Assessment of Farmer Knowledge and Practices towards Rice GAP Standard in Namxouang Irrigation Development Area, Vientiane Capital, Lao PDR

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Abstract

The objectives of the study aims to discover socio-economic background, assess knowledge and practices, and factors affecting farmers' knowledge and practice on Good Agriculture Practices (GAP). The survey includes 70 samples in Namxouang irrigation development area, Vientiane Capital, Lao PDR. Interviews were used for data collection. Both descriptive and inferential statistics were applied to analyze farmer knowledge, practices, and factors influencing farmer knowledge and practices towards rice GAP standards. The findings revealed that the overall average of farmer knowledge and practices related to rice GAP were 0.54 and 0.45, respectively, meaning that their knowledge was at a moderate level and their practices were moderate. On the other hand, gender, experience, annual income, and amount of credit had a significantly positive influence on farmer knowledge

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towards rice GAP standards; while media perception and amount of credits had significantly influenced farmer practices towards rice GAP. In conclusion, training courses are required to increase farmer knowledge and practices on rice production at GAP standards, to help them improve rice quality and productivity in the study area.

Keywords: Commercial Rice Production, Knowledge and Practice, Laos, Irrigated Area, Rice GAP

1. Introduction

Rice production is viewed as an indicator for poverty reduction and food security. There are many areas of Laos that still face chronic rice deficits even though it is largely self-sufficient in rice at the national level and exports small volumes of rice to neighbouring countries. In dealing with the problem of rice insufficiency, the Lao government has focused on increasing rice productivity through the use of high-yielding varieties, fertilizer application, management practice improvements, and cropping intensity in lowland farming systems (FAO, 2020 and Newby et al., 2013). In addition, the Agricultural Development Strategy to 2025 and Vision to 2030 and the 9th National Social and Economic Development Plan also mandate that food security is the highest priority in the agriculture sector. In this context the Ministry of Agriculture and Forestry (MAF) needs to emphasize good soil management, use of improved seeds, suitable fertilizer packages, and integrated pest management to intensify production and increase yield. At the same time, it is required to promote the building of rice storage or warehouses and to improve the existing irrigation systems in priority areas for clean, modern, and sustainable agriculture for food security and food safety, which is increasingly in demand in the domestic and international markets (MPI, 2021; MPI, 2016; MAF, 2010a; and MAF, 2010b). Therefore, green and sustainable agricultural development is a priority policy that includes the system of rice intensification (SRI), rice GAP, and organic rice that are promoted to farmers to increase productivity and improve its quality for export based on the requirements of regional and international markets (MAF, 2021; MAF, 2015; and MAF, 2012).

Recently, rice production in Laos has become a major agricultural activity, accounting for over 75% of the gross cropped areas. As a result, the country is expected to become a major rice exporter over the next decade, with the aim of increasing the export of rice from 90,000 tons in 2020, to 150,000 tons in 2021 (FAO, 2020; Wailes and Chavez, 2012; and Pandey, 2001). In addition, the government also prioritize 10 target areas over the country to produce at least 3.7 million tons of rice annually for food security and export (MAF, 20022). However, rice production in Laos for food security and export still faces many problems because it is insufficient to meet demand from domestic consumers. In addition it has been threatened by climate change, with annual losses at 10% of harvested rice, and poor transportation logistics to move rice to deficit areas; including the instability of production, land degradation, land use issues, and a number of large scale investment projects affecting production areas. Moreover, some households with access to irrigation cultivate other crops in paddy fields during the dry season as an alternative to producing a second crop of rice; with some of them converting their land to fish ponds, and sell their land to city people (MPI, 2021; Sacklokham, 2014 and Sourideth et al., 2011). At the same time, the adoption of SRI and organic rice production still faced several problems, because the practice of SRI always threatened by pests mainly snails and crabs; while organic rice needs to apply high technique and costs, yet the yield are not different between non-SRI and inorganic rice (Bourjac et al., 2017 and Phranakhone and Nanseki, 2015).

