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Knowledge, attitudes, and practices regarding Alternate Wetting and Drying (AWD) rice cultivation among farmers in community enterprise groups for large-scale agriculture in Suphan Buri province, Thailand

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Abstract Results revealed that farmers possessed a very high level of knowledge regarding AWD rice cultivation, with correct response rates ranging from 76.7% to 100% across 15 assessment items. They exhibited consistently positive attitudes towards AWD implementation, with mean scores between 4.23 and 4.83, rating five items as "Strongly Agree" and ten as "Agree." In terms of practice, farmers demonstrated high to highest levels of AWD implementation across ten practices, with mean scores ranging from 4.00 to 4.67. Furthermore, farmers' AWD practice levels were significantly associated with gender, age, total rice farming area, AWD farming area, and attitude towards AWD ($p < 0.05$), while farming experience and attendance in AWD training showed marginal significance ($p < 0.1$).

Keywords: Alternate wetting and drying, Rice cultivation, Community enterprise, Knowledge attitudes and practices

Introduction

Agriculture is a significant contributor to greenhouse gas emissions and ultimately climate change. Rice farming is especially vulnerable to climate-related issues, such as droughts, unpredictable rainfall, pest infestations, and higher production costs, due to its substantial water requirements. A lack of water can cause planting to be delayed, resulting in lower yields and consequently reduced income (Netaji, 2023). As a result, improvements in how efficiently water is used, such as Alternate Wetting and Drying (AWD), have garnered considerable attention. AWD is a water management method that alters the field conditions from wet to dry and back again. This can cut water use by up to 30% and reduce methane emissions, a greenhouse gas 25 times more potent than carbon dioxide at warming the planet (Bouman *et al*., 2007; Lampayan *et al*., 2015). AWD reduces production costs, raises yields,

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and increases farmers' net income (Rejesus *et al.*, 2011), while also improving soil aeration, enabling plants to support root growth and nutrient absorption (Royal Irrigation Department, 2016).

The AWD method offers several benefits, including lower water usage, climate-resilient production, improved yields, and reduced costs; nonetheless, its implementation is obstructed by farmers' inclination towards traditional practices. Phuttharatraksa and Leknoi (2021) identified that farmers encounter challenges, including unfamiliarity with AWD techniques, concerns about increased weed growth, and uncertainty regarding effectiveness. The adoption of AWD relies on farmers' knowledge, positive attitudes, and socioeconomic factors that influence their decisions regarding farming systems or practices, collectively affecting the efficient implementation of the practice (Beharielal *et al.*, 2022).

The province of Suphan Buri in Thailand has been the focus of government attempts to encourage the growing of rice in a sustainable manner using AWD. The goal of these initiatives is to minimise the amount of greenhouse gas emissions while simultaneously increasing the carbon credit income. Doem Bang Nang Buat District, which includes the Doem Bang Sub-district, is a region in central Thailand known for its rice production. The district's clay and highland soils are supported by irrigation that is available year-round, serving as a place for the dissemination of AWD innovations. Understanding the relationships between socioeconomic factors, farmers' knowledge, and attitudes towards AWD is crucial for identifying adoption barriers and developing effective extension strategies.

The study examined the knowledge, attitudes, and practices concerning AWD rice cultivation among members of large-scale agricultural community enterprises in Suphan Buri Province and explored the relationships between socioeconomic characteristics and AWD practices.

Materials and methods

The agricultural community enterprise is situated in Doem Bang Sub-district, Doem Bang Nang Buat District, Suphan Buri Province, consisting of 143 members who cultivate around 6,000 rai of rice employing AWD methods. This site was chosen as the study area because it functions as a model demonstration site for AWD implementation. The research location consists of upland clay soils equipped with continuous irrigation systems, providing ideal conditions for the implementation of AWD. Government extension programmes have advocated for the adoption of AWD as a sustainable alternative to traditional flooded rice cultivation, highlighting water management techniques that mitigate prolonged field submersion. This technology provides notable benefits compared to conventional methods, such as lower methane emissions, reduced water usage, and improved production efficiency, all while ensuring yield stability.

