



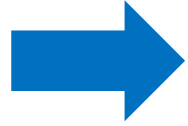
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Impacts of climate variations on litchi yield in China

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1. Introduction



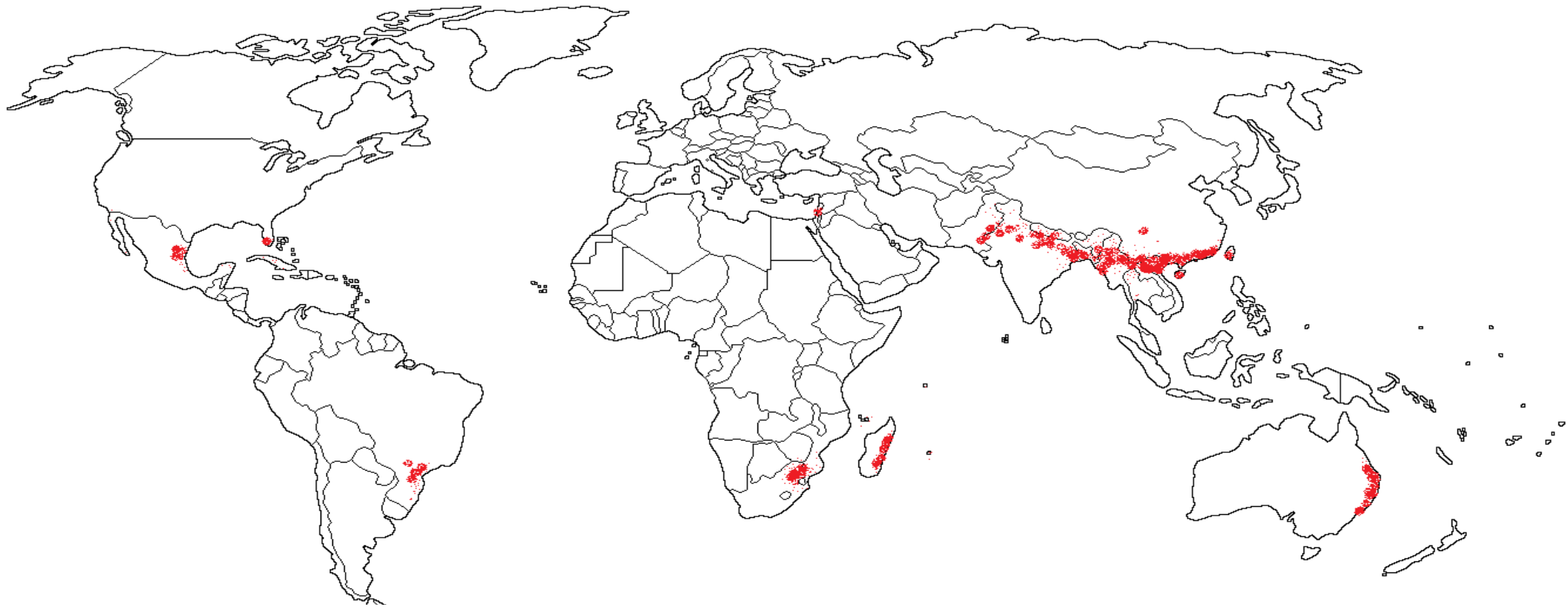
Background

Litchi is known as “the queen of fruits” due to its unique shape, beautiful color and mouth-watering taste. Nevertheless, lots of people are not enough lucky to taste it because of many reasons. Less and unstable yield is one of the main reasons.





