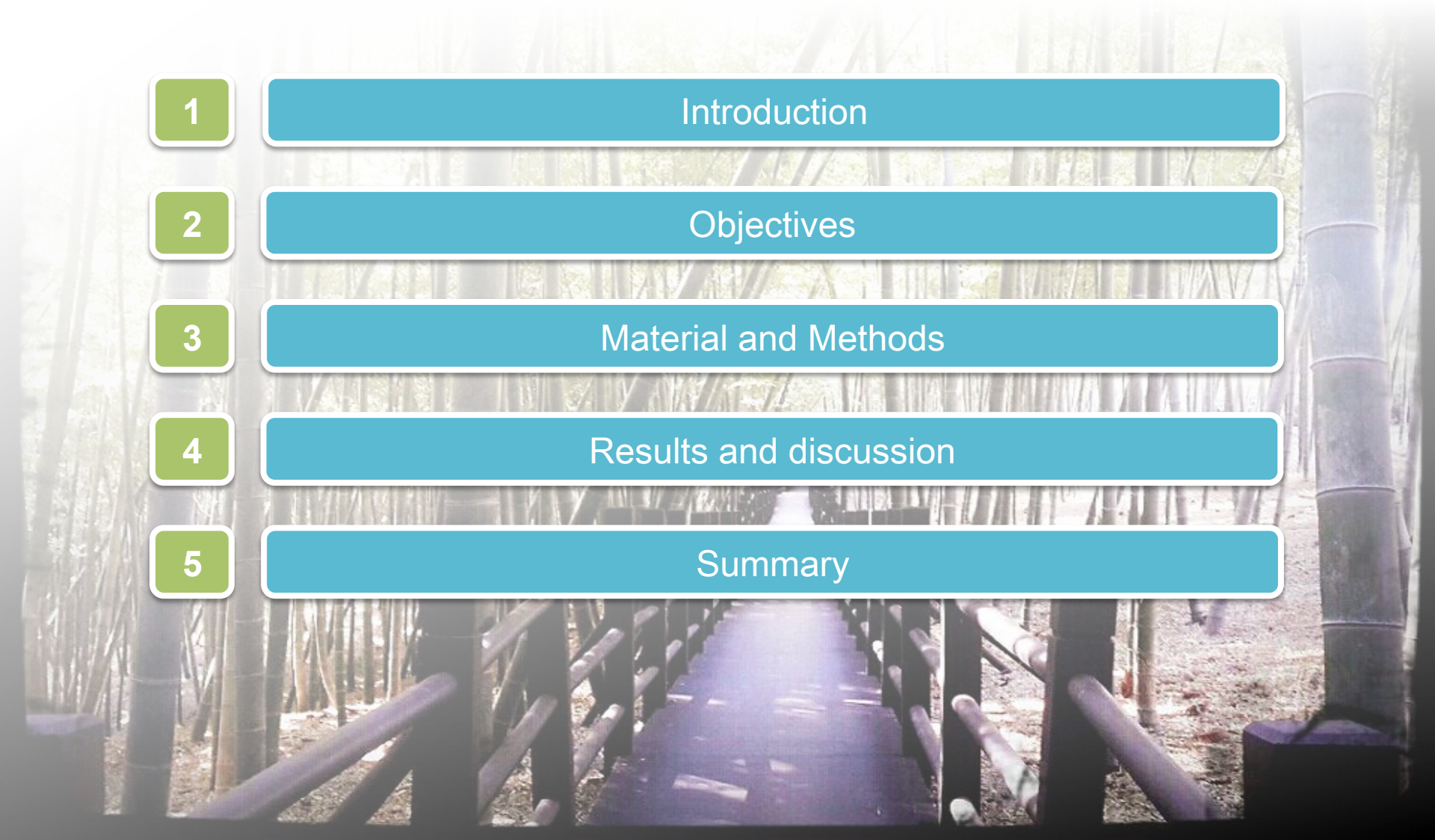
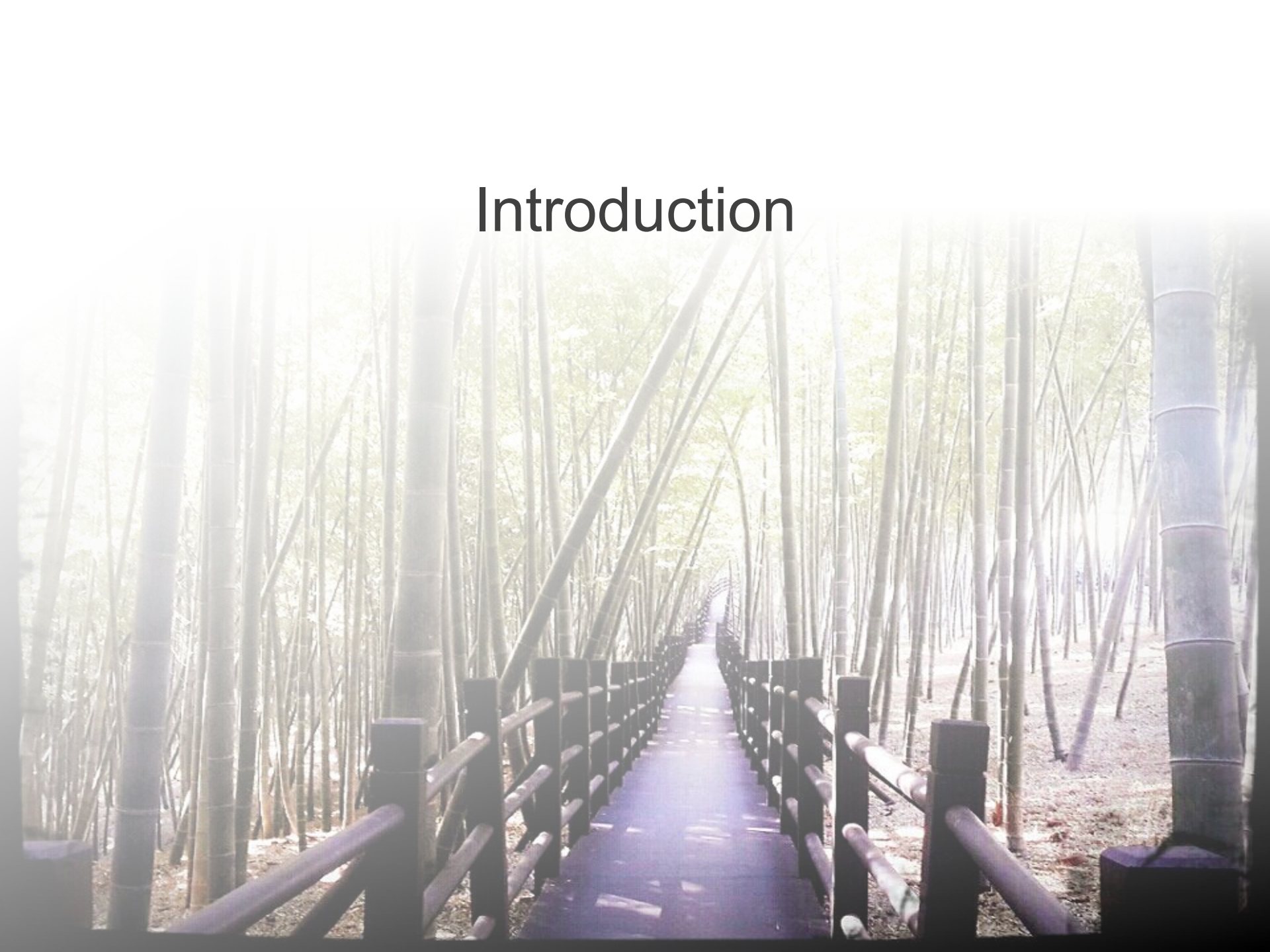
Biomass and belowground soil carbon and nitrogen stocks in three bamboo plantations in Korea

Contents



Introduction



Introduction

- Bamboo species have been an important material for paper or building and for soil conservation to help slope stability, reducing run-off and soil erosion.

