of trained occupational health professionals. In many farming communities, ergonomic risks are often identified only after musculoskeletal symptoms occur, resulting in delayed prevention and intervention. Therefore, there is a clear need for practical, accessible, and user-friendly tools that enable local health personnel and community workers to conduct ergonomic risk assessments efficiently under field conditions.

Therefore, this study aimed to develop and evaluate a LINE-based ergonomic risk assessment application integrated with a chatbot recommendation system. Specifically, the study aimed to: (1) assess the validity of the developed application, (2) compare the time efficiency between paper-based and application-based ergonomic assessments, and (3) evaluate user satisfaction among health personnel and farmers. This approach supports Sustainable Development Goal (SDG) 3: Good Health and Well-Being by enhancing ergonomic risk surveillance among informal agricultural workers.

2. Materials and Methods

2.1 Research Design

This research and development study involved creating an application to assess, analyze, process, display results, and provide recommendations for ergonomic risk reduction. The application was then evaluated by experts and actual farmers, who then refined it for greater efficiency.

2.2 Sample and sampling

The sample was divided into 3 groups: Group 1 consisted of 3 health and information system experts who evaluated the quality of the created application and the suitability of the content for the purpose, as well as the accompanying images. For Group 2, there were 30 application users, including subdistrict health promotion hospital staff, research assistants, and farmer leaders or village public health volunteers who used the data collection tools. Group 3 was the group evaluated by the application. The sample size for Group 3 (farmers) was determined using the estimated sample size in prevalence studies. The formula used was: $n = Z^2P(1-P) / d^2$ where Z represents the standard normal deviation corresponding to a 95% confidence level ($Z = 1.96$), P represents the estimated prevalence of health effects among sugarcane farmers obtained from a previous study ($P = 0.09$) [15], and d represents the acceptable margin of error ($d = 0.05$). Based on this calculation, the required minimum sample size was 125 participants. In this study, 125 farmers were recruited, which was considered sufficient to represent the target population and achieve the study objectives. According to national agricultural statistics, Thailand has approximately 4.7 million rice farmers and approximately 0.33 million sugarcane farmers nationwide [16]. In the selected study area of Suphan Buri Province, a list of registered farmers was obtained from local agricultural and health authorities and used as the sampling frame for random selection. Eligible farmers were identified from official community records provided by local health promotion hospitals and agricultural offices. Selected farmers were contacted through village health volunteers and invited to participate in the study. Those who met the inclusion criteria and agreed to participate were enrolled after providing written informed consent. The three sample groups were used for different quality assessments. Experts assessed application quality; public health personnel and research assistants assessed usability; and farmers assessed ergonomics in sufficient numbers for the study. The farmers used a simple random sampling method, randomly selecting from a list of farmers in the study area until the sample size was complete. Farmers were considered inclusive if they had been engaged in rice and sugarcane farming as their full-time job for 1 year, could communicate in Thai, and were willing to participate in the project voluntarily. Exclusion criteria included being absent on the scheduled data-collection date.

2.3 Application creation

The REBA standard ergonomic risk assessment tool was developed into an application using the System Development Life Cycle (SDLC). This sequential software development process, coupled with cloud-based web application technology, begins with problem definition, system analysis, system design, system development, system testing, and installation and maintenance. Each phase flows sequentially, like a waterfall,

and can be reversed to improve previous steps. The application, developed by an information technology expert in collaboration with researchers, is called “AgriCare LINE,” or the “Ergonomics Application for Agriculturist Care.” The application creation process involves five steps as follows:

Step 1: Problem Identification

The project began by studying the problem within the context of the relevant target groups: farmers, public health officials, and village health volunteers. Qualitative data were collected through in-depth interviews to understand the health risks arising from on-the-ground work. This included ergonomic risks, namely the risk of musculoskeletal pain in farmers. In addition, problem identification also included a literature review [4-6] to explore prior knowledge, existing tools, and relevant studies. This approach aimed to derive an academically grounded approach to support the application's development.

Step 2: System Analysis

The system analysis defines the system's scope, requirements, and functionality. Based on the data collected in Step 1, the development team establishes a preliminary system structure, defining the user groups, system goals, and the conceptual framework for the risk assessment using the standard REBA tool [12], as well as the interrelationships between the various system components. This serves as the basis for system design.

Step 3: System Design

Design both the front- and back-end of the system using LINE LIFF (LINE Front-end Framework) technology to develop a web app embedded within LINE OA, enabling users to access forms via mobile devices. Vercel (Hosting) was used to host the front-end (React.js) and back-end (Node.js API) embeddings in a serverless system. Firebase (Cloud Firestore) was used as the primary database to collect real-time form data, which was displayed and analyzed in Google Sheets and BigQuery. Wireframes and user interfaces (UIs) were also designed using human-centered design principles to enhance the user experience.

Step 4: System Implementation

The application was developed using NextJS, NodeJS, and the Firebase SDK. GitLab was used as a version control system to manage the CI/CD (Continuous Integration/Continuous Deployment) process, connecting it to Vercel to ensure continuous, automated system deployment. The questionnaire included in the application is a REBA risk assessment form. Once the user completes the form, the system sends data via an API to Firebase Cloud Firestore for real-time storage. The data is then connected to Google Sheets using Google Apps Script, enabling local staff to access it immediately. Some data is linked to Google BigQuery for in-depth analysis. System testing consisted of two levels: Unit Testing, which tests individual functionalities, and User Acceptance Testing (UAT). Thirty public health officers from subdistrict health promotion hospitals and research assistants were recruited to conduct a hands-on trial of the system. A questionnaire was used to assess system satisfaction and usability, informing development based on recommendations.