1. Introduction



A rough map of global litchi distribution



1. Introduction



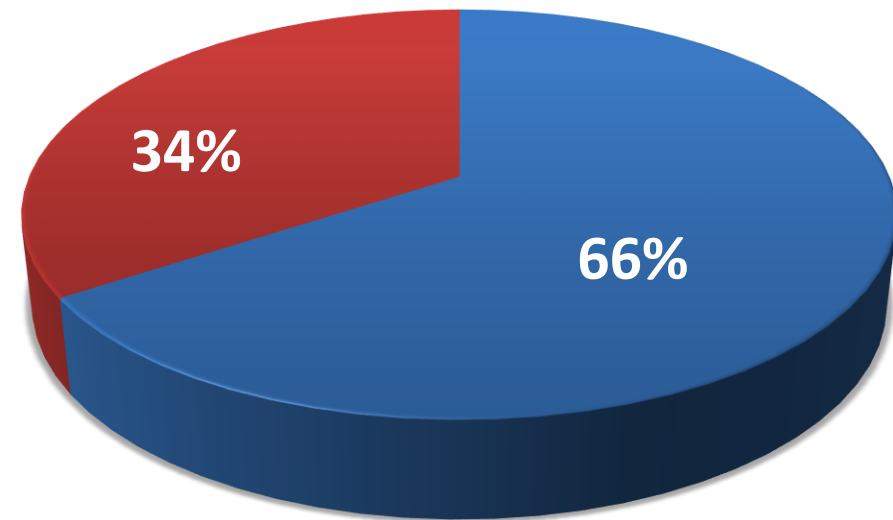
- China

approximately 2300 000 t = 66%

- Vietnam, India, Thailand, Bangladesh, Nepal, Spain, Israel, US and Mexico, Australia, Madagascar, South Africa, Brazil, Mauritius, Reunion, etc

