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Rice Farmers' Perception and Adaptation to Climate Change in Agricultural Zoning of Bangkok.

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It is acknowledged that climate change have crucial impacts on agricultural productions, while many farmers do not have a perception to climate change and how to response to the change. This study examined rice farmers' perception towards climate change, in agricultural zoning of eastern Bangkok, and investigated farmers' adaptation in climate change. A hundred rice farmers in Ladkabang area were interviewed during June to July 2016. Results revealed that about 88% of respondents perceived increase in temperature, whilst 76% of respondents perceived high variation in distribution and decrease an amount of rainfall. The major adaptation practices consisted of change in rice variety (77%), construction pond in rice field (55%) and attending agricultural production technique training (78%). Pearson's correlation revealed that age of farmer, farmer group membership, the numbers of family labour, extension of contacts, and perceived temperature demonstrated a significant correlation with the climate change adaptation measure. The finding provided information for the key stakeholders in climate change adaptation management area for farmers in agricultural zoning of Bangkok, Thailand.

Keywords: rice farming, farmer perception, farmer adaptation, climate change, climate change perception, peri-urban rice farming.

Introduction

Currently, climate change is causing the extreme. The global temperatures are rising and are likely to rise every year due to the climate variability in rainfall and distribution of rain, as well as variations in temperature and humidity. Agriculture is always vulnerable to unfavorable weather events and climate conditions (Basak, 2009). Accordingly, studies on climate impacts and adaptation strategies are increasingly becoming major areas of scientific concern, e.g. impacts on the production of crops such as

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maize, wheat and rice (Kang *et al.*, 2009). The changes in temperature and precipitation will result in changes in land and water regimes that will subsequently affect agricultural productivity (Kurukulasuriya and Mendelsohn, 2003). High temperatures would cause a marked decrease in world rice production and distribution of rice food in different parts of the world might be affected greatly by the global climate changes (Nguyen, 2005). IPCC (2007) stated that agricultural production is highly influenced by climatic conditions.

In Thailand, like the other developing countries, agriculture is potentially affected by climate change (Attavanich, 2013). The distribution of precipitation during the rainy season will directly impact on agricultural productivity (Chula Unisearch, 2010). Poapongsakorn *et al.,* (2014) indicated that climate change affected agricultural in term of floods, droughts, rising temperatures. The main effects of climate change on the agricultural sector of the country are a declining agricultural productivity (NSTDA, 2008). Numerous pieces of research indicated that change in temperature and rainfall cycle affected the decline in yield of Thai rice. (*e.g* Agarwal,2008; Kawasaki and Herath, 2011, Office of Environmental Policy and Planning, 2000). Nevertheless, some studied found that climate change is projected to increase rice yield (*e.g* Chinvanno *et al.,* 2006 and Khamwong and Praneetvatakul, 2011)**.**

Bangkok is one of the ten regions in Thailand with higher temperatures in every April of the year and faced increase in flooding. In Bangkok, the large parts of the land are an agricultural area. Rice is the majority agricultural crop. There is more than 121,568 rai of rice plantations with annual total productivity of 204,858.5 ton (Bankok Agricultural Extension Office, n.d.). As for the temperature and rainfall in Bangkok during the past 11 years (2001-2013), the statistic showed that the average temperature in Bangkok is likely to be higher, rising from approximately 37.4 ℃ in the year 2001 to 40.1 ℃ in the year 2013. This change may affect the growth and yield of rice. Since the International Union for Conservation of Nature (IUCN) indicated that temperatures above 35 ℃ induced sterility and reduced the number of grains. High temperatures in October will affect the ripening stage of crops when they have a lower temperature tolerance (IUCN, 2014)

As mentioned above, Ladkrabang district is designated as an appropriate area for rice production rice in Bangkok. It is the third largest rice cultivation area in Bangkok consisting of the total of 16,619 rai of rice farming land. The report by the Bankok Agricultural Extension Office points out that the situation in crop cultivation in Bangkok is likely to decline steadily include a decline in rice production. In 2001, an average rice yield of Bangkok is decreasing from 748 kilograms per rai to 679 kilograms per rai (OAE, 2014). In addition, the flood situation in Thailand in 2011, affected farmers about 1,284,106

households causing damage to agricultural land over 12.60 million rai. Rice production is mostly affected by the flood with 9.98 million rai (DDPM, n.d). Ladkrabang district is one of the areas that was damaged by the flood. The Geo-Informatics and Space Technology Development Agency (GISTDA) announced that Ladkrabang district is one of the areas affected by flood that require to be vigilant and alert to the public.