On the other hand, the export of rice still has a challenges. Most farmers still practice traditional techniques and produce rice for subsistence in rainfed areas using different varieties, often mixed, in milled rice for sale. Thus, the improvement of the farming system, the farmers' knowledge, and practices are required to increase rice yield and improve its quality, based on local and regional market requirements (Liese et al., 2014). The research revealed that the rice GAP method could increase and improve the tillers, panicle, yield, quality, and reduce weed pressure, it increase from 1 to 2.7 tons per hectare in Tanzania (Senthilkumar et al., 2018 and Huyly et al., 2011); the practice of rice GAP provided a number of other potential benefits, including increasing production by 13%, from 3 to 3.5 tons per hectare, and raising the price of both sticky and non-glutinous rice steadily from 25% to 30% compared to non-GAP rice (MI, 2017). While Mushobozi (2010) and Tubvongsa (2022) indicated that GAP implementation especially, record-keeping and certification, increased production costs, but the yield and price were not different between GAP and non-GAP rice.

However, the previous research found that education level, household size, annual income, land use size, and climate change perception had statistically significant effects on the adoption of climate smart agriculture. Similarly, training, expansion contract, household size, land use ownership, and farming experience influencing on adoption of rice production practice (Ayenew and Tilahun, 2022 and Abubakar et al., 2019). Moreover, it is also confirmed that age, education, family labor, farming experiences, family activities, and profit margin influence on the participation of rice organic farmer association (Phranakhone and Nanseki, 2015). While Rapankum et al. (2022) discovered that farming experience, labor type, farm size and amount of raw milk produced has significantly affected on farmers' acceptance of dairy farming standard.

The Namxouang Irrigation Development Area (NIDA) in Naxaythong District, Vientiane Capital, Lao PDR is a large irrigation system that is classified as an intensive irrigated area, which is an important source of food for people in Vientiane Capital. Farmers frequently receive support in the form of agricultural inputs through many pilot projects to increase rice yield and quality to obtain high prices and market access. However, farmers in this area still face the same problems as farmers elsewhere in Laos, with their rice being threatened by pests and diseases that cause low yields and poor quality. Similarly, many varieties are cultivated and mixed in rice for milling, resulting in problems to access local markets, and rice traders sometimes failing to purchase their rice or purchasing at a cheaper price. On the other hand, the production cost is very high compare to the yield obtained especially machine cost for land preparation and threshing as well as labor cost for transplanting and harvesting, so some farmers change from the practice of transplanting technique to apply dry sowing technique to reduce the costs, thought it needs to apply chemicals to control weeds, pest, and diseases, and it provides low yield. As it has been reported that the average rice yield in this area is 3.1 tons per hectare (DAFO, 2018); yet it is indicated that farmers in Vientiane capital can produce rice 4.41 tons per hectare in average (LSB, 2021). Therefore, NIDA was selected as a study area because it has potential resources to practice rice GAP to increase yield, quality, and prices in the future. Thus, the objective of this study aims to explore the socio-economic background of rice farmers, assess their knowledge and practices as well as the factors affecting knowledge and practice on rice GAP standard. The results of the research will be used as a reference for concerned organizations to encourage farmers to improve rice quality and to increase yields and prices in the study area and other related irrigated areas over the country.

2. Methodology of the Study

2.1 Sample size

The study applied both qualitative and quantitative approaches for data collection. It integrated different research techniques which included a literature review, key informant interviews, and a household survey. For the literature review, many existing reports, statistics, official regulations, and other related documents from public and private stakeholders were reviewed to understand the situation of rice production in the study area. At the same time, the agriculture and forestry office, industry and commerce office, and the office of the Namxoung irrigation development area, including village authorities in the study area were interviewed to understand in more detail about rice production. For the household survey, individual rice farmers were interviewed face to face, to obtain personal and socio-economic background data, level of knowledge, and types of practices used related to rice GAP standard.

The population of the study area included 2,189 rice farmer households in 10 villages under NIDA in Naxaythong District, Vientiane Capital. The interview sample size was calculated by using Arkin (1974) formula as follows:

$$n = \frac{p(1-p)}{\left(\frac{SE}{t}\right)^2 + \frac{p\,(1-p)}{N}} = \frac{0.95(1-0.95)}{\left(\frac{0.05}{1.96}\right)^2 + \frac{0.95(1-0.95)}{2,189}} = 70$$

Where: n = Sample size, P = Percent of occurrence in the population (95%), SE = Standard error = 0.05, N = Total population, t = Confident level factor = 1.96

The samples included 70 rice farmer households, while sample size larger than 30 is a standard normal distribution (Islam, 2018).