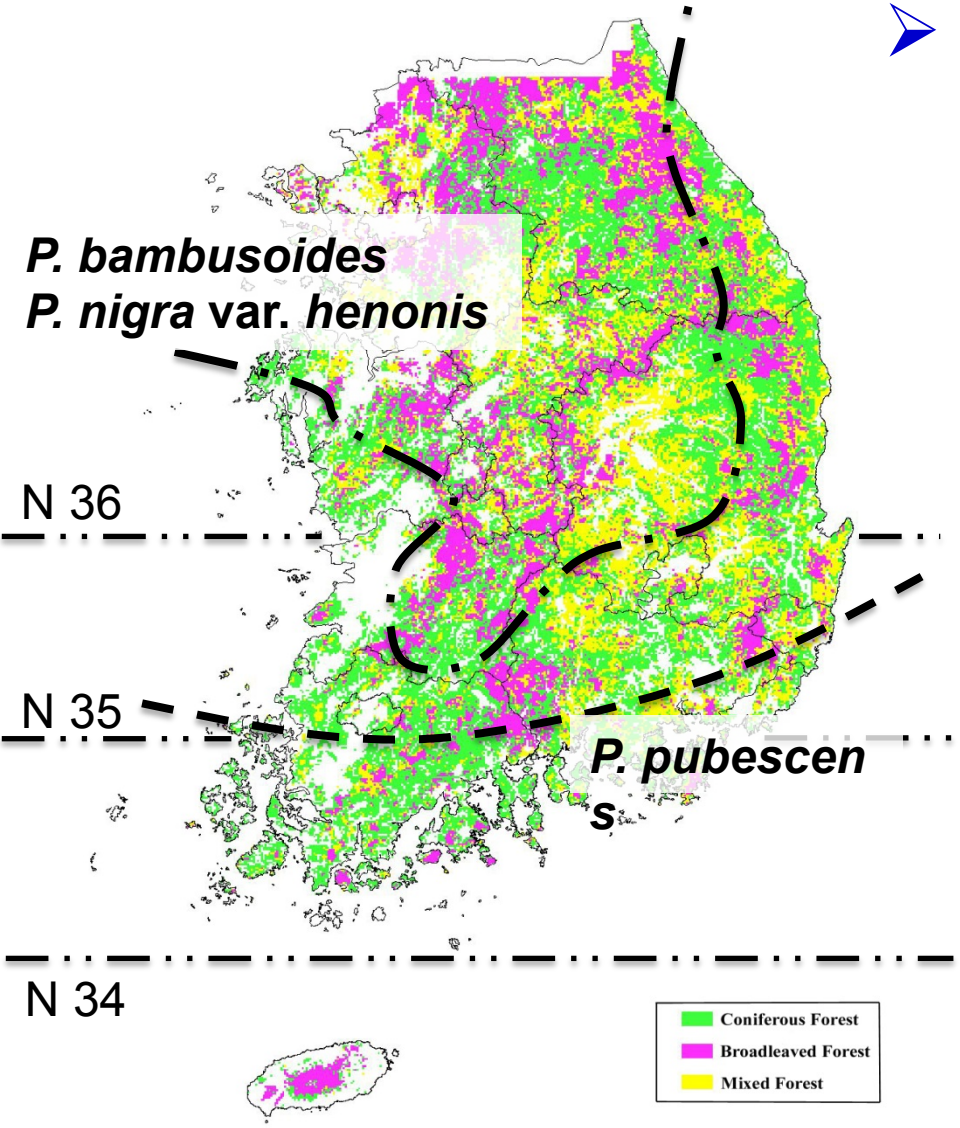
- Bamboo has turned recently into a globally important biomass resources besides being a traditional source of energy and other multiple uses.

Introduction

- Korea accounts for about 70 species of bamboo and 11 species (*Phyllostachys bambusoides* Sieb. et Zucc, *P. nigra* var. *henonis* Stapf ex. Rendle, *P. pubescens* (Mazel) Ohwi, *Sasa gracilis* (Nakai) T. Lee, *Arundinaria simonii* A et C Riviere, *Sasa borealis* (Hack.) Makino, *Pseudosasa japonica* (Sieb. et Zucc.) Makino) occur dominantly in warm temperate forest zones of the country.

- Three bamboo species among them are intensively planted for edible shoot (*P. pubescens*) and for multipurpose use (*P. nigra* var. *henonis*, *P. bambusoides*) in Korea.

Distribution of bamboo species



➢ **Forest land : 6.4 million ha**

Unit : million ha

- Conifer = 2.707 (42%)
- Hardwood = 1.666 (26%)
- Mixed = 1.873 (29%)
- Bamboo = 0.007 (0.9%)
- Others = 0.148 (2.1%)

Bamboos are generally distributed in the southern part along the seashore in the eastern and western area.

Bamboo uses

Bamboo sap

Bamboo oil

Bamboo sprout

Rice in bamboo

Bamboo uses

Bamboo charcoal

Bamboo pellet

Household items

Objectives

Objectives

Although there have been many studies to evaluate the effect of bamboo species on biomass production and its partitioning in different plant parts in bamboo plantations in Korea, major uncertainties remain in relation to the importance and behavior of biomass production and belowground C and N stocks by different bamboo plantations in local level.

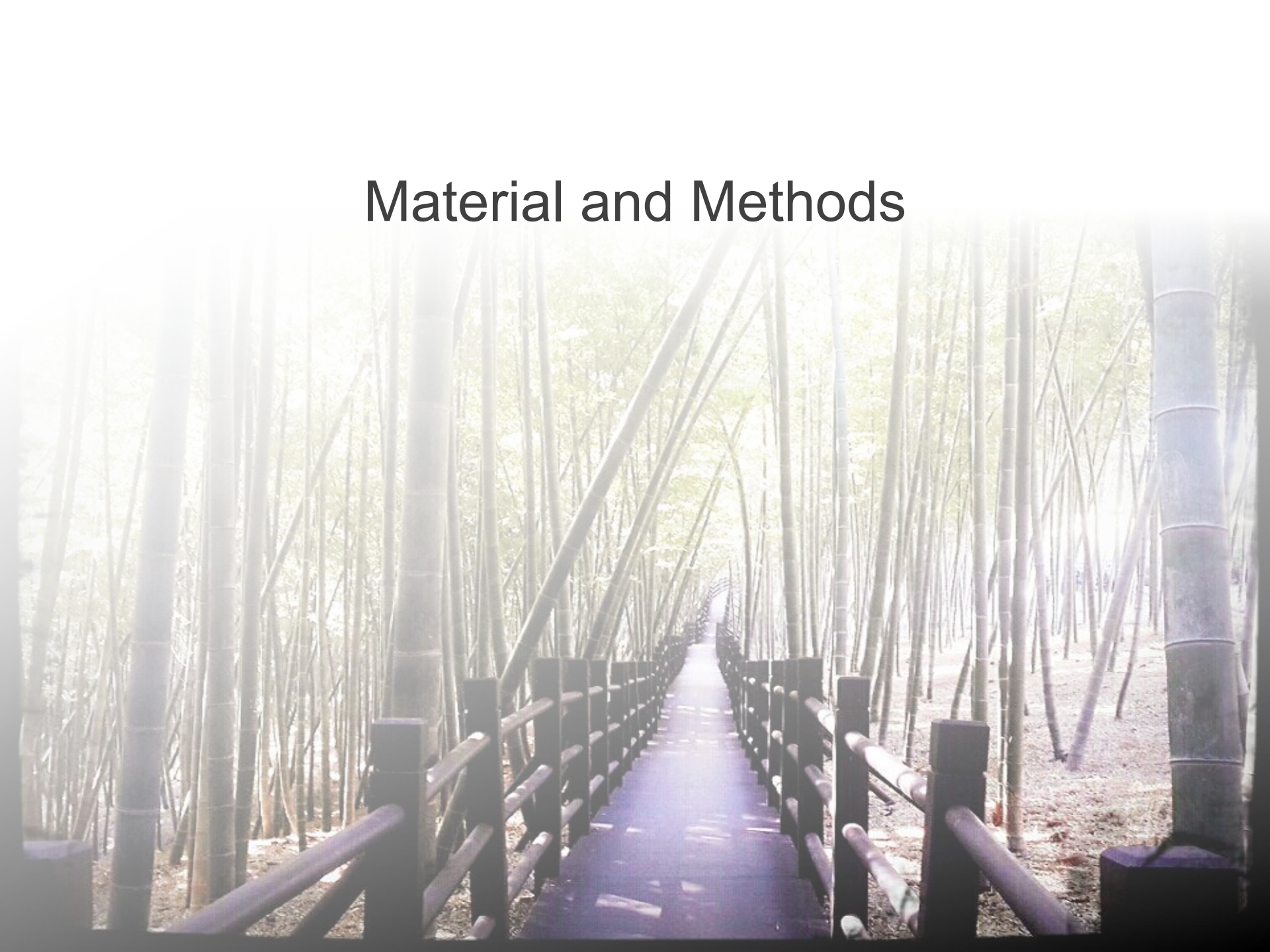
The objectives of this study were to evaluate