Many farmers do not have a perception of climate change, and how to response to the change. In order to understand farmers' perceived climate change and information on farmer adaptation measure, numerous studied were attempted to investigate farmers' perception and adaptation to climate change in the specific region. In Thailand, several studies investigated farmers' perception and adaptation to climate change such as Kerdsuk and Sukchan (2005) revealed farmers' perception of climate change in Thung Kula Rong Hai, Roi-et Province. Suta *et al.,* (2014) unvailed perception and adaptation of upland farmer's production system to climate variability, Chiang Mai. Additionally, Kittipongvises and Mino (2015) studied farmers' perception to climate change in the northeast of Thailand.

However, in order to develop a strategy for a farmer in agricultural zoning in Bangkok, the relevant organizations needs to understand farmers' perceive climate change and their adaptation practice to the change. From previous studied, it was found that there are still a lack of the research on farmers perceive climate change in agricultural zoning of Bangkok. Therefore, this study examined rice farmers' perception towards climate change, in agricultural zoning of eastern Bangkok, and investigated farmers' adaptation to climate change, together with examined the relationship between farmers' socio-economic characteristics perceived on climate change and the adaptation measures to climate change. The study aimed to contribute to share the understanding and knowledge farmers' perception toward climate change on rice farms. This results will help relevants organizations aiming at generating adaptive strategies on climatic changes specifically on farmer perception.

Material and Method

Study area and sample size

This study was conducted in the Ladkrabang district, one of agricultural zoning of Bangkok with the third highest concentration of rice production in Bangkok, accounting for 16,619 rai or 13.67% of total rice cultivated area in Bangkok.

The sample was randomly selected from rice farmers during June and July 2016. A structured questionnaire was used to interview rice farmers. A

total of 100 rice farmers were invited to take part in the study with represents 20% of total rice farmers who were listed in farmer registration database with Ladkrabang Agricultural in year 2016.

Data Analysis

Data were analyzed using SPSS programs. Descriptive analyses were applied to determine respondents' profile, perception about changes in temperature and rainfall, together with the data on farmers' adaptation according to the changes of temperature and rainfall in their rice farming. The explanatory climate parameters including rainfall and temperature were considered (Chung *et al.*, 2015).

The bivariate correlation procedure computed Pearson's correlation coefficient that measures the associations between two variables (Atreya *et al.*, 2012). In this study, bivariate correlation was employed to measure the relationship of climate change adaptation practice with farmer characteristics, and perceived climate change.

Result and Discussion

Socio-economics characteristics of rice farming in the study area

As showed in Table 1, the sampled farmers represent medium-sized rice farming with average 4.69 hectares (ha) of farm size indicating medium-sized rice farming (Kaenmanee *et al.*, 1982). More than half the respondents (77%) were male, and have average ages during 54.51 years. The education level of respondents was primary school education at an average 6.69 year in schooling. About 76 percent of them were married, and only 10 farmers had a position in the leadership in farmer group. Ninety-two percent is belonging to farmers' groups, particularly, the member of Bank for Agriculture and Agricultural Cooperatives (BAAC) which provided loans service directly to individual farmers. As far as experience in rice farming is concerned, results showed that respondents had an average 31.75 years of rice farming experience. Concerning the land ownership, results revealed that only 17% of rice farmers had their own land, whistle 95% of the respondents were rented land to grow rice. It was noticed that rice farmers in *peri*-urban area had contacts with extension at 5.08 times per year.