Step 5: System Deployment and Utilization

After trial and optimization, the researchers installed the system and implemented it in a rice- and sugarcane-farming community. Public health officers and research assistants were able to directly collect user data and send assessment results back to users via the LINE Messaging API. A dashboard was also created to display aggregated data. Public health officers or health policymakers in the farming area can use the results to efficiently and quickly manage farmers' ergonomic risks.

2.4 Research tools

The research instruments were developed based on standardized ergonomic assessment concepts [17] and previous related studies [6,7,8]. The questionnaire items were adapted from existing ergonomic and health assessment tools and modified to suit the agricultural context. Content validity was assessed by three experts in occupational health and information technology using the Index of Item-Objective Congruence (IOC), with all items demonstrating values greater than 0.5. The instruments were pilot-tested among a small group of non-sample participants to evaluate clarity, comprehension, and usability before final data collection.

The research tools were divided into four parts: an ergonomic assessment form, an application, an application quality assessment form, and an application satisfaction assessment form. The results are as follows:

1) The ergonomic assessment is a whole-body assessment method. The farmers' most risky, unnatural, and muscular postures were analyzed using the standard Rapid Entire Body Assessment (REBA) tool for assessing standing work. Scores were generated for each body part, and the frequency of work performed and the force applied. The calculations were performed using the REBA Employee Assessment Worksheet, which was divided into two groups: Group A (torso, neck, and legs) and Group B (upper arms, lower arms, and wrists). Scores ranged from +1 to +4 for each part. When the overall score is added, a high score indicates an increased risk of skeletal and muscular injury [17].

2) The ergonomic risk assessment application was developed in the form of a LINE Chatbot. The questions were based on the standard tools of REBA and were accompanied by easy-to-understand illustrations. The assessment content was verified for accuracy. The application began with a LINE Official Account. Users clicked a link in a LINE OA message to open the application developed with the LINE Front-end Framework (LIFF) to display the web application. After clicking the link, the system redirected to the LINE login process. The system then displayed a form designed for risk analysis. This form ran on a web application hosted on Vercel's Frontend service.

After users completed filling out the information and submitted it, the form sent data via an API to a backend system hosted on Vercel. This API connects to a central database that uses Firebase (Cloud Firestore) to store data. The data was then managed and analyzed. It connected to Google Sheets to display basic information in tabular form and to BigQuery for in-depth analysis or large-scale data. Furthermore, during the system development process, the researcher wrote code using various tools and submitted it to GitLab. When the code was pushed, the system automatically deployed it to Vercel, both the Frontend and Backend. Next, the system interpreted the evaluation results and quickly notified the user with an explanation via LINE LIFF. The application's working process is shown in Figure 1.

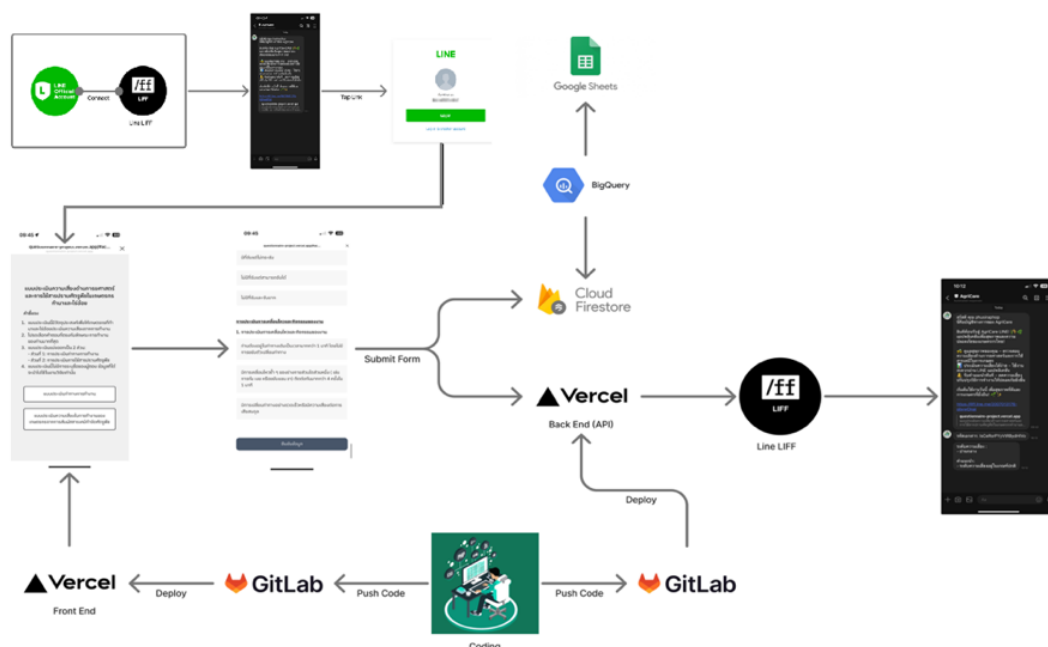


Figure 1. Workflow of the ergonomic risk assessment application, illustrating the stages of problem identification, system analysis, system design, system implementation, and system deployment.