1) the **allometric equations** of different bamboo species

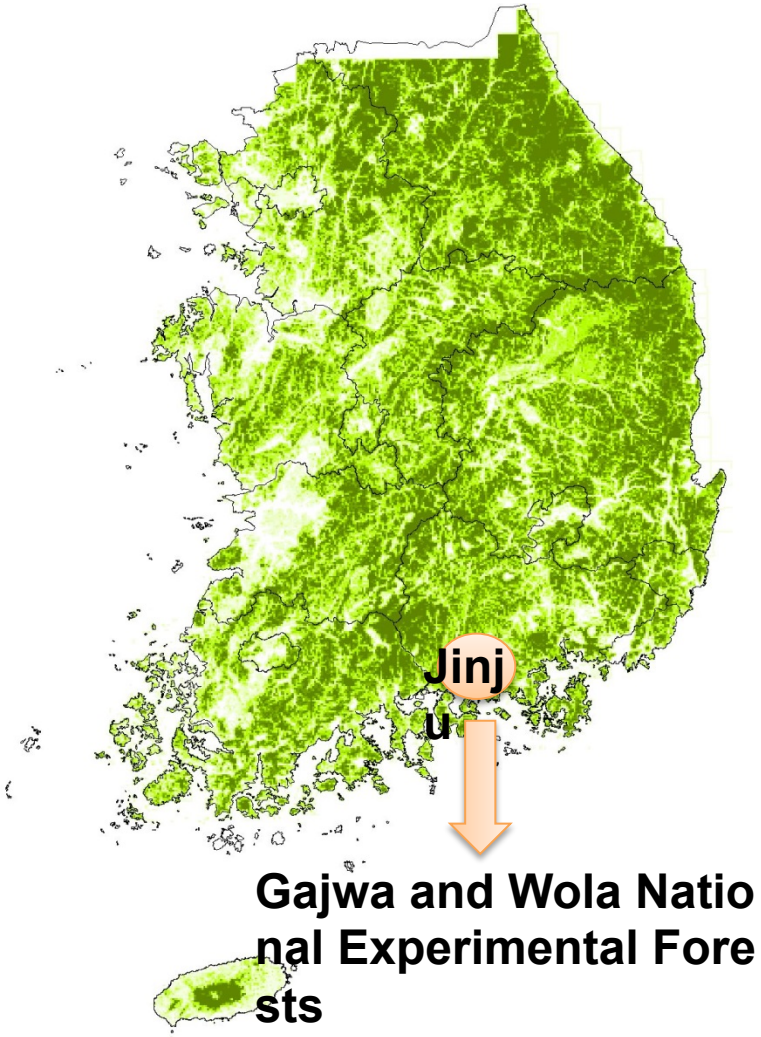
2) the **estimation of biomass production** in different bamboo species.

3) the **belowground C and N stocks** from different bamboo plantations in local level.

Material and Methods



Description of the study site



- Annual precipitation
  - **1,490 mm/yr**
- Annual temperature
  - **13.1°C**
- Soil
  - **Slightly dry**
  - **Dark-brown forest soil** (Inceptisol)
  - Originating from **Sandstone or shale**
  - **Silt loam texture**

Major bamboo species

Phyllostachys pubescens

Phyllostachys bambusoides

Phyllostachys nigra var. *henonsis*

Material and Methods(Biomass)

- Aboveground biomass sample

  - **Culm**, **branch** and **leaf** parts

- Belowground biomass sample

  - **Rhizome** and **root** parts

  - 2 m× 2 m dimension into 1.2m depth

Material and Methods(Biomass)

- Allometric model : **logY = a+blogD**
- Linear-quadratic model : **$Y=aD+bD^2$**
- Linear model with DBH and height : **$Y=a+bD^2H$**

Y is the biomass (g)

D is diameter at breast height (cm)

H is height (m)

a and b are regression parameters

Material and Methods(Soil)

1. Forest floor

   - Using a 900 cm^2 quadrangle steel frame (30 × 30 cm).

   - C and N concentrations were determined using an elemental analyzer (Thermo Sci entific, Flash 2000, Italy).

   - C and N stocks of forest floor litter were estimated by multiplying dry weight and C a nd N concentrations.

Material and Methods(Soil)

2. Dead bamboo woods (> 2cm diameter)

1> Sound dead bamboos of branches and leaf with green color culms

2> Intermediate dead bamboos with few branches of brown color culms

3> Rotten dead bamboos broken into pieces without maintaining their original shape