approximately 1200 000 t = 34 %

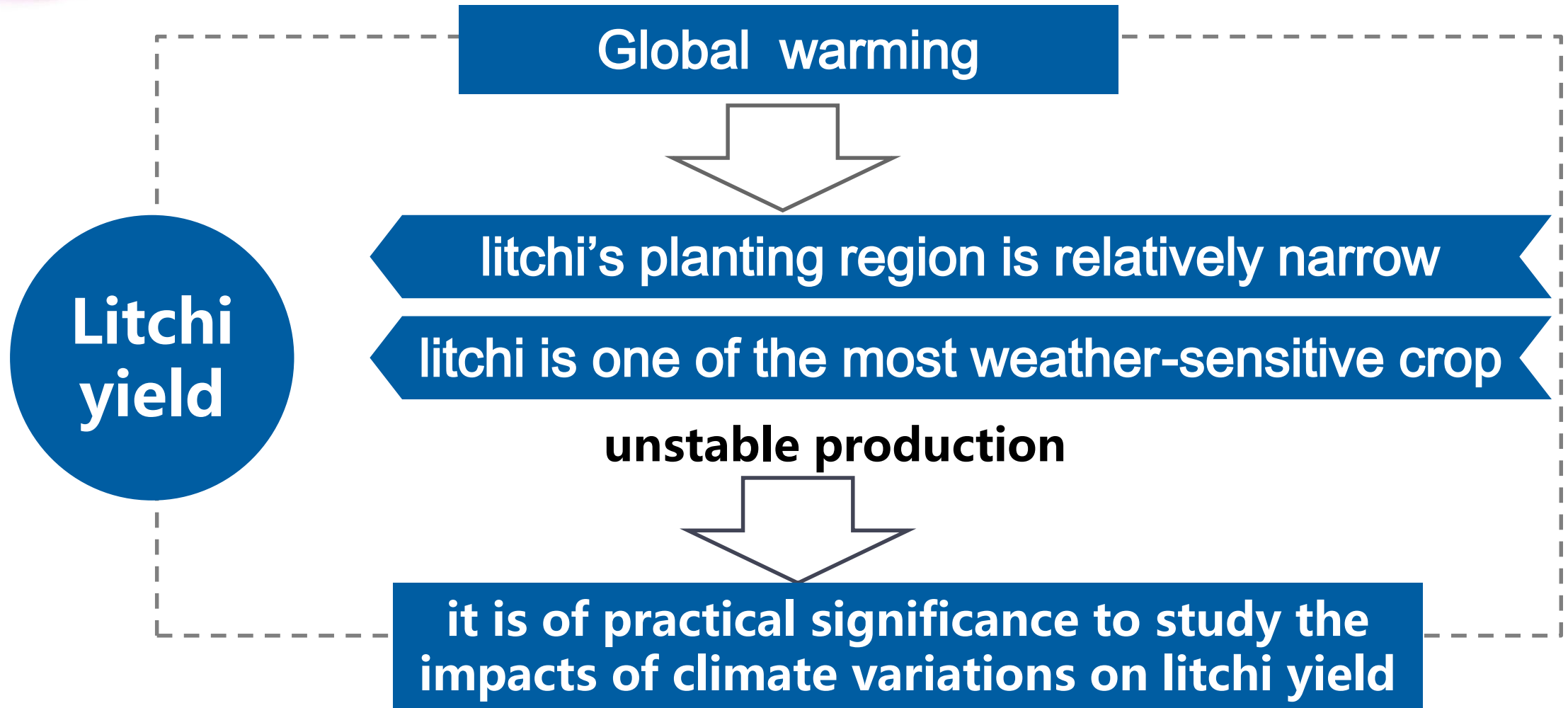
Global litchi production



■ China ■ Other countries

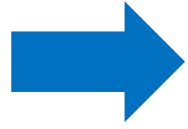


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2. Data

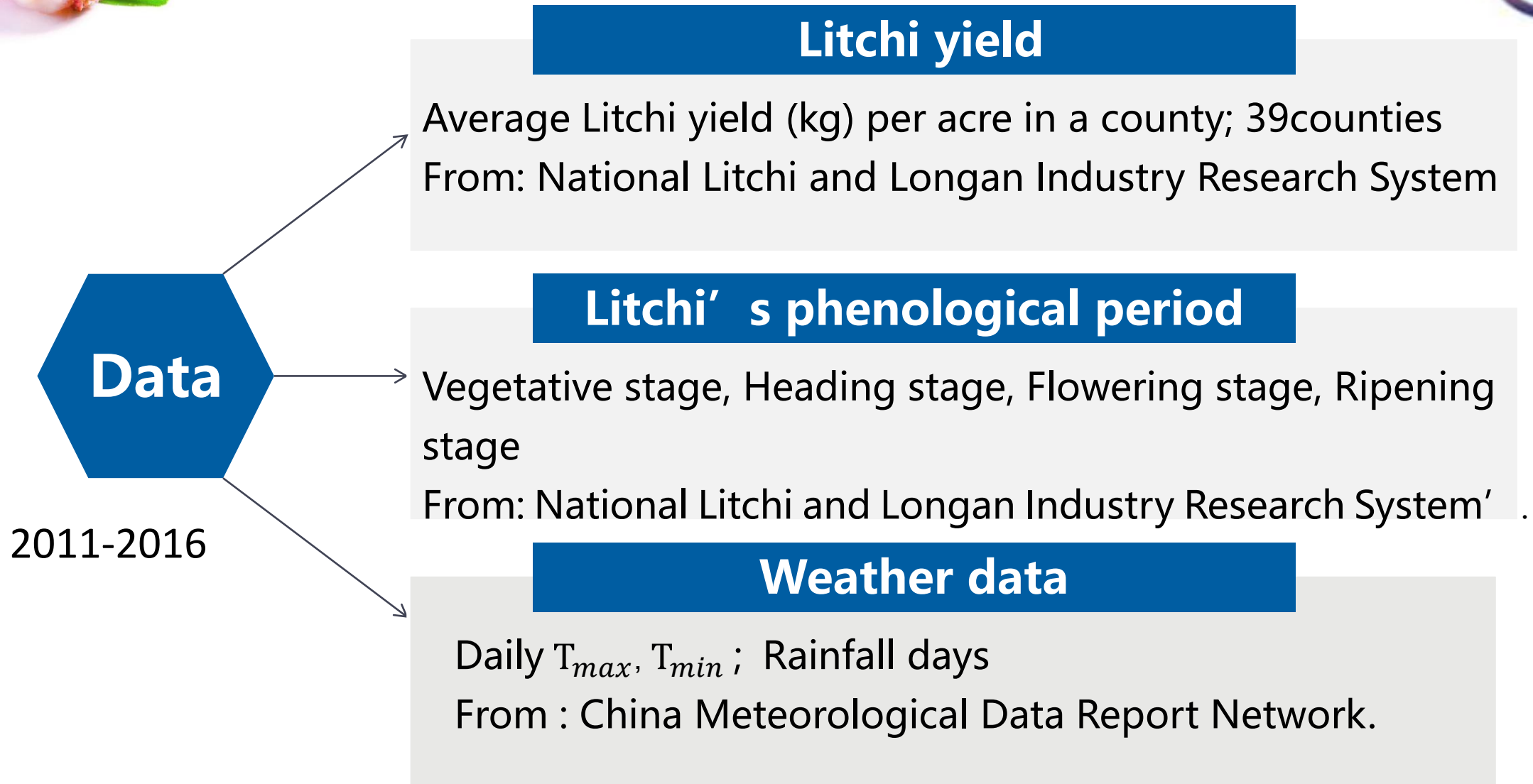


Litchi's main producing area

Hainan	Haikou
	Danzhou
Guangdong	Maoming
	Zhanjiang
	Shenzhen
Guangxi	Qinzhou
	Beihai
	Yulin
Fujian	Zhangzhou
	Ningde



2. Data





2. Data



Model construction

The two-way fixed effect model is constructed as follows:

$$y_{it} = x_{it}\beta + \alpha_i + \lambda_t + \varepsilon_{it}$$

Where y_{it} denotes county-average litchi yield in county i and year t . x_{it} represents weather variables, including the means of daily T_{max} , T_{min} , and the rainy days during each litchi's growth stage. We also controlled for county-level fixed effects (represented by α_i) and year fixed effects (denoted by λ_t) to remove the effects of unobserved factors that are unique to each county and the effects that are common to all counties in a given year on yield. ε_{it} is the error term. β is the parameter vector that gives the responses of rice yield to weather variations.