2.2 Data Collection

The samples were selected through purposive and snowball sampling techniques, because there are many group of people in the study areas who practice and do not practice rice production due to they have no paddy land, so the study would like to focus on farmers who practice wet season rice cultivation, and who knew well and could give information about rice production techniques, so the information provided can be represented for the population in the study area. The interviews were used for both secondary data and primary data collection. The questionnaire was developed by reviewing related papers based on the research objectives, and was checked by an advisory committee and three experts who specialized in rice production, for content validity; it was revised, then tried out with 30 samples for a reliability test, which was 0.84 (Kuder and Richardson, 1937).

2.3 Data Analysis

For data analysis, the collected qualitative data was summarized and grouped to explain the situation and answer the objectives. For the quantitative data, the descriptive statistics were used to analyze frequency, percentage, arithmetic means, standard deviation, minimum, and maximum. Moreover, the inferential statistics analysis also was applied to find the factors affecting farmer knowledge and practices toward the rice GAP standard by using Ordinary Least Square regression to find the relationship between personal background, socio-economic factors, and farmer knowledge and practices towards rice GAP standard. While the rice GAP standard proposed in this study was developed and integrated based on Lao and Thai rice GAP standards, some criteria may excluded, because they are not appropriate to the existing situation. However, the standard intense to improve rice quality and increase its yield and price as well as reduce herbicide application through the practice of dry sowing technique.

Moreover, farmer knowledge and practices of the rice GAP standard in this survey was measured by interview questions which consisted of five key components including: integrated land use and water management; integrated rice crop management; integrated pest management; integrated harvesting management; and, a traceability system. For knowledge, it had 20 multiple choice questions; each question was divided into four options and there was only one correct answer identified in the rice GAP standard; while the practice included 25 yes/no questions. The farmer knowledge and practice were analyzed and divided into three levels as followed,

Farmer Knowledge	Farmer Practice
0.00 – 0.33 refers to low level	0.00 – 0.33 refers to rarely practice
0.34 – 0.67 refers to moderate level	0.34 – 0.67 refers to moderate practice
0.68 – 1.00 refers to high level	0.68 – 1.00 refers to often practice

The Ordinary Least Square (OLS) method was applied in order to find the factors affecting farmer knowledge and practices towards rice GAP standard in the study area. Therefore, the variables and model used to measure the results were described as follows:

Dependent variables: The dependent variables were knowledge (Y_1) and practice (Y_2); with knowledge and practice being calculated from correct answers and yes answers.

Independent variable: X_1...... X_{10} are identified in table 1. However, the data collected for OLS estimation is limited, some variables are not collected, because the farmers in this area have never practice rice GAP yet. It only would like to measure the basic factors affecting knowledge and practice of farmers in the study area.

Table 1 The definition of independent variables

Symbols	Definitions	Type of Variables
X1	Age	Scale
X2	Gender	(dummy, male=1, female=0)
X3	Marital Status	Nominal
X4	Household size	Scale
V5	Education	Ordinal
X6	Farming experience	Scale
X7	Decision making	Nominal
X8	Media perception	Nominal
X9	Annual income	Scale
X10	Amount of credits	Scale

The relationship between independent and dependent variables was measured through the OLS model. The measured form of equation was specified as follows:

$$Y_{1i} = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \dots + \beta_{10} x_{10i} \quad \text{(1)}$$

$$Y_{2i} = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \dots + \beta_{10} x_{10i} \quad \text{(2)}$$

3. Results and Discussion

3.1 Personal and Socio-Economic Background of Respondents

From the survey, it found that the majority of the respondents was male, accounting for 72.9%, the rest 27.1% were female. The average age was 51.53 years old ranking from 24 to 75 years old; most of them were married, accounting for 95.7%. The rest 2.9% and 1.45% were windowed and single. The average household size was 5.47 people per household ranking from two to 11 people. While 98.6% of them finished at least primary school up to university level; the rest, 1.4% were illiterate. Their rice farming experience was 29.84 years on average, varying from five to 55 years. Moreover, they also had equal rights between husband and wife in making decisions on agricultural activities in the household, accounting for 60%. The remaining 40% were decided by only one person: the husband, or the wife, or the parents, or the son, or the daughter.