Table 1 Socio-economics characteristics of rice farming in the study area

Characteristics	Mean	SD
Male headed (% of household)	77	
Age of farmer (year)	54.51	12.659
Year in schooling (year)	6.69	1.852
Marriaged status (% of household)	76	
Leadership in farmer groups (number)	10	
Farmer group membership (% of household)	92	
Household size (members)	2.09	.452
The number of family labour (number)	1.09	.288
Year in farming experience (year)	31.75	18.014
Farm size (hectares)	4.69	.486
Land ownership (% of household)	17	
Rented land (% of household)	95	
Extension contacts (times per year)	5.08	4.155

Source: Computed by the authors from survey data

Farmers' perception of changes in temperature in the study area

The result of farmers' perception of the change in temperature in the study area is presented in Figure 1. It is showed that the majority of the respondents (88%) perceived changes in temperature over the past 10 years. They have mentioned about an increase in temperature, while only eight percent of respondents indicated about a decrease in temperature. Very few farmers pointed out that no changes in temperature (1%) and don't know about the changes in temperature (3%). The result consistency with many previous studied, such as, Fosu-Mensah *et al.*, (2012), Tambo and Abdoulays (2013) and Shukla *et al.*, (2016) showed the majority of the households have perceived climate change, mainly in the form of increasing temperature.

To verify farmers' perceived regarding long-term change in temperatures, the historical annual average temperature (℃) in Bangkok, Thailand from 1997 to 2015. It is confirmed that temperatures have slightly increased particularly from 2008 to 2012 (Fig.2)

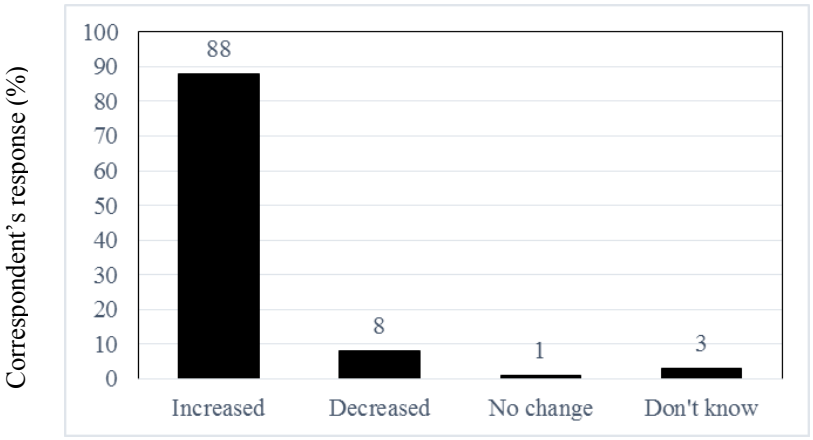

Fig. 1 Farmers' perception of changes in temperature (%) in the Ladkrabang district.
Source: Computed by the authors from survey data

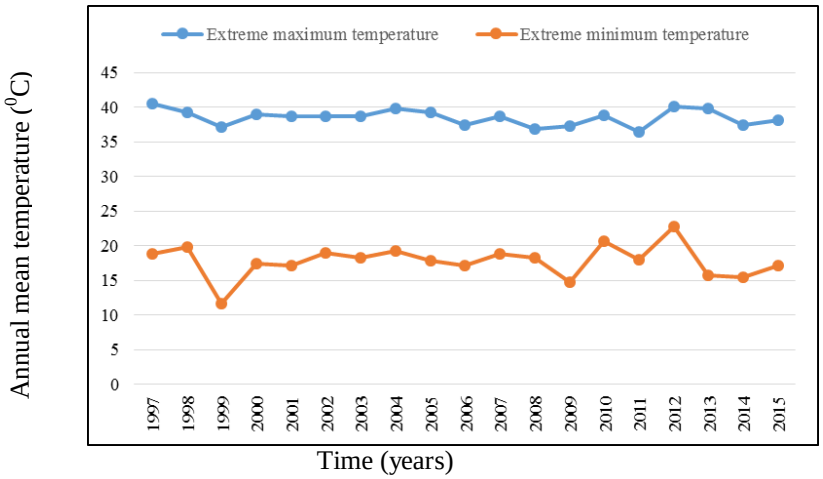

Fig.2 Annual mean temperature (℃) in Bangkok, Thailand
Source: National Statistical Office (2015)

Farmers' perception of changes in rainfall in the study area

The results of interview about farmers' perception regarding the changes in rainfall in Figure 3 shows that farmers agreed to changes in rainfall pattern in Ladkrabang district, Bangkok. Approximate 76% of respondents noticed a decrease in rainfall, and 17% of respondents indicated a change in timing of the rain. Only one percent of respondents notified that it is not changed in rainfall, and two percent of respondents reported that they don't know the change in rainfall in the past few years. Thes results indicated that rice farmers in the

study area perceived a reduction in rainfall over the past ten years which are in the line with the research result conducterd by Roco *et al.,* (2015).