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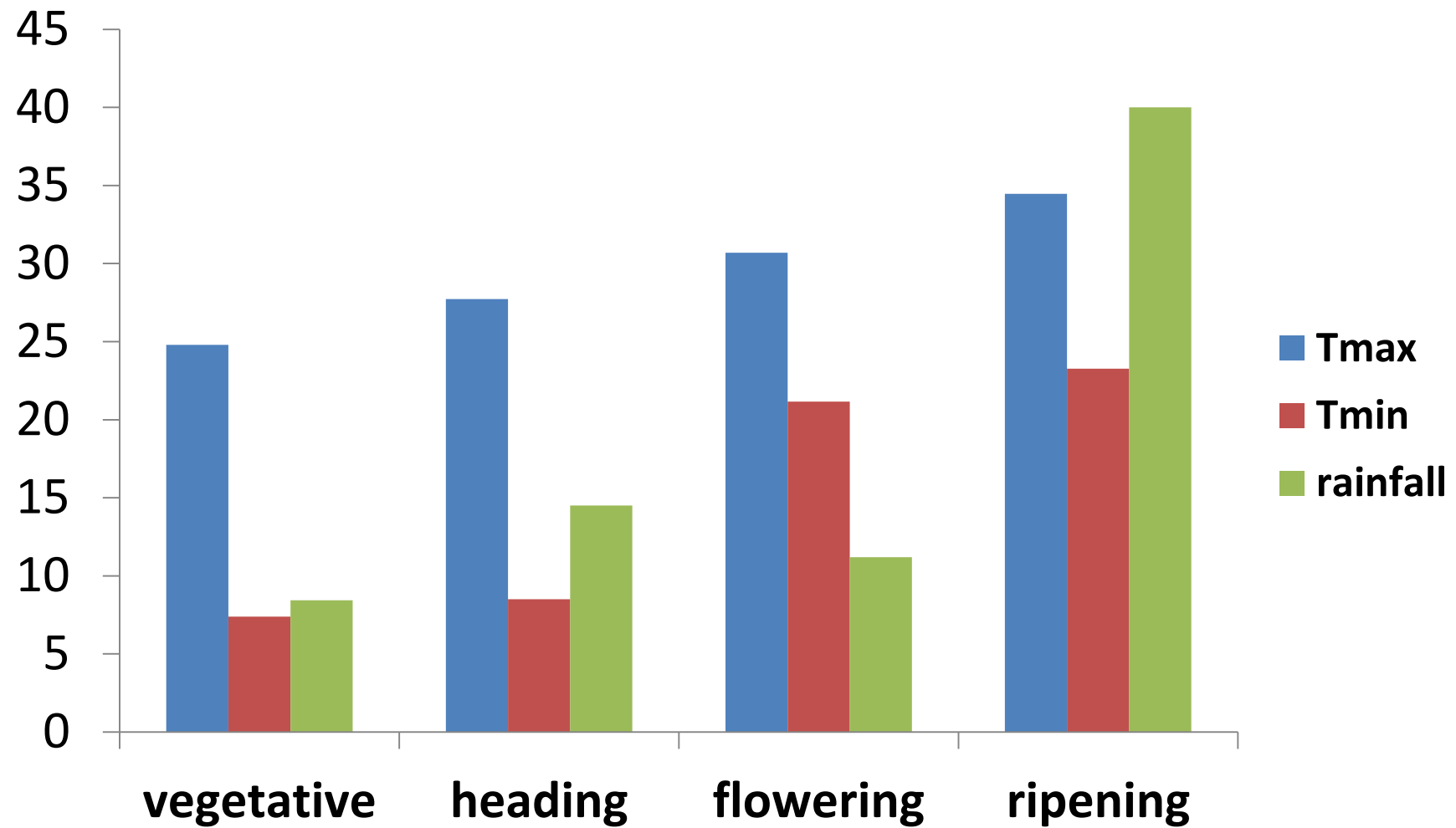


3. Descriptive statistics

Variables	Obs	mean	sd	min	max
yield	234	1522.43	1180.06	48.56	6452.71
vegetative:T _{max}	234	24.8	3.42	13	37
vegetative:T _{min}	234	7.38	3.65	0	21
vegetative:rainfall	234	8.44	8.02	0	64
heading:T _{max}	234	27.72	3.11	12	37
heading:T _{min}	234	8.51	3.79	-1	21
heading:rainfall	234	14.5	9.6	0	48
flowering:T _{max}	234	30.7	2.51	23	40
flowering:T _{min}	234	21.16	11.7	2	21
flowering:rainfall	234	11.19	6.33	0	30
ripening:T _{max}	234	34.47	2.15	26	41
ripening:T _{min}	234	23.26	2.66	12	27
ripening:rainfall	234	40	5.76	0	88

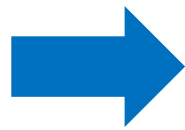


3. Descriptive statistics





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The effects of climate variations on litchi yield



Coefficient estimates of weather variables show that rainfall had negative impacts on litchi yield during both the vegetative stage and the flowering stage, while higher T_{min} during the heading stage and T_{max} during the flowering stage has positive impacts on litchi yield.

vegetative: T_{max}	vegetative: T_{min}	vegetative: rainfall	heading: T_{max}	heading: T_{min}	heading: rainfall
5.61	6.14	-18.67**	-17.88	43.17**	-4.87
flowering: T_{max}	flowering: T_{min}	flowering: rainfall	ripening: T_{max}	ripening: T_{min}	ripening: rainfall
60.28*	0.01	-35.60***	26.44	21.72	-15.76



Different litchi varieties



‘Feizixiao’, ‘Guiwei’ and ‘Heiye’ are the three main litchi varieties whose production account for approximately 65% of national total litchi production . As these litchi varieties exist differences in their physicochemical properties and genetic traits, it is necessary to examine whether the weather effects on yield estimated above differed by litchi variety.