3) The application quality assessment form examined the quality of the application's content, format, response, usability, and language used. Experts were university professors with a master's degree or higher in related fields, including information technology and health. They independently assessed the application

using the Index of Item-Objective Congruence (IOC), which yields three scores: -1, 0, and +1. The researchers used a total score of items less than 0.5 to improve the application and submit it to the experts for further consideration [18].

Evaluating the quality of the application in 5 areas: usability, content appropriateness, data privacy and confidentiality, output presentation and functional performance, and overall appropriateness. There are 18 questions with 5 levels of choice, ranging from 1 (least) to 5 (most), with scores 2, 3, 4, and 5 corresponding to little, moderate, much, and most, respectively. The results were interpreted overall and item-by-item based on the average values according to Best [19] criteria: low, moderate, and high quality. The scores were equally spaced within each level, ranging from 1.00-2.33, 2.34-3.67, and 3.68-5.00, respectively.

4) Application usage satisfaction assessment covers 4 aspects: usability, content appropriateness, design and visual, and impact and practical use. There are 20 questions with 5 levels of choice, ranging from 1 (least) to 5 (most), with scores 2, 3, 4, and 5 corresponding to little, moderate, much, and most, respectively. The results were interpreted overall and item-by-item based on the average values, according to Best's [19] criteria: low, moderate, and high satisfaction. The scores were equally spaced within each level, ranging from 1.00-2.33, 2.34-3.67, and 3.68-5.00, respectively.

2.5 Data collection

Data collection was divided into two phases: the application development and creation phase, and the farmer implementation phase.

During the creation and development phase, an ergonomic assessment form with modified wording and images illustrating work postures to facilitate understanding was submitted, based on the REBA standard. The first group of experts assessed the app's consistency index against the objectives. The second group of experts then trialed the app and completed a quality assessment via a Google Form registered to their personal e-mail. The assessment period was 1 week, followed by a non-sample group (tryout) to determine comprehension of the language used and the appropriateness of communication with the farmers. After the test, actual data were collected from farmers in Suphan Buri Province, Thailand.

In the implementation phase, the tool users were nurses, public health professionals, and research assistants. Data were collected using structured interviews and the application. The start and end times of both document-based and application-based interviews were recorded. The data collection period was 1 week after the farmer sample was completed. The researcher assessed the application's satisfaction using Google Forms, which can record data without identifying respondents, ensuring data authenticity and anonymity. The recorded data were then analyzed.

2.6 REBA process

The REBA standard risk assessment tool is a whole-body risk assessment method developed by Hignett and McAtamney [17]. It selects the most difficult, time-consuming, or forceful work postures. This is based on an interview to select the postures that pose the greatest risk to the skeleton and muscles. REBA has 15 steps in total, divided into 3 parts as follows:

Part A (Steps 1-6) assesses neck and trunk angulation during rotation or leaning, and legs during standing or kneeling. This is then combined with a cross-matrix between the neck and trunk, scoring 1-9 points. This is then combined with the force and workload scores, with the potential for an additional score of 0-3.

Part B (Steps 7-13) assesses upper and lower arm angulation during rotation or leaning, and a cross-matrix between the upper and lower arms, scoring 1-9 points. Material grip, movement, and work activities are also assessed, with the potential for an additional score of 0-3.

Part C (Steps 14-15) is derived by combining the scores from Parts A and B with a cross-matrix for a final assessment. The scores are then graded into five risk levels: 1, 2-3, 4-7, 8-10, and >10. Scores are interpreted as very low, low, moderate, high, and very high risk, respectively. Recommendations are tailored according to the risk level.

2.7 Data analysis

Data were analyzed using descriptive and inferential statistics. In descriptive statistics, the variables were measured at different levels, including discrete variables (e.g., ergonomic risk levels) and continuous variables (e.g., application satisfaction scores), with discrete variables analyzed using frequencies and percentages, and continuous variables using means and standard deviations. Inferential statistics were tested according to the following objectives: 1) the results of creating and developing an ergonomic risk processing application using IOC calculations, considering criteria greater than or equal to 0.5, and the suitability of the application greater than 80%. 2) Evaluate the efficiency of the ergonomic risk processing application by testing the duration of use of both assessment forms with a paired t-test. 3) Evaluate the satisfaction of using the ergonomic risk processing application with the set criteria (greater than 4.00 out of a full score of 5.00) with one sample t-test, setting statistical significance at 0.05.