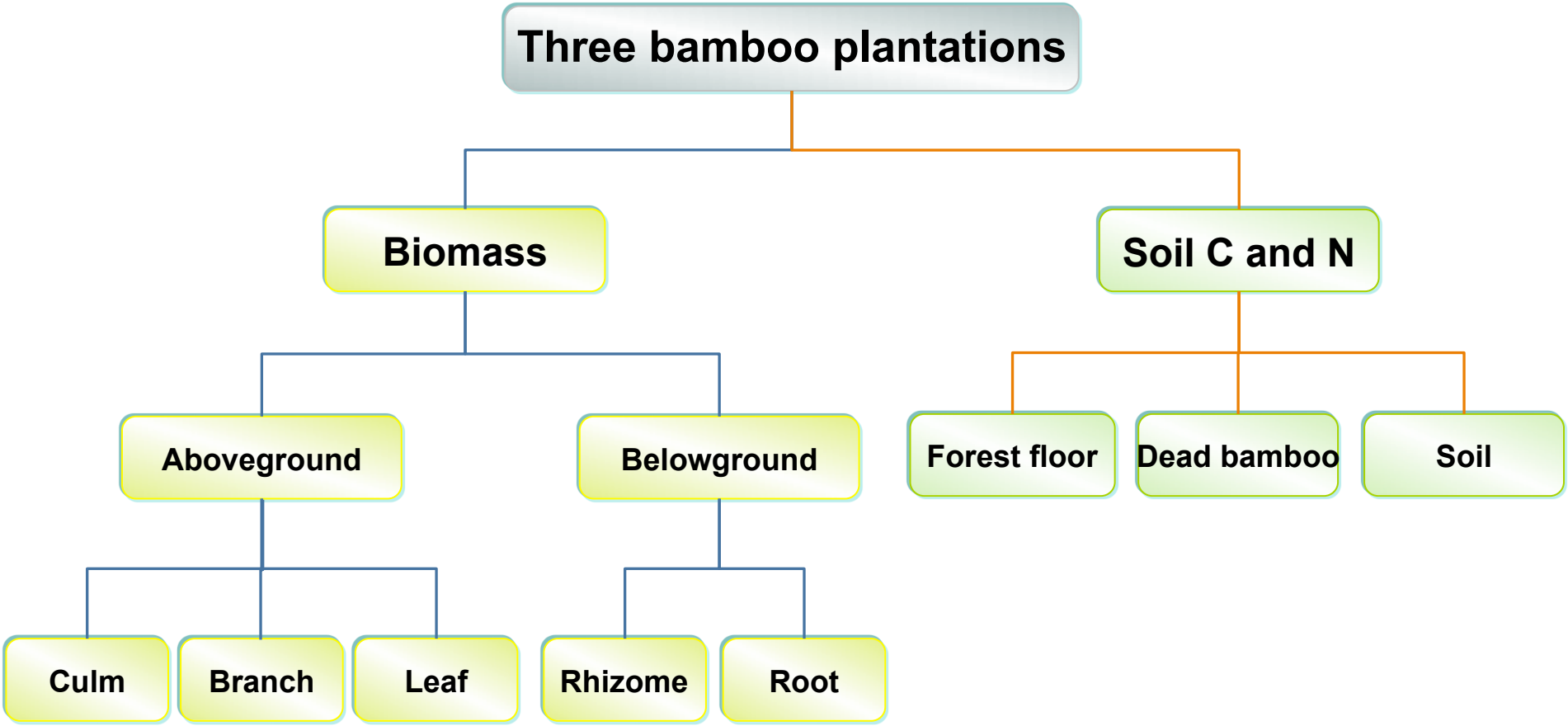
- C and N concentrations in the ground materials were determined using an elemental analyzer.

Material and Methods(Soil)

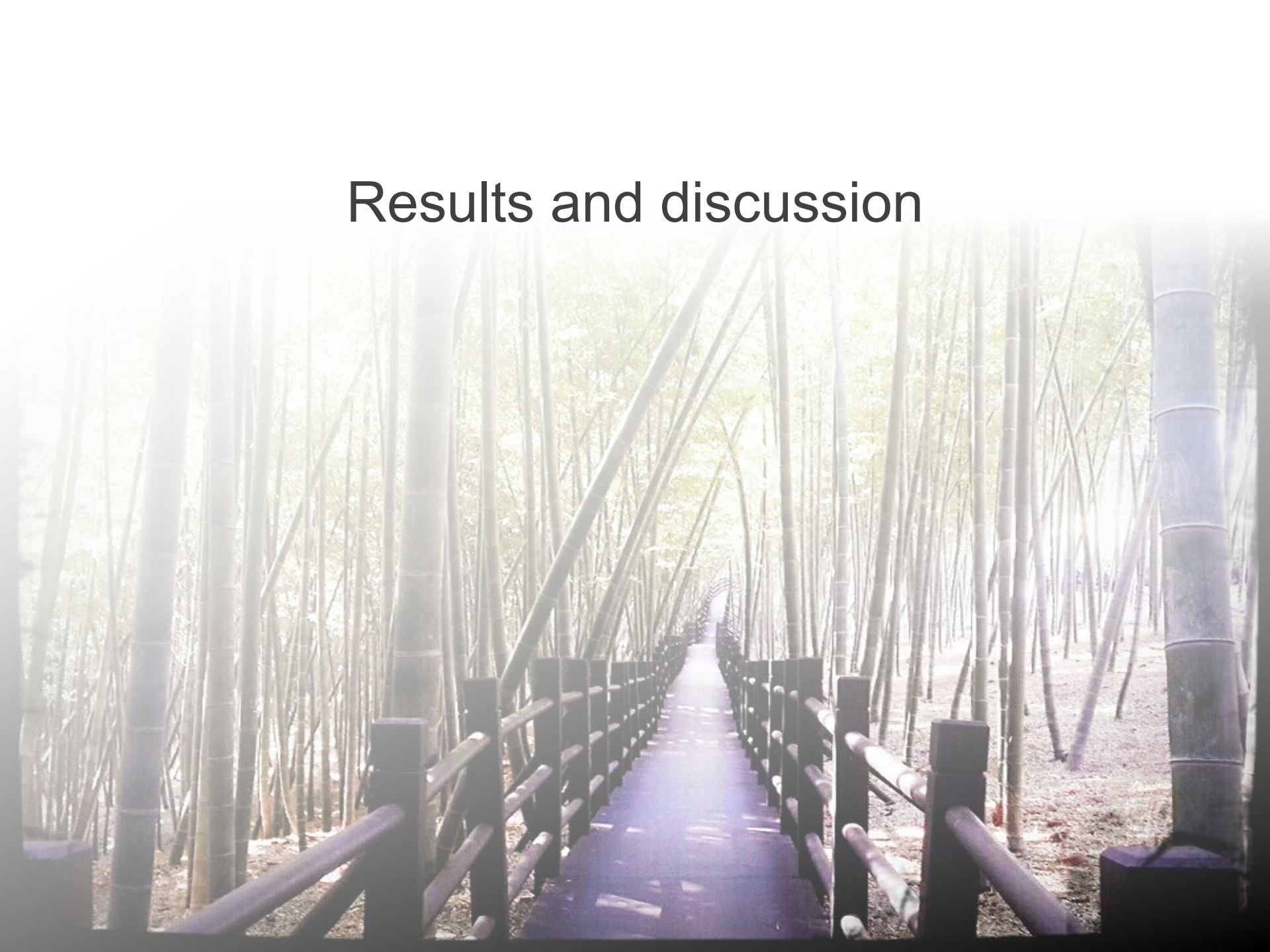
3. Soil

- Soil samples at three depths (0-10, 10-20, 20-30 cm) using a 400 cm^3 stainless steel core.
- The soil samples were air-dried and put through a 2 mm sieve to measure coarse fragment of >2 mm prior to the soil C and N analysis using an elemental analyzer.
- Soil C and N stocks were calculated using by concentrations of C and N with soil bulk density and coarse fragments content of each soil depth.