The result also revealed that 62.9% of the respondents were rice farmers. The rest 37.1% were weavers, traders, businessmen, government officials, construction workers, and livestock producers. There were 92.9% who obtained information related to rice production from training, television, and other sources. On the other hand, the average annual income was US$8,715, ranging from US$1,729 to US$33,600 per household; while 25.7% had access to credit to support agriculture production, the rest 74.3% never had access to credit.

3.2 The Farmer Knowledge towards Rice GAP Standards

An analysis of the data found that the overall average of farmer knowledge of the rice GAP standard was 0.54, meaning that their knowledge was at a moderate level (Table 2). It also revealed that the highest average of their knowledge was on integrated land use and water management, accounting for 0.79, meaning that their knowledge was at a high level; the result may be related to most of the criteria used to measures in this component was linked to traditional rice production techniques that they practiced for many generations; especially their knowledge of suitable water levels for rice in the field, the best land preparation techniques for efficient rice growth, and the requirement for fallowing land and soil fertility management; they were 0.87, 0.84, and 0.80 respectively on average, meaning that their knowledge was at a high level, but their knowledge on requirements for efficient water management was at a moderate level, being only 0.63 on average.

In comparison, farmer knowledge towards the traceability system of the rice GAP standard was the lowest when compared to other factors; being only 0.31 on average, meaning that their knowledge was at a low level. While the highest and lowest knowledge levels of each measured criteria in this component were not different; the highest level of their understanding was on the main objectives of farm recording for traceability, but their lowest level of knowledge was understanding about the basic requirements of farm recording for traceability, which were 0.33 and 0.30 on average, meaning they were both at a low level. As a result, they had never been trained on the rice GAP system by any organization, so they did not know about the importance of farm recording, the type of information that should be recorded, and what the recorded information is used for.

On the other hand, the average knowledge levels on integrated rice crop management, integrated pest management, and integrated harvesting management were 0.62, 0.53, and 0.46, respectively; meaning that their knowledge of these three components was moderate. However, there were many measured criteria of knowledge on the rice GAP standard from three factors were at the high, moderate, and low levels; for example their knowledge of the basic requirements to protect the body during spraying chemicals, the suitable time for extracting mixed rice varieties, and the best techniques for keeping chemicals safely before and after use, averaged 0.96, 0.84, and 0.77, respectively; meaning that they were at high levels. At the same time, their knowledge of the suitable interval density for efficient rice growth, the best options for selecting good rice seeds, and the best period of time to reduce moisture content of harvested rice, averaged 0.67, 0.66, and 0.63, respectively; meaning that they were at moderate levels. Another example was their knowledge of the best time to harvest and obtain maximum rice yield and the best techniques for controlling weeds in the rice field, averaged 0.26 and 0.09, respectively, meaning that they were at low levels.

However, it could summarize that the farmer's knowledge towards rice GAP standard was in moderate, but they still needed to enhance their knowledge a little bit more on integrated rice crop management, integrated pest management, and integrated harvesting management, because their knowledge on some measure criteria from these three components were low. Moreover, prior to promote them practice rice GAP production to improve quality and increase its yield and price; it firstly needed to train farmers on traceability system, because their knowledge was low on every measured criteria in this section. Therefore, it could confirm that if they were trained on each measured criteria and know their importance, so they would change their practice to improve rice quality.

Table 2 The farmer knowledge towards rice GAP standards

Items	$\overline{X}$	S.D.	Level of knowledge
Integrated land use and water management	**0.79**	**0.39**	**High**
1. Requirement for fallowing land and soil fertility management	0.80	0.40	High
2. Requirement for efficiency water management	0.63	0.48	Moderate
3. Best land preparation for efficiency rice growth	0.84	0.36	High
4. Suitable water level management for rice in the field	0.87	0.33	High
Integrated rice crop management	**0.62**	**0.46**	**Moderate**
1. Best option for selecting good rice seed or variety	0.66	0.47	Moderate
2. Avoidance of seed repetition or changing seeds	0.61	0.49	Moderate
3. Suitable age of rice seedling for transplanting	0.37	0.48	Moderate
4. Suitable interval density for efficiency rice growth	0.67	0.47	Moderate
5. Best time for re-transplanting un-growth seedlings	0.74	0.44	High
6. Frequency of rice crop monitoring	0.43	0.49	Moderate
7. Suitable time for extracting mixed rice varieties	0.84	0.36	High

Table 2 The farmer knowledge towards rice GAP standards (Cont.)