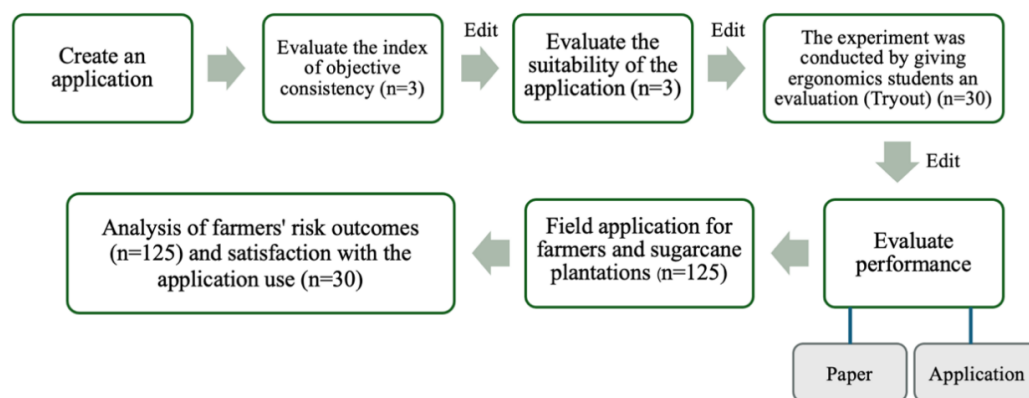


Figure 2. Research protocol of the study

2.8 Ethical Considerations

This study complied with the ethical principles outlined in the Declaration of Helsinki. Ethical approval was obtained from the Human Research Ethics Committee of Bansomdejchaopraya Rajabhat University (REC-BSRU COA 680607), dated June 23, 2025. Written informed consent was obtained from all participants before data collection. Participants were fully informed about the study objectives, procedures, potential benefits, and risks. Confidentiality and anonymity of participant information were strictly maintained throughout the study.

3. Results and Discussion

3.1 “AgriCare” Ergonomics Risk Processing Application

The research team developed an application for farmers called AgriCare. The application begins with a login via the LINE application by scanning a QR code. Upon registration, the application takes you to the home page, which provides instructions and lets you select an assessment. Each assessment item includes a brief explanation, assessing each organ individually, and options for images of farmers at different angles and degrees to reflect actual work performance. Additional explanations are provided for some questions, such as whether or not to rotate the neck. The options are yes or no. After selecting all questions, click "Save." The resulting score is then stored in a centralized database. The assessment results are sent to the LINE application, including the risk for each organ, the overall body weight, and appropriate recommendations. The application's window is shown in Figure 3.

After the application was developed, three experts evaluated its suitability using the IOC. The results showed that all items' values were higher than 0.5. Three other experts also tested the application. The experts gave an average score of 4.87 ± 0.11 (out of 5.00), which is at the highest level. The opinions were: “This application is very useful, but some questions require understanding or expertise to evaluate. Farmers with different skills may find it difficult to self-evaluate some questions.” and “the application's responses are easy to understand by explaining risks and recommendations. However, it would be clearer if there were illustrations to illustrate the instructions.”