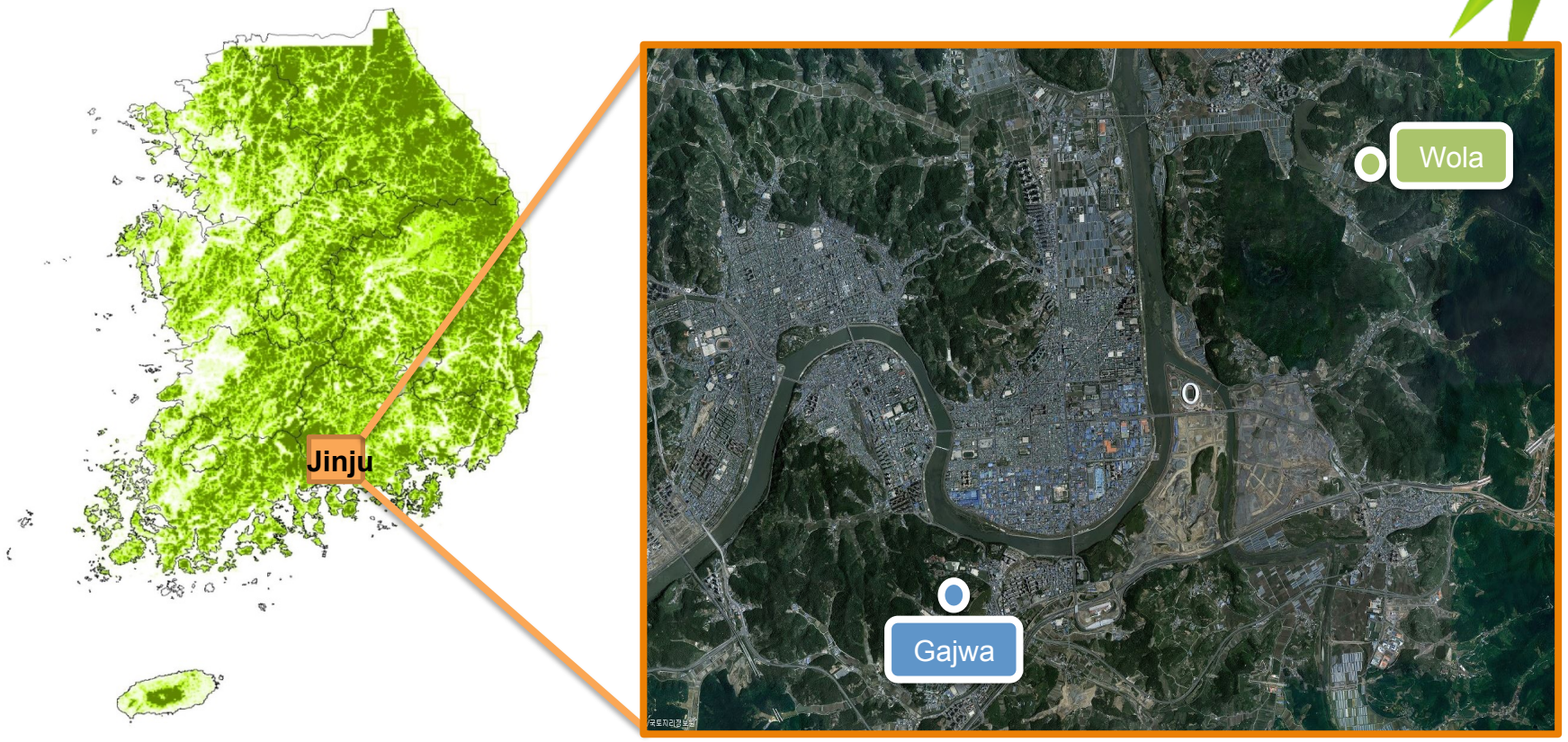
Material and Methods



Results and discussion

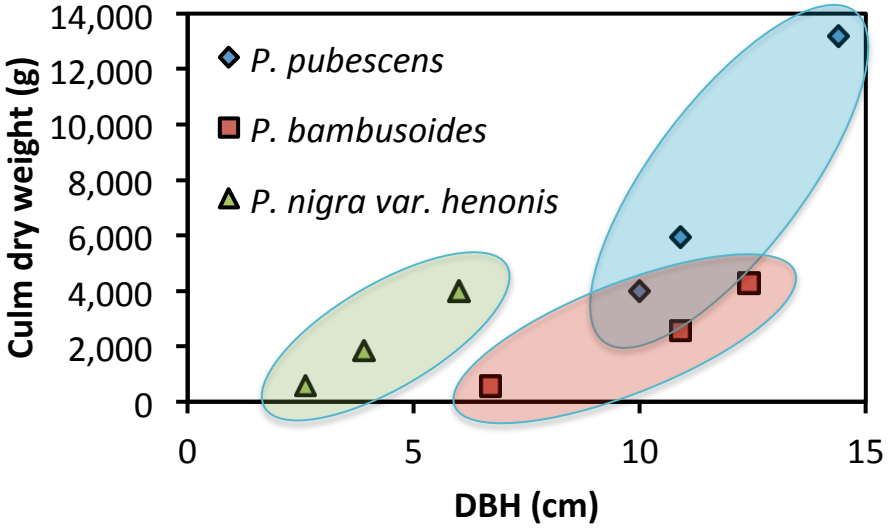


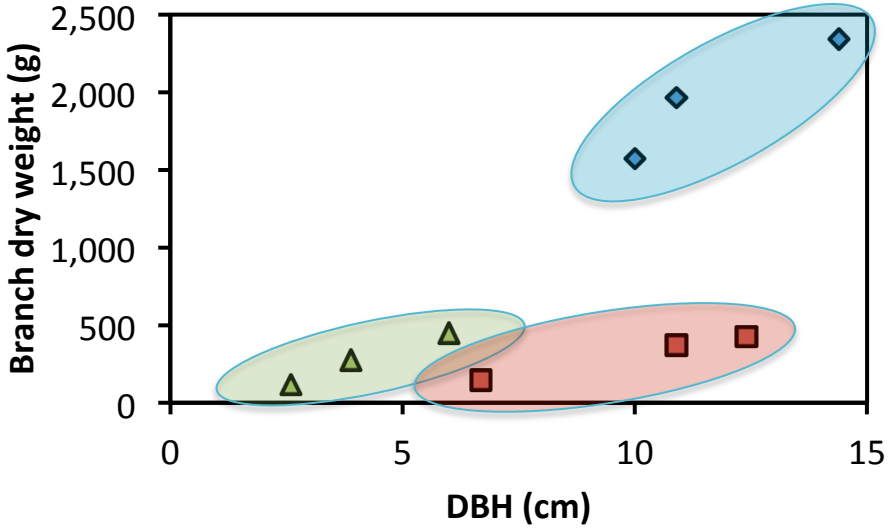
General stand characteristics

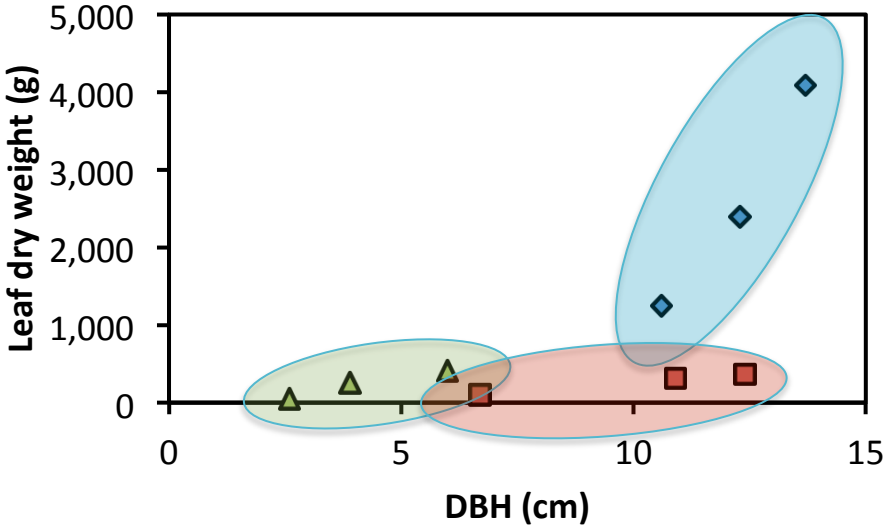


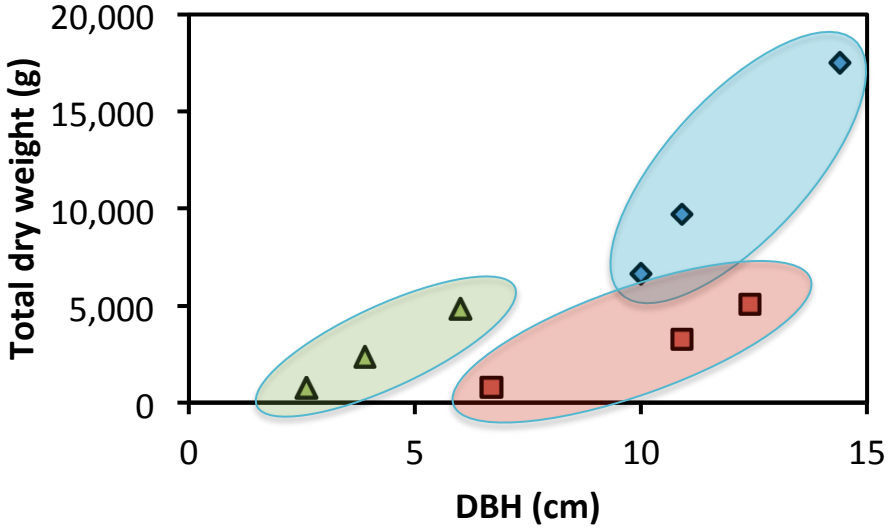
Location	Plantation	Location	Planting year	Elevation (m)	DBH (cm)	Height (m)	Stand density (culm/ha)
Gajwa	*P. pubescens*	35°9′41″ N 128°6′18″ E	1970-72	53	8.9/5-13	13.2/7-17	3,050