Items	$\overline{X}$	S.D.	Level of knowledge
Integrated pest management	**0.53**	**0.40**	**Moderate**
1. Best technique for controlling weed in rice field	0.09	0.28	Low
2. Best technique to protect and control diseases in the field	0.39	0.49	Moderate
3. Best technique to control insect in the field	0.37	0.48	Moderate
4. Best technique to control snails	0.69	0.46	High
5. Best technique to control rodents	0.46	0.50	Moderate
6. Requirement to protect body during spraying chemicals	0.96	0.20	High
7. Best technique for keeping chemicals safely after used	0.77	0.42	High
Integrated harvesting management	**0.46**	**0.47**	**Moderate**
1. Best time to harvest and obtain maximum rice yield	0.26	0.44	Low
2. Best period of time to reduce humidity of harvested rice	0.63	0.48	Moderate
3. Requirement for good storage condition for keeping rice	0.36	0.48	Moderate
4. Criteria for the best quality of rice for selling	0.61	0.49	Moderate

Table 2 The farmer knowledge towards rice GAP standards (Cont.)

Items	$\overline{X}$	S.D.	Level of knowledge
Traceability system	**0.31**	**0.46**	**Low**
1. Basic information that required to record for traceability	0.31	0.46	Low
2. Requirement of farm recording for traceability	0.30	0.46	Low
3. Main objective of farm recording for traceability	0.33	0.47	Low
Overall average knowledge towards rice GAP standard	**0.54**	**0.44**	**Moderate**

3.3 The Farmer Practices of Rice GAP Standards

Based on the research findings, the farmers in the study area knew well some basic criteria related to the rice GAP standard, yet they did not carry out some practices because of environmental conditions such as soil fertility, threat of pests, diseases, water availability, labor, and machine costs. Therefore, the overall average farmer practices to meet the rice GAP standards were 0.45, indicating moderately practiced (Table 3).

The study also indicated that the farmer practices on integrated land use and water management was practiced most frequently when compared to other factors, averaging 0.82, meaning that they were often practiced. Although most of the criteria measured in this component were often practiced, being higher than 0.68 on average; yet only one criteria was measured, the application of organic fertilizer or manure during land preparation being moderately practiced, averaging 0.50, because many farmers pointed out that organic fertilizer increased the cost of production and was effective only slowly on rice growth, so some of them did not apply it.

On the other hand, it also was found that farmers practices related to the traceability system were rarely practiced when compared to all other components in the rice GAP standard; as the overall measure of this criteria averaged 0.00, meaning it was only rarely practiced. The farmers in the study area had never made any records for traceability. Some remembered only the date of sowing seeds based on the lunar calendar. They did not make any record because they had never been trained about the rice GAP, so they did not know what the purpose of recording was. In addition, it would waste their labor and time to make notes and to keep records, especially since traders or collectors never asked for records and the price of rice did not change or increase if they made notes and kept records.

At the same time, the average of farmers practicing integrated harvesting management, integrated rice crop management, and integrated pest management was 0.51, 0.50, and 0.40, respectively, meaning that they were all in a moderate practice. However, the results of measuring criteria from these three factors had different levels of practice, including often, moderate, and rarely practiced. While the most often practiced of the measured criteria in these three components were the best techniques for keeping chemicals before and after use, the avoidance of seed repetition, and the best techniques for controlling snails in the rice field, averaging 0.87, 0.86, and 0.81, respectively, being often practiced. In contrast, the most rarely practiced of the measured criteria were the practices related to the best technique for controlling pests, diseases, and weeds in the rice fields, averaging 0.03, 0.04, and 0.14, respectively, being rarely practiced. On the other hand, some measured criteria were moderately practiced such as a suitable time for re-transplanting, a suitable interval density of rice seedling for transplanting rice, and fertilizer application techniques, averaging 0.66, 0.61, and 0.56, respectively.