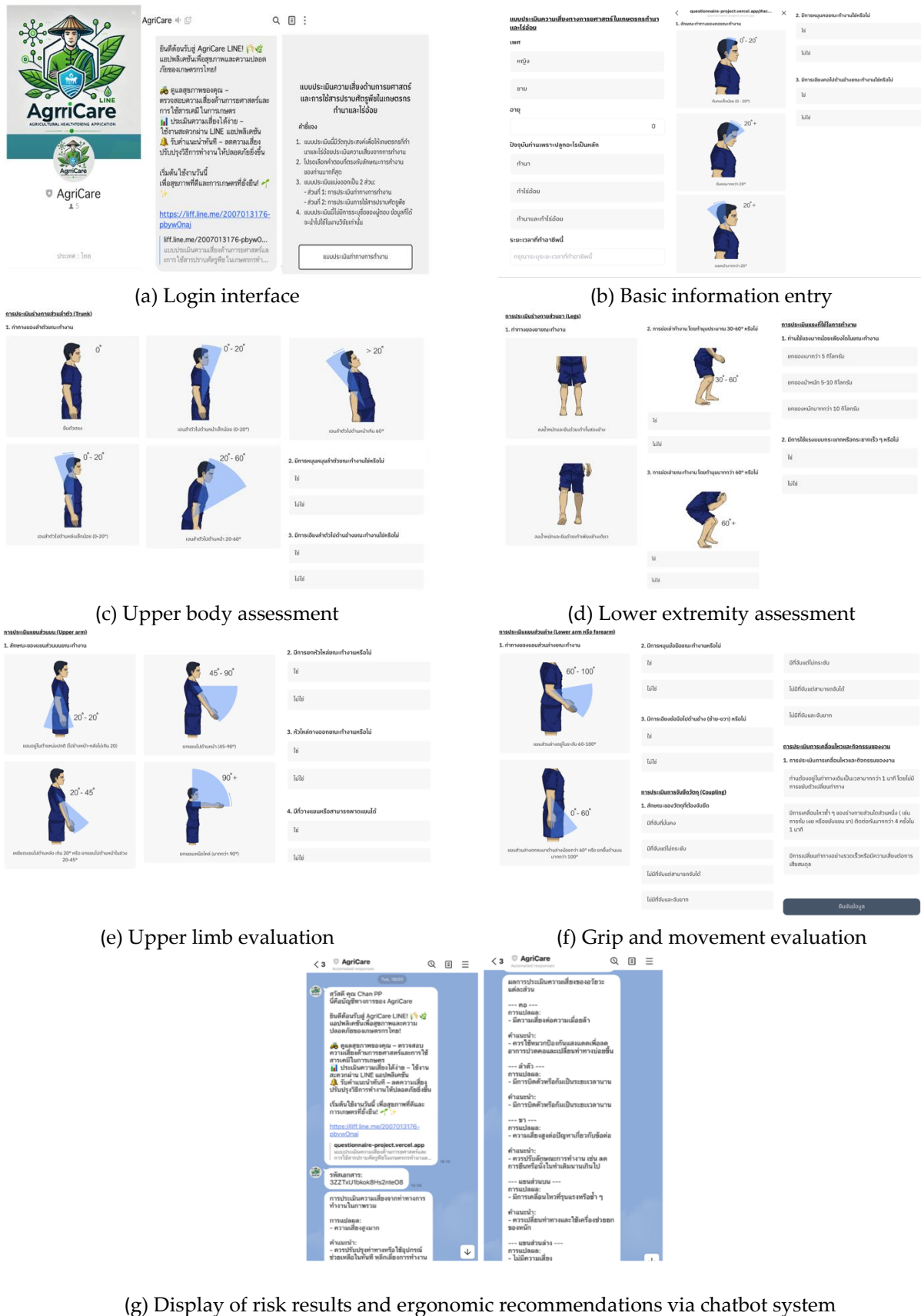


Figure 3 (a-g). Screenshots of the AgriCare ergonomic risk assessment application

3.2 Ergonomics Risk Processing Application Performance

The effectiveness of the test between the traditional (paper) format and the ergonomic risk assessment application was analyzed into two parts: time efficiency and user outcomes. The results are as follows:

Time efficiency, the paper format was compared with the ergonomic risk assessment application. The results showed that the application significantly reduced the interview, recording, and interpretation time compared to the traditional format ($p < 0.05$), from 16.55 ± 3.16 to 2.11 ± 0.69 points per person, as shown in Table 1.

Table 1. Comparison of time performance between paper and application (n=30)

Efficiency	Paper		Application		t	p
	Mean	SD	Mean	SD		
Interview duration (minutes)	5.82	1.57	2.11	0.69	24.621	<0.001**
Recording time (minutes)	3.47	1.02	Automatic			
Interpretation period (minutes)	7.21	2.45	Automatic			
Total	16.55	3.16	2.11	0.69		

Note: ** $p < 0.001$

In addition to time efficiency and user satisfaction, the performance of the developed application was evaluated for accuracy and consistency in ergonomic risk scoring. The automated REBA scoring results generated by the application were consistent with manual REBA assessments performed by trained personnel, indicating reliable system performance. The digital system also demonstrated stable operation during repeated testing sessions, suggesting its suitability for routine ergonomic risk monitoring in agricultural settings. Furthermore, content validation conducted by ergonomic experts confirmed the appropriateness of posture classification and scoring logic used in the application.

Outcomes efficiency, the comparison of pain or injury scores of various body organs, grip, and movement, it was found that the scores obtained from the paper and the scores obtained from the application were not different (the paper total risk score for all organs was 16.90 ± 4.03 and from the application was 17.26 ± 1.74 , $p = 0.657$), as shown in Table 2.

Table 2. Comparison of performance outcomes between paper and application (n=30).

Organs assessed	Score			t-test	p
	Full score	Paper	Application		
All organs	35	16.90 (4.03)	17.26 (1.74)	-0.449	0.657
Neck and neck rotation	4	2.43 (0.85)	2.03 (0.18)		
Body and body rotation	6	3.57 (1.16)	3.23 (1.04)		
Legs and standing	4	2.20 (0.96)	3.13 (0.43)		
Upper arm and shoulder lift	6	2.90 (0.88)	2.60 (1.40)		
Lower arm	2	1.73 (0.45)	1.50 (0.50)		
Hand and wrist, and wrist rotation	4	1.70 (0.70)	2.20 (0.80)		
Additional force	3	1.10 (0.92)	1.53 (0.68)		
Grasping objects	3	0.27 (0.68)	0.03 (0.18)		
Movement	3	1.00 (0.26)	1.00 (0.00)		

3.3 Satisfaction from using the application system

The satisfaction assessment results for 30 application users, including subdistrict health promotion hospital staff, research assistants, and farmer leaders or village public health volunteers, found that they were most satisfied across all areas questioned. The top three highest average satisfaction scores were: it reduced assessment time and steps compared to the previous method; assessment data can be used to improve

behaviors; and it has the potential to be applied in other communities or more broadly. The average scores were 4.86 ± 0.34 , 4.83 ± 0.37 , and 4.80 ± 0.41 , respectively (Table 3).

Table 3. Satisfaction with using the application system (n=30)

Satisfaction	Mean	SD	Interpretation
Usability			
The application is easy to use and not complicated.	4.76	0.50	high
The system responds quickly and without errors.	4.63	0.56	high
Processing and display are accurate.	4.73	0.52	high
It can be used smoothly on smartphones.	4.77	0.43	high
The application is stable during use.	4.56	0.56	high
Content Appropriateness			
The application content is clear and easy to understand.	4.55	0.62	high
The content covers essential information for health assessment.	4.63	0.49	high
The health and risk advice is actionable.	4.67	0.48	high
The system's terminology and language are appropriate for the target audience.	4.63	0.49	high
The language and presentation format are user-friendly.	4.64	0.44	high
Design and Visual			high
The layout of the application's elements is appropriate.	4.56	0.56	high
The accompanying images are clear and supportive, helping clarify the information.	4.73	0.52	high
The font style, size, and layout are appropriate for reading.	4.66	0.54	high
The use of colors and graphics is attractive and not distracting.	4.60	0.56	high
The application has a credible image.	4.67	0.60	high
Impact and Practical Use			
The application helps identify health risk levels.	4.76	0.50	high
The assessment results can be used to improve behavior.	4.83	0.37	high
It is useful for long-term health monitoring.	4.76	0.43	high
It reduces assessment time and steps compared to traditional methods.	4.86	0.34	high
It has the potential to be applied to other communities or the wider community.	4.80	0.41	high

The results of comparing satisfaction scores against the researcher's criteria were above 80% of the full score (4.00 out of 5.00). The study found that those who used the application were more satisfied than the criteria set, with statistical significance ($p < 0.05$) for both individual and overall scores, as shown in Table 4.