The results from the questionnaires on the changes in rainfall in Ladkabang, Bangkok were consistency with the cliamate statistics from National Statistical Office (2015) reporting that (Fig.4), there is a fluctuation of rainfall amounts during 1977 to 2015. The statistic has found increasing tendency during 2004 to 2009 (1,100.1 mm-2,014.2 mm), and after that decreasing tendency from 2014.2 mm. in 2009 to 1,221.4 mm. in 2015. This implied that farmers in the study area have awareness of the change in rainfall.

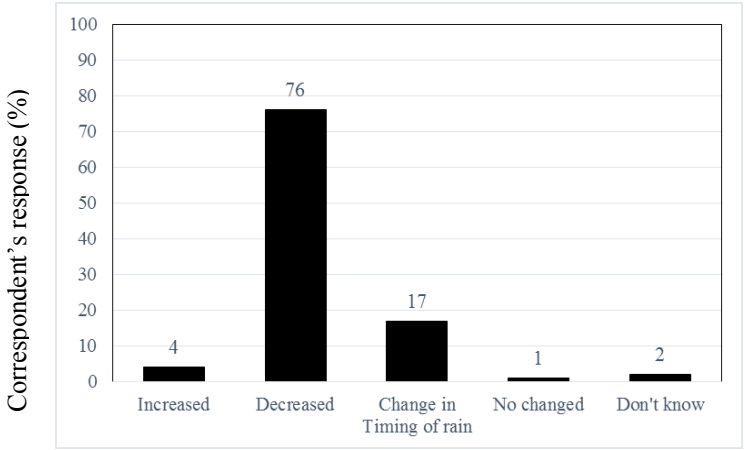

Fig. 3 Farmers' perception of changes in rainfall (%) in the Ladkrabang district.
Source: Computed by the authors from survey data

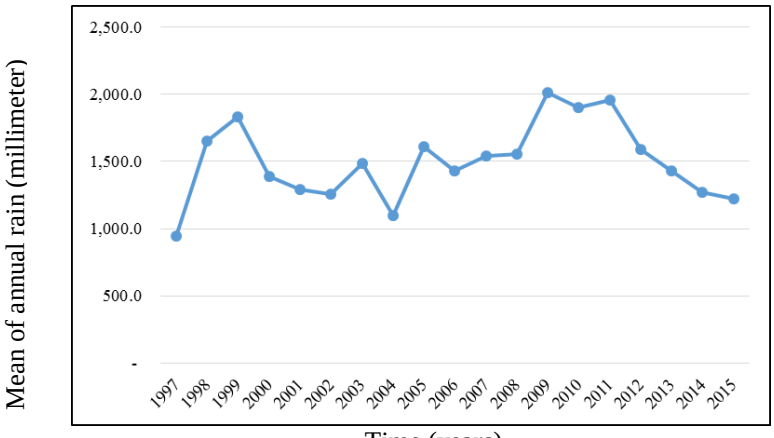

Fig.4 Annual mean rainfall (millimeter) in Bangkok, Thailand
Source: National Statistical Office (2015).

Perceived impacts of climate change on rice farming

Figure 5 shows that themajority of the respondents (84%) perceived that the climate change impacted on rice yield, 30% perceived that climate change impacted in changing rice variety. While 18% of the respondents perceived that there was the impact of climate change in the increased the cost of hired labor, 15% perceived the climate change impacted in increase in the amount of fertilizer used in rice farming. A few respondents (about 10%) perceived that climate change impacted the cost of an agricultural machine. These findings implied that farmers in the study area have awareness of the impact caused by the climate in rice farming.