Data collection

A sample of 30 farmers from the agricultural community enterprise who participated in AWD training sessions between May and July 2025 was selected to analyse initial practice patterns and decision-making processes. This study employed a simple random sampling to select the respondents. Data were collected through a structured interview instrument, developed based on pertinent literature and validated by three agricultural experts. The results of the Item–Objective Congruence (IOC) analysis indicated that all questionnaire items had IOC values 0.95, demonstrating content validity.

The research instrument consisted of four components: (1) Socioeconomic characteristics, encompassing demographics, farming experience, land tenure, extension access, and income sources; (2) AWD knowledge, evaluated through 15 true-false questions, addressing cultivation principles, growth stages, and management practices, with 1 point awarded for each correct answer; (3) Attitudes towards AWD, measured using a 5-point Likert scale, where 5 indicates strong agreement and 1 strong disagreement; and (4) AWD practices, assessed using a 5-point frequency scale, ranging from 5 for always practiced to 1 for never practiced.

The instrument was developed based on documentation from the Royal Irrigation Department, 2016 and Rice Department, 2019 and pertinent studies (Phuttharatraksa and Leknoi, 2021; Mahadi *et al.*, 2018; Oladele *et al.,* 2019; Samoy-Pascual *et al.,* 2022; Suwanmaneepong *et al.,* 2023).

Data analysis

The statistical analysis was divided into two parts. Descriptive statistics were employed to analyse the general characteristics of the respondents, as well as their levels of knowledge, attitudes, and practices regarding AWD rice cultivation, using frequency, percentage, mean, and standard deviation.

Knowledge levels were assessed using a dichotomous scoring system, where correct responses were assigned 1 point and incorrect responses 0 points. Total scores were then calculated for each farmer following the approach of Mondal *et al.* (2014). Attitudes and practices were measured using a five-point scale according to Kitpredaborisut (2006) as follows:

Mean scores 4.51 – 5.00 = Highest level
Mean scores 3.51 – 4.50 = High level
Mean scores 2.51 – 3.50 = Moderate level
Mean scores 1.51 – 2.50 = Low level
Mean scores 1.00 – 1.50 = Lowest level

Furthermore, chi-square analysis was utilised to investigate the relationship between farmers' socioeconomic status, knowledge, attitudes, and their practices concerning AWD rice cultivation.

Results

Socioeconomic factors of participants

Result showed, 66.7% of respondents were female, with 60.0% aged ≤50 years. Educational attainment was predominantly lower secondary to vocational level (83.3%), and 70.0% had <50 years of rice farming experience (Table 1). Nearly all farmers (93.3%) belonged to agricultural groups, with 60.0% cultivating <30 rai total and 70.0% using AWD on areas <30 rai. All respondents received government agricultural extension services, and 63.3% attended more than 100 training sessions annually. While over 60.0% earned <10,000 THB yearly from AWD rice farming, more than 70.0% had not received any carbon credit income.

Table 1. Socioeconomic status of rice farmers for large-scale agriculture

Variables	**Per cent**
Gender	
Male	33.30
Female	66.70
Age	
Lower than 50 years	40.00
50 years and above	60.00
Highest educational level	
Lower than a bachelor's degree	83.30
Bachelor's degree and above	16.70
Experience of rice farming	
Less than 50 years	70.00
50 years and above	30.00
Organisational membership	
No	6.70
Yes	93.30
Total farming areas (unit: rai)	
Less than 30 rai	60.00
30 rai and above	40.00
AWD farming areas (unit: rai)	
Less than 30 rai	70.00
30 rai and above	30.00
Receiving agricultural extension from the government	
No	-
Yes	100.00

Table 1. (Continued)

Variables	Per cent
Less than 100 times a year	36.70
100 times a year and above	63.30
Income from AWD	
Less than 10,000 Thai baht	60.00
10,000 Thai baht and above	40.00
Carbon credit sales experience	
Yes, with a return or money	20.00
Yes, without return or money	70.00
Hesitant about participating	10.00

Farmers' knowledge of AWD rice cultivation

Farmers' knowledge of AWD rice farming was assessed through a set of 15 questions, as presented in Table 2. The results showed that farmers answered 100% correctly on six items. For additional items, farmers demonstrated a high level of understanding, with correct response rates ranging from 93.3% to 96.7%. These findings reflect that farmers possess the highest level of knowledge about AWD rice cultivation. However, only 76.7% of farmers correctly answered that "the pipes should have a diameter of 6 inches". Overall, the farmers possessed a very high level of knowledge regarding AWD practices in rice cultivation for almost all items.