From the discussion in this section, the farmers' practice level towards rice GAP standards was moderate. Thus to encourage farmers in this area engage in rice GAP production, they still needed to be train on some measured criteria of integrated land use and water management, integrated rice crop management, integrated pest management, and integrated harvesting management, because some criteria from these components were sometimes practice; while some of them rarely practice. However, it needed to emphasize on the traceability system, because they never practiced it at all.

Table 3 The farmers' practice level towards rice GAP standards

Items	Mean	S.D.	Practice level
Integrated land use and water management	**0.82**	**0.35**	**Often**
1. Cutting paddy straw completely after harvesting	0.84	0.36	Often
2. Burning the straw entirely after harvesting	0.83	0.38	Often
3. Leaving the straw dry after harvesting	0.93	0.25	Often
4. Applying organic fertilizer or manure during land preparation	0.50	0.50	Moderate
5. Rice field bunds must be clean, firm, and in good condition	0.91	0.28	Often
6. Having one dry plow and wet plow before level soil for transplanting	0.83	0.38	Often

Table 3 The farmers' practice level towards rice GAP standards (Cont.)

Items	Mean	S.D.	Practice level
7. Leaving plowed soil to make it softly at least one week	0.92	0.26	Often
8. Know suitable water level for different stages of rice growth	0.83	0.38	Often
Integrated rice crop management	**0.50**	**0.32**	**Moderate**
1. Selecting the certified source of seeds	0.26	0.44	Rarely
2. Avoidance of seed repetition or changing seeds	0.86	0.35	Often
3. An appropriate age of rice seedlings for transplanting	0.24	0.43	Rarely
4. A suitable interval density of rice seedling for transplanting rice	0.61	0.49	Moderate
5. A suitable time for re-transplanting	0.66	0.47	Moderate
6. Fertilizer application technique	0.56	0.50	Moderate
7. The frequency of rice monitoring	0.53	0.50	Moderate
8. An suitable time for extracting mixed rice in the field	0.31	0.46	Rarely
Integrated pest management	**0.40**	**0.32**	**Moderate**
1. The best technique for controlling weed in the rice field	0.14	0.35	Rarely
2. The best technique for controlling diseases in the rice field	0.04	0.20	Rarely
3. The best technique for controlling pests in the rice field	0.03	0.16	Rarely

Table 3 The farmers' practice level towards rice GAP standards (Cont.)

Items	Mean	S.D.	Practice level
4. The best technique for control snails in the rice field	0.81	0.39	Often
5. The best technique for control rodents in the rice field	0.14	0.35	Rarely
6. Requirement for protecting body during spraying chemicals	0.76	0.43	Often
7. The best technique for keeping chemicals before and after use	0.87	0.33	Often
Integrated harvesting management	**0.51**	**0.47**	**Moderate**
1. Know rice harvesting time to obtain maximum yield	0.57	0.49	Moderate
2. Number of days for drying harvested rice in the field to reduce humidity	0.66	0.47	Moderate
3. An appropriate place or storage for keeping rice	0.31	0.46	Rarely
Traceability system	**0.00**	**0.00**	**Rarely**
1. Record land use background	0.00	0.00	Rarely
2. Record name and source of input use	0.00	0.00	Rarely
3. Record the steps of rice production technique	0.00	0.00	Rarely
4. Keeping record for traceability	0.00	0.00	Rarely
Overall average practice towards rice GAP standard	**0.45**	**0.32**	**Moderate**

3.4 Factors Affecting Knowledge and Practices related to the Rice GAP Standard

The analysis of Ordinary Least Square (OLS) (Table 4) found that gender, farming experience, annual income, and the amount of credit had positive significant relationships, with farmer knowledge towards the rice GAP standard at a statistical level of 0.05 and 0.001. On the other hand, age, marital status, household size, education level, the role of decision making and media perception did not have a significant relationship with knowledge of the rice GAP standard, so it could be presented as follows:

Knowledge (Y_1) = 0.043 + 0.152(Gender) + 0.056(Experience)
+ (0.029(Income) + 0.011 (credits)... (3)