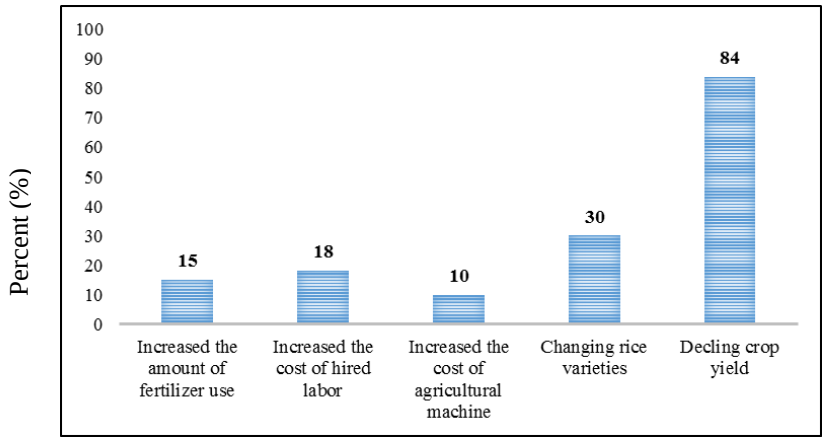

Fig.5 Perceived impacts of climate change on rice farming
Remark: The respondents can choose more than one choice
Source: Computed by the authors from survey data

Farmers' adaptation to climate change

Farmers who responsed that they have awareness of climate change were the asked to indicate their adaptation in their rice farming in response to change in temperature and rainfall.

Table 2 presents adaptation measures to change in temperature and rainfall. The adaptation measures attending agricultural production technique were identified as the majority adaptation measure (78%), since attending in training from relevantorganizations can help farmers to improve their new knowledge and adjust their rice farming under the current situation, particularly, rice farming techniques in response to climate change. About 77% of the respondents informed that they made an adaptation by changing rice variety because farmer attempted to find out appropriate rice varieties which were

suitable for their rice faming climate condition. Such as, RD6 grows very well during the rainy season, hence, start planting RD6 during June and July would yield high advantage (Kawasaki and Herath, 2011).

About 55% of the farmers constructed a pond in a rice field since most of the respondent farms were not located near water sources. In order to avoid suffering from water shortage and storage rainwater, the farmers constructed a pond, they also gained benefit from fish farming. Pond construction was one option for adaptation for sustainable management of water (FAO, 2014). And 34% of the respondents shifted the dates of growing rice, in order to avoid high temperature. This finding was consistent with the studies of Fosu-Mensah et.al (2012) and Tambo and Abdoulaye (2013) indicated that farmers shifted the dates of planting their crops in order to adaptation to the change.

Some of farmers adapted to climate change by applied soil conservation technique and increased an amount of fertilizer and pesticide use. It was noticed that about 9% farmers reduced their farm size in response to the change in climate.

Table 2 Farmers' adaptation measure to climate change

Adaptation measures	Frequency	Percent
M1: Change in growing date	34	34.0
M2: Increasing an amount of fertilizer and pesticide use	13	13.0
M3: Soil conservation technique	25	25.0
M4: Change in rice variety	77	77.0
M5: Reduce farm size	9	9.0
M6: Construct pond in rice filed	55	55.0
M7: Attending agricultural production technique training	78	78.0
M8: Find off-farm jobs	48	48.0

Source: Computed by the authors from survey data
Remark: The respondent can choose more than one choice

The correlations between socio-economic, perceived climate change and adaptation measures

The result in Table 3 revealed that age of farmer, farmer group membership, the numbers of family labour, extension contacts and perceived temperature had a significant correlation with the climate change adaptation measure.

Age of farmer correlated at 5% levels with soil conservation technique adaptation measure (M3). Old farmers were more likely to adapt to climate change by applying soil conservation technique to improve soil and cover water

for rice field. Soil conservation practices have proven effective in soil erosion reduction and maintaining soil productivity (Garbrecht *et al.*, 2015).

For farmer group membership, the result revealed correlated at 5% with an increase of the amount of fertilizer and pesticide used (M3). This may imply that farmer group may provide agricultural inputs (fertilizer, pesticide, and seed) for a member, hence, a farmer who belongs to the group were more likely to increase an amount of fertilizer and pesticide used in their rice farming. Similarly, the result found that the number of family member labors correlated at 1% with increasing of the amount of fertilizer and pesticide used (M3). It can indicate that rice farmers who have a large number of family labour were more likely to increase an amount of fertilizer and pesticide used in their field in response to the change of climate. As far as farmers' perceived on climate change, the result found that perceived temperature correlated at 1% with increasing of the amount of fertilizer and pesticide used (M2). This indicates that farmers who awared of the change in temperature were more likely to increase an amount of fertilizer and pesticide used in their rice farming. Changes in climate may also cause larger (or smaller) losses of nitrogen. This may also lead to changes in the demand for fertiliser (Olesen and Bindi, 2002).