Feizixiao



Guiwei



Heiye



'Feizixiao' vs. 'Guiwei' vs. 'Heiye'



Litchi varieties	vegetative: Tmax	Vegetative: Tmin	vegetative: rainfall	heading: Tmax	heading: Tmin	heading: rainfall
Feizixiao	35.83	-1.07	-24.40**	-30.51	85.04**	-0.69
Guiwei	-139.50***	37.56	-3.05	-48.17	2.94	6.66
Heiye	-65.92*	34.36	-40.76**	20.82	-2.26	-9.11
Litchi varieties	flowering: Tmax	flowering: Tmin	flowering: rainfall	ripening: Tmax	ripening: Tmin	ripening: rainfall
Feizixiao	126.44***	-0.23	-23.37	30.34	-19.04	-21.46
Guiwei	-47.74	-2.48	-15.90	239.41***	22.72	-28.48*
Heiye	-22.70	-0.19	-45.46***	327.67***	78.55	-25.76**



'Feizixiao' vs.' Guiwei' vs. 'Heiye'



Weather effects on litchi yield differed substantially by litchi varieties during different phenological period.

- For 'Feizixiao', its yield is associated with the vegetative stage, heading stage and flowering stage.
- The yield of 'Guiwei' is related to vegetative stage and ripening stage but not the heading stage and flowering stage.
- As for 'Heiye', the vegetative stage, flowering stage and ripening stage have significant influence on its yield, while the effect of heading stage on its yield is not significant.



'Feizixiao' vs.' Guiwei' vs. 'Heiye'



The effects of rainfall on the yield of different varieties of litchi

Specifically, rainfall has a negative but not the same effect on the yield of different litchi varieties during different phonological period.

During the vegetative stage, one rainfall day increase will reduce the yield of 'Feizixiao' 24.40 kg/acre and 'Heiye' 40.73 kg/ acre. During the flowering stage, the yield of 'Heiye' will reduce 45.47 kg/ acre with the rainfall days increasing one day. During the ripening stage, the yield of 'Guiwei' will reduce 28.50 kg/ acre and 'Heiye' 25.74 kg/ acre if the rainfall days increase one day.



'Feizixiao' vs.' Guiwei' vs. 'Heiye'



The effects of T_{max} and T_{min} on the yield of different varieties of litchi

Temperature impacts on yield also differed considerably by litchi variety. For 'Feizixiao', its yield is significantly related to T_{min} during the heading stage and T_{max} during the flowering stage. The yield of 'Feizixiao' will increase 85.04 kg/acre with 1°C increase in T_{min} during the heading stage and 126.44 kg/ acre if T_{max} increase 1°C during the flowering stage. For 'Guiwei', higher T_{max} during different phenological periods has different impact on its yield. The effect of higher T_{max} on the yield of 'Guiwei' was negative during the vegetative stage when the yield of 'Guiwei' will decrease 139.50 kg/ acre with T_{max} 1°C higher, which is opposite to the ripening stage when the yield of 'Guiwei' will increase 239.41 kg/ acre with T_{max} 1°C higher. As for 'Heiye', its yield is mainly affected by T_{max} during the ripening stage when the yield of 'Heiye' will decrease 327.67 kg/acre with T_{max} 1°C higher. Besides, a 1°C increase in T_{max} during the vegetative stage will also decrease the yield of 'Heiye' by 65.92 kg/ acre.



5. Conclusions



- Meteorological factors affecting litchi yield are not the same during different growth periods.
- Litchi yield is negatively related to rainfall during the vegetative and flowering stages.
- Litchi yield is positively related to daily minimum temperature during the heading stage and maximum temperature during litchi' s flowering stage.
- The effects of climate variations on different varieties of litchi are not the same.



**Thank you
for your attention!**

**Reporter: Wen'e Qi
Date: 23 October 2017**