Wola	*P. bambusoides*	35°12′24″ N 128°10′21″ E	1994-95	139	3.4/2-8	9.0/3-14	11,875
	P. nigra var. *henonis*	35°12′25″ N 128°10′20″ E	1994-95	135	4.2/2-8	9.1/6-15	12,950

Dry weight of sampled bamboo (current year old)

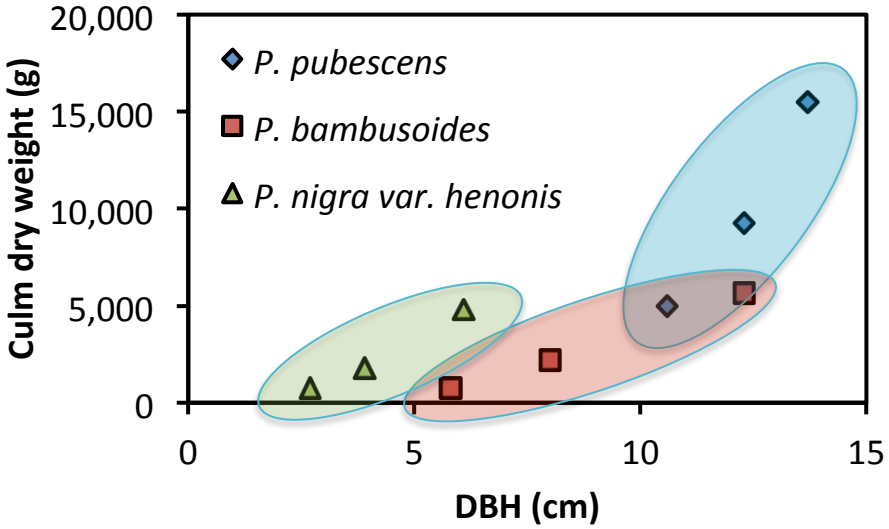


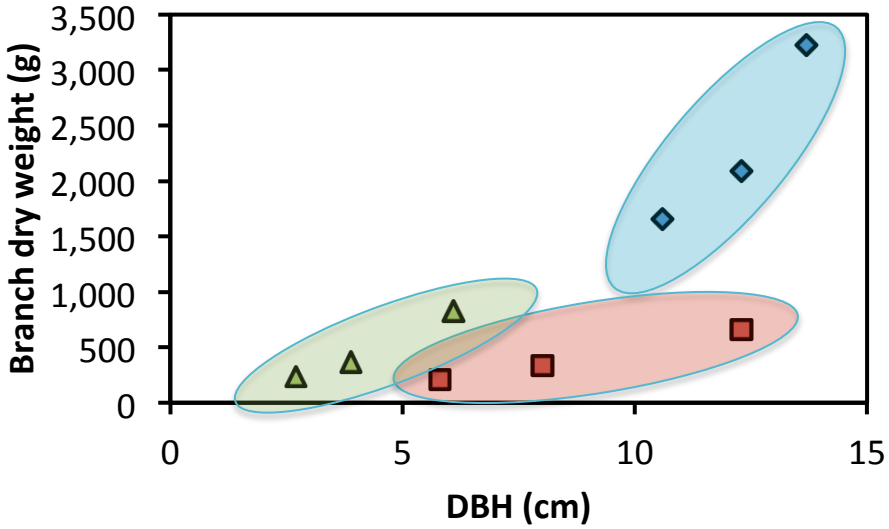


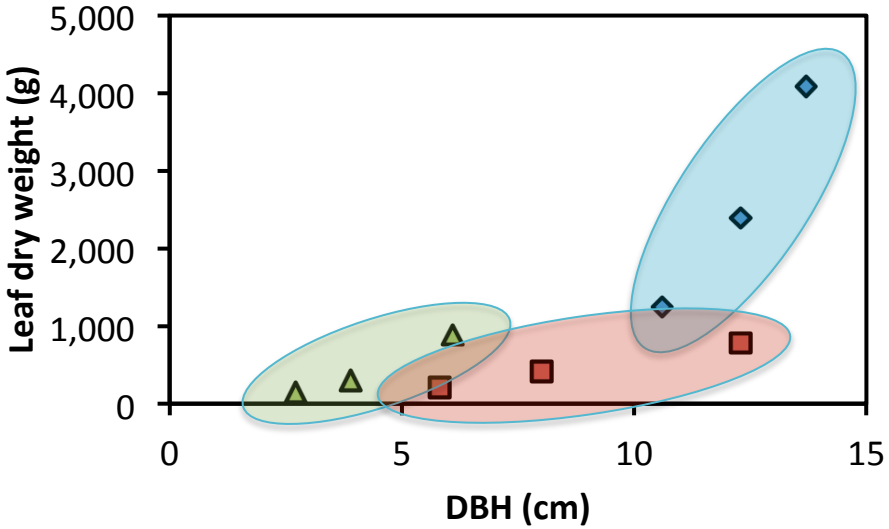


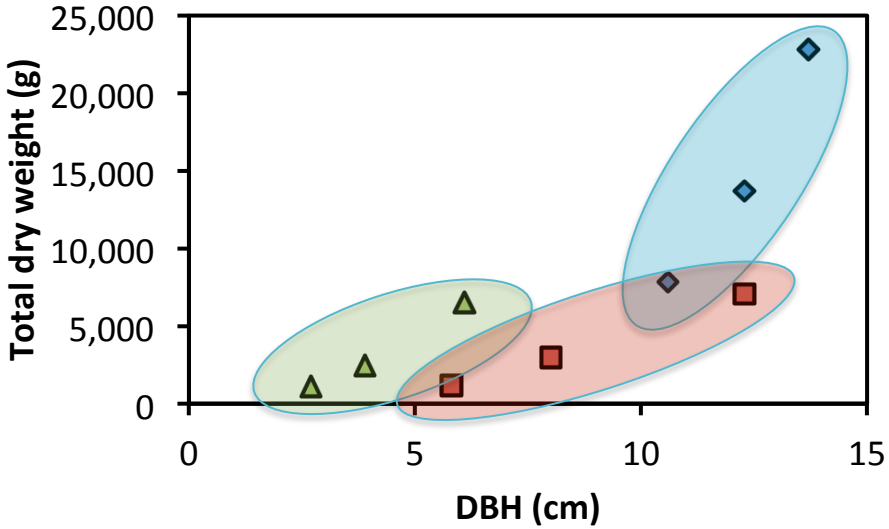


Dry weight of sampled bamboo (>1-year-old)