Table 2. AWD knowledge assessment items

(Unit: per cent)

Items	True	False
1) AWD involves periodically alternating between flooded and drained field conditions.	100.00	-
2) AWD reduces water consumption by 15–20% compared to continuous flooding.	100.00	-
3) AWD enhances root and stem development through improved soil aeration.	100.00	-
4) AWD requires precise field levelling for effective water level control.	96.70	3.30
5) Water level monitoring requires 6-inch diameter PVC pipes.	76.70	23.30
6) PVC monitoring tubes should be installed 20 cm deep with a 5 cm surface protrusion.	96.70	3.30
7) Water drainage is initiated when the pipe water level drops >10 cm after 15–20 days post-sowing.	93.30	6.70
8) AWD implementation must align with specific rice growth stages.	100.00	-
9) AWD application requires reliable water control infrastructure.	93.30	6.70

Table 2. (Continued)

(Unit: per cent)

Items	True	False
10) AWD is suitable for sandy and saline soil conditions.	96.70	3.30
11) AWD is applicable exclusively to rainfed rice systems.	100.00	-
12) AWD implementation increases production costs due to additional labour requirements.	93.30	6.70
13) AWD improves water use efficiency and yield per unit area.	100.00	-
14) Field drying reduces rice tillering capacity.	100.00	-
15) AWD provides opportunities for carbon credit revenue generation.	100.00	-

Farmers' attitudes towards AWD rice cultivation

The results of farmers' attitudes towards AWD across 15 items, with mean scores ranged from 4.23 to 4.83 (SD = 0.461–0.858) (Table 3). Five items were rated as "Strongly agree": complications in field humidity management, benefits of AWD yield, adaptation to climate change, future commitment to AWD, and AWD as the predominant method moving forward. Ten items received "Agree" ratings: ease of implementation, input cost reduction, soil quality improvement, disease reduction, technological facilitation, carbon credit opportunities, promotion of sustainable production, interest in training, expectations for farmer adoption, and the importance of institutional support. Farmers demonstrated consistently positive attitudes towards the implementation of AWD.

Table 3. Farmers' attitudes towards AWD

Items	$\bar{X}$	S.D.	Interpretation
1) Field humidity management creates water use complications in rice cultivation.	4.87	0.434	Strongly agree
2) AWD implementation increases yield per unit area.	4.83	0.461	Strongly agree
3) AWD procedures are straightforward and easily implementable.	4.50	0.938	Agree
4) AWD reduces input costs through decreased seed, fertiliser, and chemical requirements.	4.50	0.630	Agree
5) AWD enhances soil quality by increasing organic matter content and improving soil structure.	4.23	0.858	Agree
6) AWD reduces disease and pest incidence in rice fields.	4.47	0.681	Agree
7) Technological innovations facilitate AWD field management practices.	4.50	0.682	Agree
8) AWD certification enables premium pricing through carbon footprint labelling and carbon credits.	4.43	0.679	Agree

Table 3. (Continued)

Items	$\bar{X}$	S.D.	Interpretation
9) Adapting farming methods to climate change promotes sustainable rice production.	4.50	0.682	Agree
10) AWD promotion contributes to global warming mitigation efforts.	4.70	0.651	Strongly agree
11) Interest in receiving additional AWD knowledge, guidance, and training.	4.37	0.718	Agree
12) Confidence and commitment to continue AWD practices in the future.	4.67	0.661	Strongly agree
13) Expectation that most farmers will adopt AWD methods.	4.27	0.640	Agree
14) Institutional promotion and support will facilitate AWD expansion.	4.50	0.682	Agree
15) AWD will become the predominant rice farming method in the future.	4.57	0.568	Strongly agree