Table 4. Compares satisfaction with the specified criteria (more than 80%) (n=30)

Satisfaction	Mean	SD	t	p	95%CI	
					Lower	Upper
Usability	4.69	0.41	9.129	<0.001**	0.538	0.848
Content suitability	4.61	0.46	7.292	<0.001**	0.441	0.785
Design and presentation	4.64	0.47	7.416	<0.001**	0.468	0.825
Benefits and applications	4.80	0.36	11.959	<0.001**	0.668	0.944
Total	4.69	0.38	9.946	<0.001**	0.548	0.831

Notes: * $p < 0.05$, ** $p < 0.001$

Results from the ergonomic risk assessment application were analyzed using interviews with 125 farmers. The results were divided into two parts: pairwise correlation tests for each painful or injured organ and the prevalence of painful or injured organs. The results are as follows:

The results of the pairwise correlation tests for each painful or injured organ using the AgriCare application revealed that the neck risk score was highly correlated with the trunk ($r=0.677$, $p<0.01$). The trunk score showed a statistically significant correlation with the upper arm and shoulder ($r=0.549$, $p<0.01$). Other pairwise correlations are shown in Table 5.

Table 5. Relationship between pairwise organ risk scores (n=125).

Organs	1	2	3	4	5	6
1	1.000					
2	0.677**	1.000				
3	0.425**	0.326**	1.000			
4	0.349**	0.549**	0.153	1.000		
5	0.073	0.207	0.017	0.230*	1.000	
6	0.320*	0.410*	0.230*	0.376**	0.264**	1.000

Notes: 1=neck and neck rotation, 2=torso and body rotation, 3=legs and standing, 4=upper arm and shoulder lift, 5=lower arm, 6=hand and wrist and wrist rotation or twist, * $p<0.05$, ** $p<0.001$.

The study found that, within 7 days, farmers reported the most pain in their right shoulder, as classified by organs at risk from ergonomics, with 17.6 percent (95%CI=12.0-24.8), followed by neck pain, 16.8 percent (95%CI=9.9-24.5). In addition, farmers reported pain in their left shoulder, lower back, right knee, and left knee, with equal percentages (16.0%) for other organs, as shown in Table 6.

Table 6. Prevalence of actual pain or injury within 7 days (n=125).

Organs at Ergonomic Risk	Organ's pain	n (%)	95%CI
Neck and neck rotation	Neck	21 (16.8)	9.9-24.5
Body and body rotation	Upper back	12 (9.6)	4.1-14.4
	Lower back	20 (16.0)	10.4-22.4
Legs and standing	Right leg	11 (8.8)	4.8-14.4
	Left leg	10 (8.0)	3.2-13.6
	Right knee	20 (16.0)	9.7-21.6
	Left knee	20 (16.0)	10.5-21.5
	Right foot or ankle	8 (6.4)	2.4-11.2
	Left foot or ankle	5 (4.0)	0.8-8.8
Upper arm and shoulder lift	Right shoulder	22 (17.6)	12.0-24.8
	Left shoulder	20 (16.0)	11.2-23.7
Lower arm	Right elbow	18 (8.0)	4.0-12.8
	Left elbow	8 (6.4)	2.4-10.4
Hand, wrist, and wrist rotation	Right wrist or hand	14 (11.2)	6.5-17.6
	Left wrist or hand	15 (12.0)	6.5-18.3

This study developed an ergonomic risk assessment application. The REBA assessment tool is complex. Most occupational health and safety practitioners are in the industrial sector rather than in government agencies responsible for the health of informal workers. This is because Thai law requires professional safety officers to assess the risks posed by hazards that may impact worker health. Furthermore, industrial sectors with more than 100 employees must allocate a professional safety officer, who holds a degree in occupational health and safety [20]. Therefore, the industrial sector represents a larger market for ergonomic risk assessment specialists than government agencies, creating a gap in healthcare for this group. This research, therefore, developed an application to address farmers' health needs. The statistics show that Thailand has the largest population of rice farmers (4.7 million) and sugarcane farmers (0.33 million) [16]. This suggests the potential for widespread adoption. In ergonomic risk assessment, several standardized tools have

been widely used, including the Rapid Upper Limb Assessment (RULA) and the Ovako Working Posture Analysis System (OWAS). Compared to these tools, REBA provides a more comprehensive whole-body assessment suitable for evaluating complex working postures commonly encountered in agricultural work [11, 12]. The integration of the REBA method into a chatbot-based system in this study enables faster interpretation of posture risk levels while maintaining consistency with established ergonomic assessment methods. Therefore, the developed system offers practical advantages in field applications that require rapid decision-making and accessibility. The conclusions and discussions are as follows:

This study utilized NextJS, NodeJS, and Firebase SDKs, along with a version control system and a CI/CD process via GitLab connected to Vercel, to ensure continuous, efficient system improvement and release. The design incorporated the REBA standard tool, used to evaluate body posture angles and assign scores, to create a model of a farmer's posture at a specified angle. This allows users to select images easily. The system then calculates scores, assesses risk levels, and notifies the results via the LINE application in Thai, both in aggregate and organ classification formats, with appropriate recommendations. The results showed that the system provides accurate, fast, and efficient results. However, some users, particularly farmers, face limitations in distinguishing similar postures, which may lead to inaccurate selection of images that reflect actual work conditions and impaired understanding of some of the assessment text. Therefore, the researchers improved the system by adding clearer, more diverse illustrations, developing a user-friendly, relevant user manual for the target group, and conducting repeated testing with actual farmers to ensure the system could be used appropriately in rural areas. In Thailand, chatbot applications have been used to enhance health literacy, such as providing advice to farmers spraying pesticides in corn fields. The study results showed that farmers significantly increased their health literacy through the recommendation system [14], consistent with the development of this application, which can effectively enhance farmers' ergonomic risk management capabilities.

The application was evaluated by information technology and health and safety experts. The evaluation assessed five quality dimensions: usability, content appropriateness, data protection and privacy, display and functionality, and overall appropriateness. The validity score for all quality questions was greater than 0.5, which met the measurement and evaluation criteria [18]. Furthermore, the experts gave an average score of 4.87 ± 0.11 (out of a full 5.00), which is considered high. However, the experts suggested minor adjustments, such as numerical indications for bending or angles, to improve understanding. The target audience should also be clearly identified, as some farmers, particularly those who are uneducated or elderly, may not be able to use the application for evaluation. The researchers completed the adjustments before using it with the farmer sample. The target audience for the application was identified as local health officials, village health volunteers, and community farmer leaders, who can then expand and share their recommendations with farmers.

The results of the efficiency test, in terms of the time between the paper assessment and the application, when applied to actual farmers, found that the assessment was convenient and fast. The time for interviewing, recording, and interpreting the results was significantly reduced ($p < 0.05$) compared with the paper, from 16.55 ± 3.16 to 2.11 ± 0.69 minutes per person. The feedback was provided automatically. In addition, when evaluating the satisfaction of those who used the application, it was found that the average satisfaction level was 4.69 ± 0.38 points (out of a full score of 5.00), which is high. They were satisfied that the application reduced the time and steps in the assessment compared to the paper assessment. The assessment data can be used to improve behavior and may be applied in other communities or more widely. This is consistent with the study by Kingchang et al. [21], which found that application users were highly satisfied with the platform's usability (average score 4.38 ± 0.49). The output and feedback aspects were very high (average score of 4.67 ± 0.52 for both), which is in line with expectations that the REBA ergonomic risk assessment is a complex tool that requires occupational health experts to assess. This time, information technology was used to help solve the problem. Therefore, the assessment can be generalized, with no difference in results between occupational health personnel and the general public. The application can accurately analyze and provide immediate results, resulting in the highest level of satisfaction with its usability.

The application of the application program to farmers revealed that each organ had risk factors related to other body parts. The neck risk factor was related to the torso, followed by the torso risk factor, which was

statistically significant ($p < 0.01$). Furthermore, the hands, wrists, and wrist rotation were significantly associated with pain scores for other organs. This was consistent with the actual work environment. Farmers used their wrists in every step of sugarcane farming, from cutting sugarcane to planting it in the soil and using sharp hooks to care for, weed, and trim the fields. This is consistent with the study by Hassani et al. [7], which found that working hours in the sugarcane field were associated with a 5.62-fold increase in hand and wrist pain. Therefore, attention should be paid to minimizing hand and wrist movement or wrist twisting. Wrist injuries can lead to inappropriate postures due to inadequate hand use, requiring the torso or shoulder also to be twisted. Therefore, the hands are most commonly associated with pain in other organs. Farmers had the highest prevalence of right shoulder pain, similar to neck pain, at 17.6% (95% CI = 12.0-24.8) and 16.8% (95% CI = 9.9-24.5), respectively. This may be because most farmers use their dominant hand to hold agricultural equipment. During the work process, they lift or carry heavy objects such as fertilizers or chemicals, so they use their right shoulder. Furthermore, using knives or hoes to dig soil or cut sugarcane requires more force in lifting the equipment with the right arm, leading to more injuries than other parts of the body. This is consistent with a study of farmers working in various fields and gardens in the Northeastern region of Thailand. 19.6% of farmers reported mild shoulder pain, and 6.5% reported moderate shoulder pain. Farmers growing different crops had similar shoulder pain [22]. It can be seen that farming in Thailand, whether in rice, sugarcane, tobacco, or vegetable fields, requires human labor, even though some steps are performed with machinery. Given the common agricultural materials used, shoulder pain can also occur.