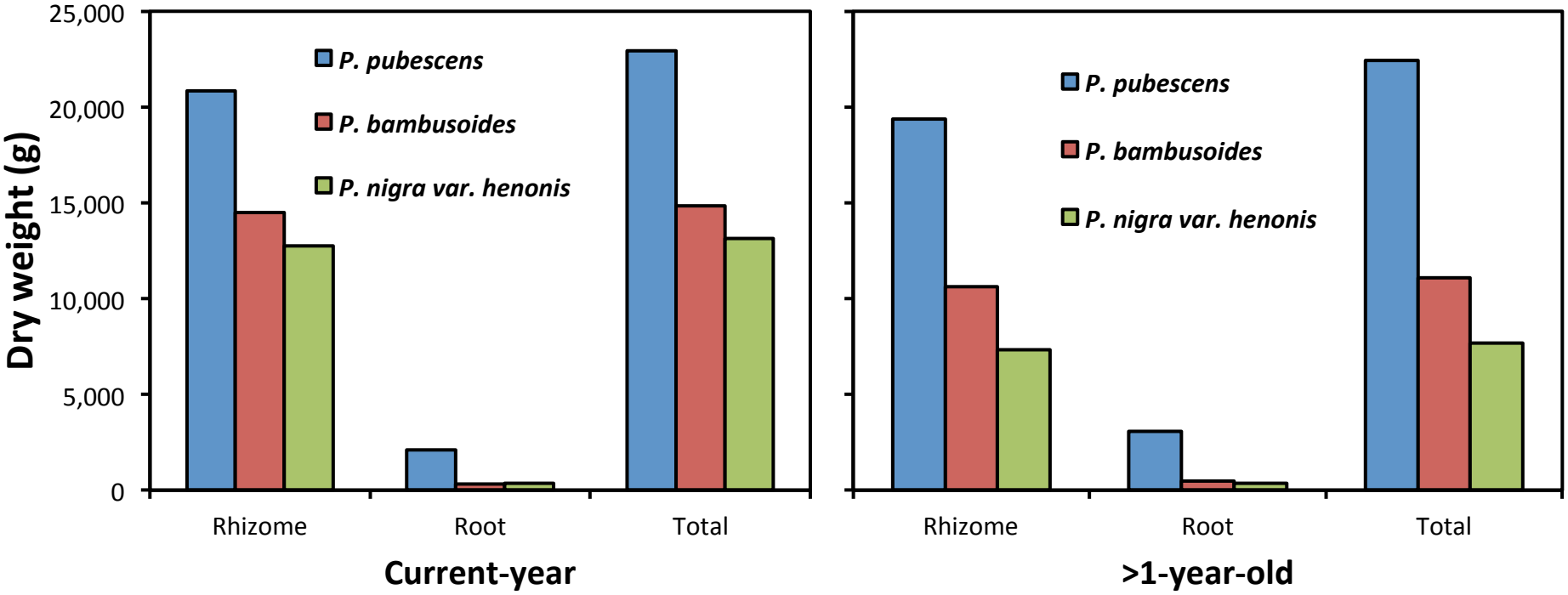








Dry weight of sampled bamboo (Belowground)



Allometric model

(logY = a+blogD)

Biomass equation form	Species	Culm age	Dependent variable	Coefficients		R^2	SEE
				a	b		
logY = a+blogD	*P. pubescens*	>1-year-old	Culm	2.441	3.151	0.894	0.195
			Branch	3.670	1.908	0.685	0.233
			Leaf	0.563	3.386	0.753	0.349
			Total	3.214	2.980	0.875	0.202
		Current-year	Culm	3.622	2.571	**0.953**	0.133
			Branch	6.030	0.753	0.367	0.232
			Leaf	4.894	1.222	0.783	0.151
			Total	5.121	2.043	**0.953**	0.106
	P. bambusoides	>1-year-old	Culm	6.732	0.295	0.060	1.352
			Branch	4.656	0.773	0.303	0.430
			Leaf	4.375	1.065	0.566	0.342
			Total	6.409	0.896	0.150	0.824
		Current-year	Culm	4.279	2.398	**0.985**	0.134
			Branch	3.445	1.595	0.818	0.345
			Leaf	2.438	2.139	0.795	0.498
			Total	4.703	2.263	**0.969**	0.186
	P. nigra var. *henonis*	>1-year-old	Culm	4.411	2.238	**0.970**	0.151
			Branch	3.760	1.607	0.848	0.260
			Leaf	2.538	2.311	0.780	0.470
			Total	4.902	2.131	**0.964**	0.156
		Current-year	Culm	4.238	2.327	**0.991**	0.104
			Branch	3.074	1.797	0.908	0.261
			Leaf	1.791	2.507	0.930	0.314
			Total	4.553	2.272	**0.985**	0.128

Linear-quadratic model

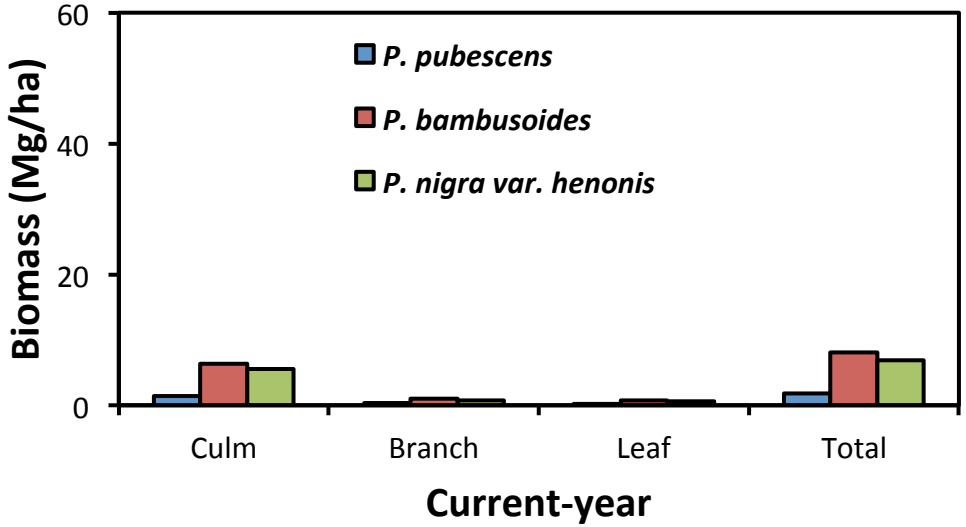
($Y=aD+bD^2$)