Moreover, it was found that rented land was correlated at 1% with find off-farm jobs (M8). It indicates that farmer who rented land for rice farming may need more income to cover their expenditure, as such, to adapt to climate change, farmers who rented land for cultivation were more likely to find off-farm jobs. Interestingly, the result found that extension contacts correlated at 5% with a change in growing date (M1), and find off-farm jobs (M8). It may be implied that extension staff provided information about the cultivation dates to farmers which awared them aboutthe climate change and can avoid by a change in growing date for a farmer and may recommend farmer to find out an off-farm job during that off-season cropping. Accordingly, farmers who were contacted by extension staff were more likely to change in growing date and find off-farm jobs. This result was in the line with the study of Tambo and Abdoulaye (2013) stated that farmers were increasing their involvement in off-farm activities due to the risk of climate change.

Table 3 Pearson's correlation between socio-economic factors and climate change adaptation measure

Factors	M1	M2	M3	M4	M5	M7	M8
Gender	.559	.994	.498	.129	.111	.869	.973
Age of farmer	.765	.477	*.030**	.289	.196	.875	.550
Year in schooling	.951	.629	.162	.381	.547	.391	.981

Table 3 (cont.)

Factors	M1	M2	M3	M4	M5	M7	M8
Marriaged status	.582	.608	.808	.697	.094	.330	.968
Leadership in farmer groups	.468	.457	.470	.334	.662	1.000	.880
Farmer group membership	.903	*.035**	.683	.497	.328	.316	.792
Household size	.663	.587	.055	.627	.884	.191	.588
The numbers of family labour	.156	*.003***	.842	.087	.819	.972	.395
Year in farming experience	.875	.387	.640	.053	.399	.993	.436
Land size	.843	.216	.724	.950	.200	.666	.686
Land ownership	.121	.343	.879	.231	.626	.475	.149
Rented land	.503	.637	.432	.214	.383	.494	*.001***
Extension contacts	*.022**	.520	.439	.329	.188	.171	*.049**
Perceived rainfall	.682	.234	.244	.685	.423	.946	.081
Perceived temperature	.609	*.005***	.388	.884	.454	.248	.636

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Conclusion

The rice farmer in Ladkabang district, one of agricultural zonings of eastern Bangkok, was selected and interviewed for this studty. Most of the responsdent farmers represented medium-sized rice farming with average 4.69 hectares. About 95% of the respondents rented land to grow rice. On average, the responsdent farners had 31.75 years of rice farming experience.

An investigation of farmers' perceived climate change found that 88% of respondents perceived increase in temperature, whilst 76% of respondents perceived high variation in distribution and decrease an amount of rainfall. The major adaptation practices consisted of change in rice variety (77%), construction pond in the rice field (55%), attending agricultural production technique training (78%), and changing the dates of growing rice (34%).

The result from Pearson's correlation, found that farmers were likely to adapt measurement to coping with climate change in their rice farming as follows:

1. Old farmers were more likely to apply soil conversation technique.

2. Farmers who belong to farmer group were more likely to increase an amount of fertilizer and pesticide used in their rice farming

3. Farmers who have a large number of family labours were more likely to increase an amount of fertilizer and pesticide used in rice farming.

4. Farmers who rented land for cultivation were more likely to find off-farm jobs.

5. Farmers who were contacted by extension staff were more likely to change in growing date and find off-farm jobs.

6. Farmers who have awareness of the change in temperature were more likely to increase an amount of fertilizer and pesticide used in their rice farming.

Based on the findings, thes study results provides information for the key stakeholders in the area of climate change adaptation management for farmers in agricultural zoning of the peri-urban area. Diverse conditions need to be understood, with particular attention given to different various characteristics such as age of farmer, farmer group membership, the numbers of family labour, extension contacts, and perceived temperature.

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