Farmers' practices of AWD in rice cultivation

The AWD implementation levels among farmers across ten practices, with mean scores varied from 4.00 to 4.67 (SD: 0.498–1.093) (Table 4). Four practices attained the highest level of implementation: land preparation ($\bar{X}$=4.60, SD=0.498), PVC monitoring tube installation ($\bar{X}$=4.67, SD=0.547), controlled field drainage ($\bar{X}$=4.63, SD=0.615), and systematic growth observation ($\bar{X}$=4.53, SD=0.507). Whereas six practices achieved "High" levels, namely: water level maintenance ($\bar{X}$=4.33, SD=1.093), fertiliser timing ($\bar{X}$=4.00, SD=0.788), pest management ($\bar{X}$=4.10, SD=0.995), moisture monitoring ($\bar{X}$=4.40, SD=0.563), irrigation documentation ($\bar{X}$=4.50, SD=0.509) and seasonal adaptation ($\bar{X}$=4.23, SD=0.935).

Table 4. Level of farmers' AWD practices in rice cultivation

AWD practice	$\bar{X}$	S.D.	Implementation level
1) Land preparation through field levelling to ensure uniform surface topography for optimal water level management.	4.60	0.498	Highest
2) Installation of perforated PVC monitoring tubes, positioned 20 cm below ground level with a 5 cm surface protrusion for water level measurement.	4.67	0.547	Highest
3) Implementation of controlled field drainage, allowing water levels to recede 15 cm below the gauge reference point before field re-irrigation.	4.63	0.615	Highest
4) Maintenance of 5–10 cm water depth above the soil surface during the seedling establishment phase.	4.33	1.093	High

Table 4. (Continued)

AWD practice	$\bar{X}$	S.D.	Implementation level
5) Fertiliser application during field wet periods (1–2 days post-drainage) to optimise nutrient root penetration.	4.00	0.788	High
6) Pest management through the utilisation of alternating wet-dry cycles to suppress insect populations.	4.10	0.995	High
7) Regular monitoring of root-zone moisture content and soil surface temperature for pest prevention.	4.40	0.563	High
8) Systematic observation of rice growth parameters (tillering, plant height, leaf coloration) throughout wet-dry cycles.	4.53	0.507	Highest
9) Documentation of irrigation frequency, timing, and field drying duration for each cycle.	4.50	0.509	High
10) Adaptation of wet-dry intervals according to seasonal weather patterns and precipitation variability.	4.23	0.935	High

Relationship between farmers' characteristics and AWD practices

The chi-square analyses of the relationships between farmer characteristics and the levels of AWD practice is shown in Table 5. The findings indicated statistically significant relationships ($p < 0.05$) for gender ($\chi^2 = 9.075$, p=.003), age ($\chi^2 = 5.625$, p=.018), total farming area ($\chi^2 = 5.625$, p=.018), AWD farming area ($\chi^2 = 6.429$, p=.011), and farmers' attitudes ($\chi^2 = 4.593$, p=.032). Marginal significance was observed for farming experience ($\chi^2 = 2.857$, p=.091) and attendance in AWD training ($\chi^2 = 3.517$, p=.061), with $p < 0.1$. However, no significant associations were found between educational level, organizational membership, AWD income, carbon credit experience, and AWD knowledge with practice levels.

Table 5. Factors associated with AWD practices in Suphan Buri

Variables	Level of AWD practices		Total[1]	χ^2	df.	p
	Less than the highest level (less than 4.51)[1]	Highest level (4.51–5.00)[1]				
Gender						
Male	30.0	70.0	100.0	9.075	1	0.003**
Female	85.0	15.0	100.0			
Age						
Less than 50 years	50.0	50.0	100.0	5.625	1	0.018**
50 years and above	91.7	8.3	100.0			

Table 5. (Continued)