The findings of this study are consistent with previous research reporting a high prevalence of musculoskeletal symptoms among agricultural workers exposed to repetitive postures and prolonged bending tasks [7,21]. Similar studies among rice and crop farmers have reported increased ergonomic risk associated with manual harvesting, tool handling, sustained trunk flexion, and repetitive movements. The observed prevalence of ergonomic risk among rice and sugarcane farmers in this study may be explained by the physical demands of agricultural activities, including repetitive bending, squatting, lifting, and tool use. Rice farming typically involves prolonged trunk flexion and knee bending during planting and harvesting, whereas sugarcane work requires repetitive upper limb movements and forceful tool use. These biomechanical exposures increase the risk of musculoskeletal strain among agricultural workers. In addition, differences in working characteristics between rice and sugarcane farming may contribute to distinct patterns of musculoskeletal symptoms, with rice farming commonly associated with prolonged bending and squatting, which increase the risk of lower back and knee disorders. In contrast, sugarcane farming involves repetitive upper-limb movements, forceful cutting tasks, and the handling of heavy tools, which increase the risk of shoulder and neck musculoskeletal disorders. Similar findings have been reported in previous studies among agricultural workers, in which task-specific ergonomic exposures were significantly associated with distinct patterns of musculoskeletal symptoms [23].

From a policy perspective, implementing digital ergonomic risk assessment tools could strengthen occupational health surveillance systems, particularly for informal workers such as farmers, who often lack access to professional ergonomic services. Integrating digital health tools into community-based healthcare services can support early detection of musculoskeletal risks and facilitate targeted interventions at the primary healthcare level. This approach is consistent with global occupational health strategies that emphasize the use of digital technologies to improve access to occupational health services and strengthen preventive systems [24, 25]. The developed system also demonstrates strong potential for scalability and real-world implementation. Because the application integrates with the LINE platform, widely used in Thailand, the system can be deployed across multiple agricultural communities without requiring additional software installation. Community health personnel, village health volunteers, and agricultural extension officers can use the system to conduct routine ergonomic risk screening and provide preventive recommendations to farmers. Furthermore, the cloud-based infrastructure enables centralized data storage and monitoring, allowing health authorities to track ergonomic risks and plan targeted occupational health interventions at the community and regional levels. Compared with traditional ergonomic assessment approaches, such as manual REBA, RULA, and OWAS evaluations, the developed chatbot-based system provides several practical advantages. Conventional ergonomic assessments often require trained personnel, paper-based recording,

and delayed data interpretation, which may limit their use in rural agricultural settings. In contrast, the proposed system integrates standardized REBA scoring into a digital chatbot platform that enables real-time risk assessment, automated scoring, and immediate feedback. Similar digital ergonomic tools have been reported in previous studies [26]; however, many systems require specialized software or technical expertise. The integration of the REBA method into a widely used communication platform such as LINE enhances accessibility, usability, and efficiency, making it more suitable for community-level occupational health applications.

Although this study was conducted in a specific agricultural area with a defined sample population, the findings may apply to other farming communities that involve similar manual labor tasks and ergonomic risk exposures. However, variations in agricultural practices, crop types, tool use, and environmental conditions across regions may influence ergonomic risk levels and the usability of digital assessment tools. Therefore, caution should be exercised when generalizing these findings to other agricultural contexts, and further studies conducted in diverse geographic regions and agricultural systems are recommended to strengthen external validity. In addition, data privacy and security considerations are essential in digital health applications that collect personal health information. In this study, data were stored in secure cloud-based systems with restricted access to authorized users only. Personal identifiers were minimized, and anonymized data were used during analysis to protect participant confidentiality. These practices align with international recommendations for digital health data governance and protection of personal health information [27, 28]. In terms of practical Health, Safety, and Environment (HSE) implementation, the findings of this study can support targeted ergonomic risk reduction strategies among farmers. These include providing training on correct working postures, promoting the use of ergonomically improved tools, conducting periodic ergonomic risk assessments using digital applications, and prioritizing preventive interventions for high-risk body regions such as the neck, shoulders, and lower back. The integration of digital ergonomic assessment tools into routine occupational health programs may enhance early risk identification and support continuous workplace safety improvement.

A strength of this study is the pilot application of an ergonomic risk assessment application for sugarcane farmers, a first in Thailand. Previously, most assessment tools were found in the industrial sector. The application can be easily extended to mobile phones. Those with occupational health knowledge or the general public can also assess the results, thus expanding the application range. However, this study has several limitations that should be considered. The application still relies on internet connectivity and the LINE platform, which some farmers do not yet have access to or are not comfortable using to read or view images on their phones. Therefore, the primary users are community health personnel, such as staff at subdistrict health promotion hospitals, village public health volunteers, and farmer leaders. Furthermore, the text displayed in the LINE application may be too small for older people, which could pose a challenge for future interpretation. For example, increasing text size, creating graphics that are more easily understood, or creating animations rather than text could also improve understanding and follow-up. Furthermore, adding video demonstrations might enhance the application's understanding and followability.

4. Conclusions

The developed ergonomic risk assessment application, coupled with a chatbot recommendation system, can be applied to farmers and provide fast, accurate assessment results. The assessment results from the application, those assessed by occupational health professionals, and those of the public were similar. The application was faster to complete interviews, record, and interpret than paper interviews. User satisfaction was highest across a wide range of users. The risk assessment results indicated that farmers were at high risk of neck-related torso injuries, and that wrist rotation or twisting was associated with injuries across all body parts. Therefore, the study recommends that the application be used to assess sugarcane farmers. In the future, health promotion programs should be implemented for at-risk organs, including recommendations for appropriate neck, back, and hand postures based on ergonomic principles and the development of labor-saving devices that reduce hand and wrist rotation or twisting, which will ultimately reduce risk.

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