Based on an analysis of the equation (3), if the number of men interviewed increases by one person, the percentage of farmer knowledge about the rice GAP would increase; or, they would be able to give more correct responses to the interview questions. This may be a result of work classification, specifically because most of the activities related to rice cultivation, such as land preparation, seed planting, monitoring rice growth, weeding, harvesting, and loading were operated by men. Women participate more in preparing rice seed for planting, transplanting, and harvesting. Therefore, men tend to know more about the details of rice cultivation techniques than women. In addition, if the experience of a farmer increased by one more year, those farmers tend to have more knowledge to provide correct answers because they may have more time to learn rice cultivation techniques based on experience from year to year. At the same time, if their income and availability of credit increased, they are able to answer more questions as well. This is because income and credit may support their investments in rice cultivation, including accessing more inputs to increase returns since they pay more attention to rice cultivation in which they have invested. This encourages them to understand more details of rice cultivation techniques than other groups of farmers.

In summary, the analysis indicates that the combination of four main input factors, namely the number of men, farming experience, annual income, and amount of credits influence the level of knowledge they have about rice cultivation techniques that are related to rice GAP standards. In contrast , the other input factors that were not significant and not included in the equation, such as age, marital status, household size, education level, the role of decision making, and media perception, do not mean they were not important since they contributed a minimal percentage or at the existing rate of inputs used. Additional training courses about producing rice to GAP requirements are needed, as well as facilitating access of farmers to credit with preferred interest rates to support farmers to acquire knowledge about the rice GAP standards, thus helping producers to improve the quality and quantity of rice that meet these standards.

In terms of practice, the analysis revealed that only perception obtained from media and the amount of credit received had a significant relationships with farmer practices related to meeting rice GAP standard at a statistical level of 0.05. While age, gender, marital status, household size, educational level, farming experience, role of decision making, and annual income did not have a significant relationship with farmers practicing rice GAP techniques, as demonstrated below:

$$\text{Practice } (Y_2) = 0.494 + 0.051(\text{Media}) + 0.005(\text{Credits}) \ldots\ldots\ldots\ldots\ldots (4)$$

From the equation (4), the analysis revealed that if the number of farmers receiving information from media increased, the practice score for applying GAP for rice cultivation increased. This result indicates that farmers may learn some activities related to rice GAP production through various media, including training, workshops, television, and radio, among others, in order to improve and increase rice production. At the same time, if the amount of credit that farmers borrowed from financial institutions to invest in agricultural activities, infrastructure, machines, and other inputs increased, the practice score would increase as well. This result may be related to the fact that most of the farmers who had access to credit have a plan and really know what they want to do; so they perform agricultural activities regularly and correctly, which increases the number of farmers who adopt GAP practices. Therefore, it was not difficult to increase rice yields and improve product quality through the GAP practices for rice. All that was needed was to provide them with useful information through the media, mainly training on rice GAP standards. At the same time, there also is a need to support low interest rates for of credit or facilitating access to credit during the rice production season, thus helping producers to invest in rice production activities such as good quality rice seeds, land preparation, fertilizer, machinery, and others based on rice GAP standards. In this manner rice production would meet market requirements that would facilitate market access and increase the price of rice as well.

From the analysis, it could conclude that the factors affecting farmers' knowledge and practice towards rice GAP standards in this study was also similar to the result of previous study which found that education, household size, annual income, land use size, and climate change perception had effects on the adoption of climate smart agriculture. And training, expansion contract, household size, land use ownership, and farming experience had influencing on adoption of rice production practice (Ayenew and Tilahun, 2022 and Abubakar et al., 2019). In addition farming experience, labor type, farm size and amount of raw milk produced has also significantly affected on farmers' acceptance of dairy farming standard (Rapankum et al., 2022). Therefore, it was extremely necessary to provide training and emphasized on factors affecting, so it could help them understood the standard, so they may adopt and practice each criteria in this study.