Variables	Level of AWD practices		Total[1]	χ^2	df	p
	Less than the highest level (less than 4.51)[1]	Highest level (4.51–5.00)[1]				
Highest educational level						
Lower than Bachelor's degree	68.0	32.0	100.0	0.120	1	0.729
Bachelor's degree and above	60.0	40.0	100.0			
Experience of rice farming						
Less than 50 years	76.2	23.8	100.0	2.857	1	0.091*
50 years and above	44.4	55.6	100.0			
Organisational membership						
No	50.0	50.0	100.0	0.268	1	0.605
Yes	67.9	32.1	100.0			
Total farming area (unit: rai)						
Less than 30 rai	83.3	16.7	100.0	5.625	1	0.018**
30 rai and above	41.7	58.3	100.0			
AWD farming areas (unit: rai)						
Less than 30 rai	81.0	19.0	100.0	6.429	1	0.011**
30 rai and above	33.3	66.7	100.0			
Attending AWD training						
Less than 100 times a year	45.5	54.5	100.0	3.517	1	0.061*
100 times a year and above	78.9	21.1	100.0			
Income from AWD						
Less than 10,000 Thai baht	72.2	27.8	100.0	0.625	1	0.429
10,000 Thai baht and above	58.3	41.7				
Carbon credit sales experience						
Yes, with a return or money	50.0	50.0	100.0	2.250	2	0.325
Yes, without return or money	66.7	33.3	100.0			
Hesitant about participating	100.0	-	100.0			
Farmers' knowledge						
Mean < 4.5	63.6	36.4	100.0	.072	1	.789
Mean ≥ 4.5	68.4	40.0	100.0			
Farmers' attitude						
Mean < 4.5	90.9	9.1	100.0	4.593	1	.032**
Mean ≥ 4.5	52.6	47.4	100.0			

*Note: significance levels **p < 0.05, *p < 0.1, [1/]* (Unit: Per cent)

Discussion

According to the study findings, gender was associated with the level of AWD practice in rice farming. Specifically, males were more likely to adopt AWD practices than females. This finding was consistent with previous research, such as the study by Nkwachukwu *et al.* (2022) and Tufa *et al.* (2022), who reported similar results. This may be attributed to the characteristics and personality traits of males, who are often more inclined to explore and experiment with new innovations in production. Males also tend to seek novelty and challenges in farm improvement, which may explain their higher tendency to adopt AWD practices in rice farming. Moreover, the results indicated a significant association between farmers' age and the adoption of AWD practices. Farmers aged 50 years and above adoption of AWD practices compared with those younger than 50 years. The findings of this study contradict those in the previous study of Suwanmaneepong *et al.* (2023), who found that older farmers tend to be less likely to adopt new innovations, being more accustomed to traditional farming methods and practices.

Regarding farming experiences, the results reveal a significant association with the level of AWD practices. This study was consistent with the Technology Acceptance Models II and III proposed by Venkatesh and Davis (2000) and Venkatesh and Bala (2008), respectively. Prior experience appears to influence the acceptance of new innovations since it plays a crucial role in shaping the perceived usefulness of an innovation, leading to the intention to apply it and ultimately facilitating its adoption in practice. In addition, the finding is also consistent with a previous study by Oladele *et al.* (2019), in that a farming experience reflects the accumulation of human capital in agricultural practices and farming expertise, enabling farmers to adapt and modify production methods to enhance efficiency. In addition, experienced farmers tend to anticipate increased farm capacity and productivity, frequently seeking new innovations to enhance their farm operations.

Farm size was also found to be significantly associated with AWD adoption. Farmers cultivating 30 rai of rice or above reported a higher proportion of AWD adoption compared to those cultivating less than 30 rai. This suggests that farmers with larger landholdings are more motivated to adopt agricultural innovations that enhance production efficiency, thereby increasing their likelihood of adopting new practices. This finding is consistent with the study by Oladele *et al.* (2019), who reveal farm size to be positively associated with the adoption of AWD since farmers with larger farm sizes generally have greater potential to explore new production innovations that enhance farm productivity. Consequently, they were also more likely to adopt new innovations or production approaches. In addition, farmers who had tested or experimented with AWD on their own plots and

observed favourable results were more likely to expand AWD adoption across a larger cultivation area.

Considering farmers' attitudes towards AWD practices, the results revealed a significant association with the level of AWD practices. This finding is consistent with the Technology Acceptance Model (TAM) proposed by Davis (1985), in that perceptions and attitudes towards technology or innovation influence acceptance and subsequent application. This reflects that farmers with positive perceptions of the benefits and utility of agricultural innovations are more inclined to adopt them. Such attitudes foster compliance with recommended agricultural practices, resulting in higher levels of AWD adoption in rice farming.

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Conflicts of interest

The authors declare no conflict of interest.

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