Table 4 Factors effecting knowledge and practice towards rice GAP standard

Effecting factors	Knowledge and practice levels					
	Knowledge Level			Practice level		
	Coefficient	Std.	P-value	Coefficient	Std.	P-value
Personal background						
(Constant)	**0.043**			**0.494**		
Age	0.023	0.028	0.414	0.005	0.014	0.743
Gender	0.152**	0.044	0.001	-0.018	0.022	0.414
Marital status	-0.075	0.090	0.405	-0.046	0.045	0.312
Household size	0.026	0.022	0.251	0.000	0.011	0.985
Education	0.008	0.016	0.647	0.011	0.008	0.188
Social factors						
Farming experience	0.056*	0.026	0.038	0.005	0.013	0.717
Decision making	0.036	0.035	0.311	-0.004	0.017	0.837
Media perception	-0.012	0.050	0.815	0.051*	0.025	0.047
Economic factors						
Annual income	0.029**	0.011	0.008	0.002	0.005	0.719
Amount of credits	0.011*	0.005	0.038	0.005*	0.003	0.034
	R Square		0.544	R Square		0.191

Remark: *, ** = Significant level at 0.05 and 0.01 respectively

4. Conclusion and Recommendation

Based on the discussion, the research can be summarized by stating that the farmers interviewed in the study area had basic knowledge and experience with practices related to the rice GAP standards. However, they carried on with traditional rice production and had never received training in rice GAP standards, the overall knowledge and general practices were at a moderate level and moderately practiced, respectively. Thus, encouraging them to adopt GAP rice production practices would not be difficult. This would result in increased rice yield, better quality, and higher prices for commercialization and export than when producing for local and regional market requirements, the farmers interviewed lacked knowledge and practice only in some measured criteria of the rice GAP standard. Only their knowledge level and cultivation practices related to the traceability system were at a low level and were rarely practiced, even though some of them knew and understood the importance of the basic information that needed to be recorded for traceability. They had never maintained any records because they had never been trained about the rice GAP standards. They did not know what the information would be used for. In addition, it would be a waste of their labor and time to take notes and keep records, while the traders or collectors had never asked for records nor purchased rice produced using the GAP standards. Thus, there is significant potential for private investors or government extension agents to encourage rice producers to engage in GAP or organic rice production for export through contract farming or in form of farmer group production; as it would not be difficult to provide training courses, to increase rice quality and yields, as well as to guarantee its price.

Moreover, there were not many criteria of knowledge that were analyzed that most farmers did not know and understand well. These included the best techniques for controlling weeds in rice fields; the best time to harvest to obtain maximum rice yields; and, the requirements of good storage conditions for keeping rice. At the same time, there were some criteria that were analyzed that most farmers know and understand at high level, but that they rarely practiced, mainly keeping farm records for traceability, best options for certified seed selection, a suitable time for extracting mixed rice in the field, among others. While some criteria analyzed were often and moderately practiced, their knowledge was at a low and moderate level especially the best harvesting time to obtain maximum rice yield, and the avoidance of rice seed repetition. The reasons they did not know and understand some criteria was because they may not be a major problem and may not be necessary for rice production in this area. Thus, they did not want to waste their time, labor, and additional expenses. On the other hand, the reason they know more, but they rarely practice the activities may be related to local environmental conditions, labor availability, and the high cost of inputs required because farm record keeping and extracting mixed rice in the field requires more labor and time, yet the market price was not affected and consumers never asked to inspect records. At the same time, to access certified seeds from a rice seed center was expensive and would increase production costs. Thus, they just sometimes exchanged rice seed or obtained new rice seeds from friends or relatives, mainly because they produced rice only for household consumption. However, in reality they still had a lack of knowledge and practice of the rice GAP standard that would enable them to increase rice quality, yields, and price.

On the other hand, the gender, farming experience, annual income, and amount of credit accessible had positive significant relationships with farmer knowledge on the rice GAP; while the perceptions from media and level of credit accessible also has a positive significant relationship with farmer practices of the rice GAP. Therefore, it is very important to train them, providing both knowledge and practices, to emphasize the criteria that were analyzed that they could not answer and rarely practiced, particularly records for traceability, integrated pest management, weed control, seed selection, and other criteria based on the rice GAP standard. Moreover, the training should include the participation of both male and female producers; while media sources about rice production is should be improved in several ways including brochures, posters, television, radio and other applications, namely because they influence adaptation of the rice GAP practices. Furthermore, financial institutions also need to improve credit accessibility, making it for easier and faster for producers to access credit. This could be through a special fund with low interest rates for farmers to help them to access inputs and lower production costs. On the other hand, the enhancement of farmer knowledge and practices based on the criteria for rice GAP standards could be through training courses for farmers at NIDA, providing an example of increasing rice yields and quality in an irrigated area to obtain higher returns.

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