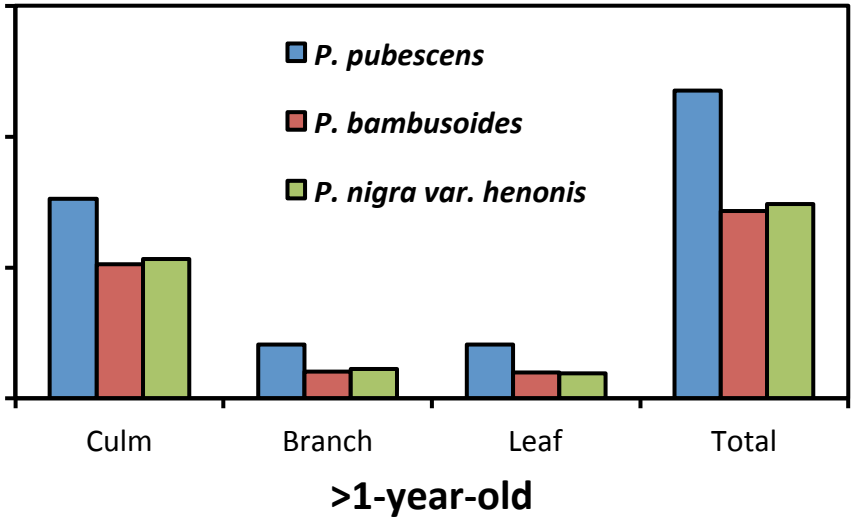
Biomass equation form	Species	Culm age	Dependent variable	Coefficients		R^2	SEE
				a	b		
$Y=aD+bD^2$	*P. pubescens*	>1-year-old	Culm	-1.014	0.258	**0.991**	1.274
			Branch	0.034	0.029	**0.973**	0.494
			Leaf	-0.295	0.071	**0.965**	0.653
			Total	-1.275	0.358	**0.991**	1.819
		Current-year	Culm	-0.791	0.225	**0.992**	0.982
			Branch	0.293	0.005	**0.964**	0.466
			Leaf	0.201	0.001	**0.986**	0.239
			Total	-0.297	0.221	**0.994**	1.210
	P. bambusoides	>1-year-old	Culm	0.626	0.024	0.684	1.732
			Branch	0.116	0.007	0.869	0.158
			Leaf	0.118	0.005	0.905	0.150
			Total	0.861	0.037	0.740	2.026
		Current-year	Culm	-0.092	0.154	**0.994**	0.258
			Branch	0.065	0.003	**0.967**	0.070
			Leaf	0.046	0.004	**0.980**	0.045
			Total	0.019	0.160	**0.993**	0.343
	P. nigra var. *henonis*	>1-year-old	Culm	-0.129	0.149	**0.994**	0.270
			Branch	0.038	0.016	**0.977**	0.093
			Leaf	-0.030	0.028	**0.954**	0.135
			Total	-0.120	0.193	**0.995**	0.319
		Current-year	Culm	-0.032	0.119	**0.996**	0.174
			Branch	0.034	0.007	**0.976**	0.056
			Leaf	0.011	0.010	**0.962**	0.063
			Total	0.013	0.136	**0.994**	0.277

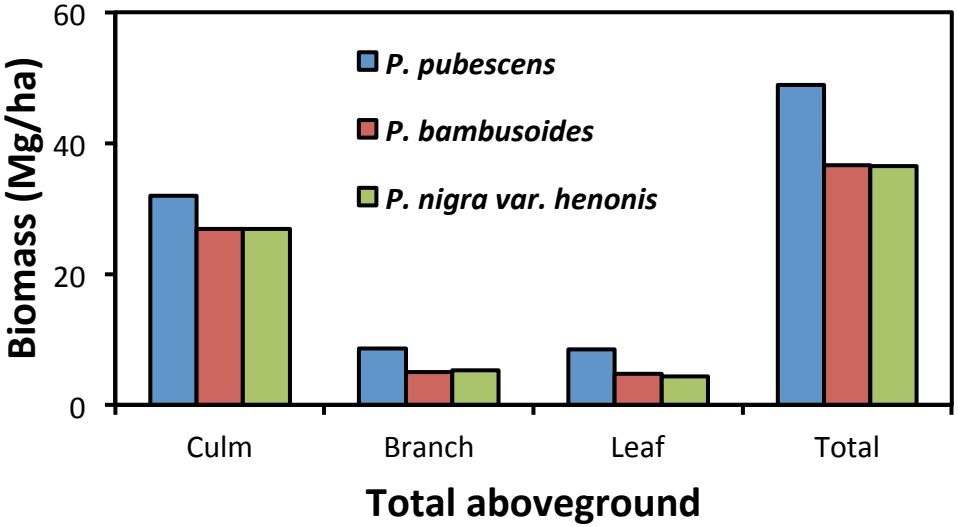
Linear model with DBH and height ($Y=a+bD^2H$)

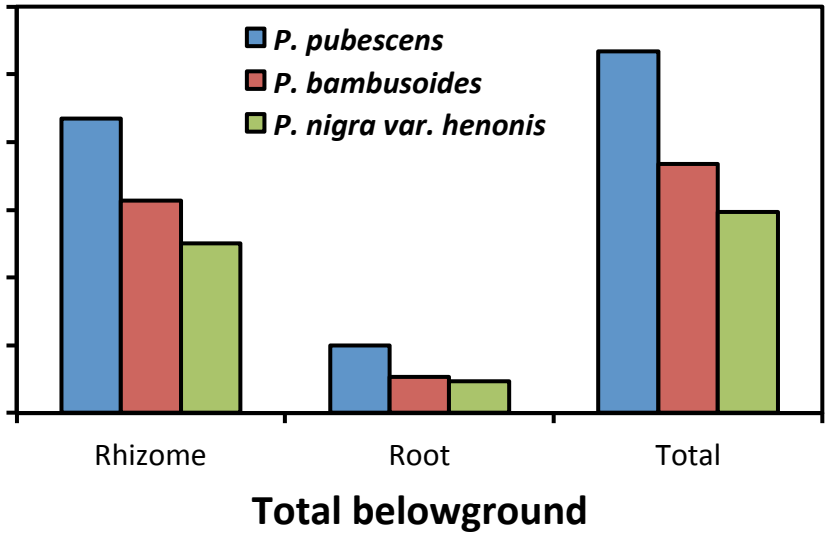
Biomass equation form	Species	Culm age	Dependent variable	Coefficients		R^2	SEE
				a	b		
$Y=a+bD^2H$	*P. pubescens*	>1-year-old	Culm	-0.918	0.012	**0.960**	1.077
			Branch	0.775	0.002	0.645	0.563
			Leaf	-0.206	0.003	0.763	0.758
			Total	-0.350	0.017	0.928	2.043
		Current-year	Culm	0.416	0.009	**0.979**	0.730
			Branch	1.387	0.001	0.437	0.446
			Leaf	1.067	0.001	0.633	0.295
			Total	2.870	0.011	**0.971**	1.007
	P. bambusoides	>1-year-old	Culm	1.428	0.003	0.113	1.847
			Branch	0.264	0.000	0.172	0.175
			Leaf	0.281	0.001	0.276	0.173
			Total	1.974	0.004	0.130	2.183
		Current-year	Culm	0.290	0.010	**0.986**	0.218
			Branch	0.141	0.001	0.760	0.080
			Leaf	0.104	0.001	0.819	0.060
			Total	0.535	0.012	**0.974**	0.342
	P. nigra var. *henonis*	>1-year-old	Culm	0.286	0.011	**0.994**	0.154
			Branch	0.163	0.002	0.881	0.103
			Leaf	0.047	0.002	0.872	0.137
			Total	0.496	0.015	**0.992**	0.239
		Current-year	Culm	0.310	0.009	**0.987**	0.186
			Branch	0.101	0.001	0.892	0.055
			Leaf	0.054	0.001	0.868	0.064
			Total	0.465	0.010	**0.979**	0.288

Biomass production of three bamboo plantation (Linear-quadratic model ($Y=aD+bD^2$))

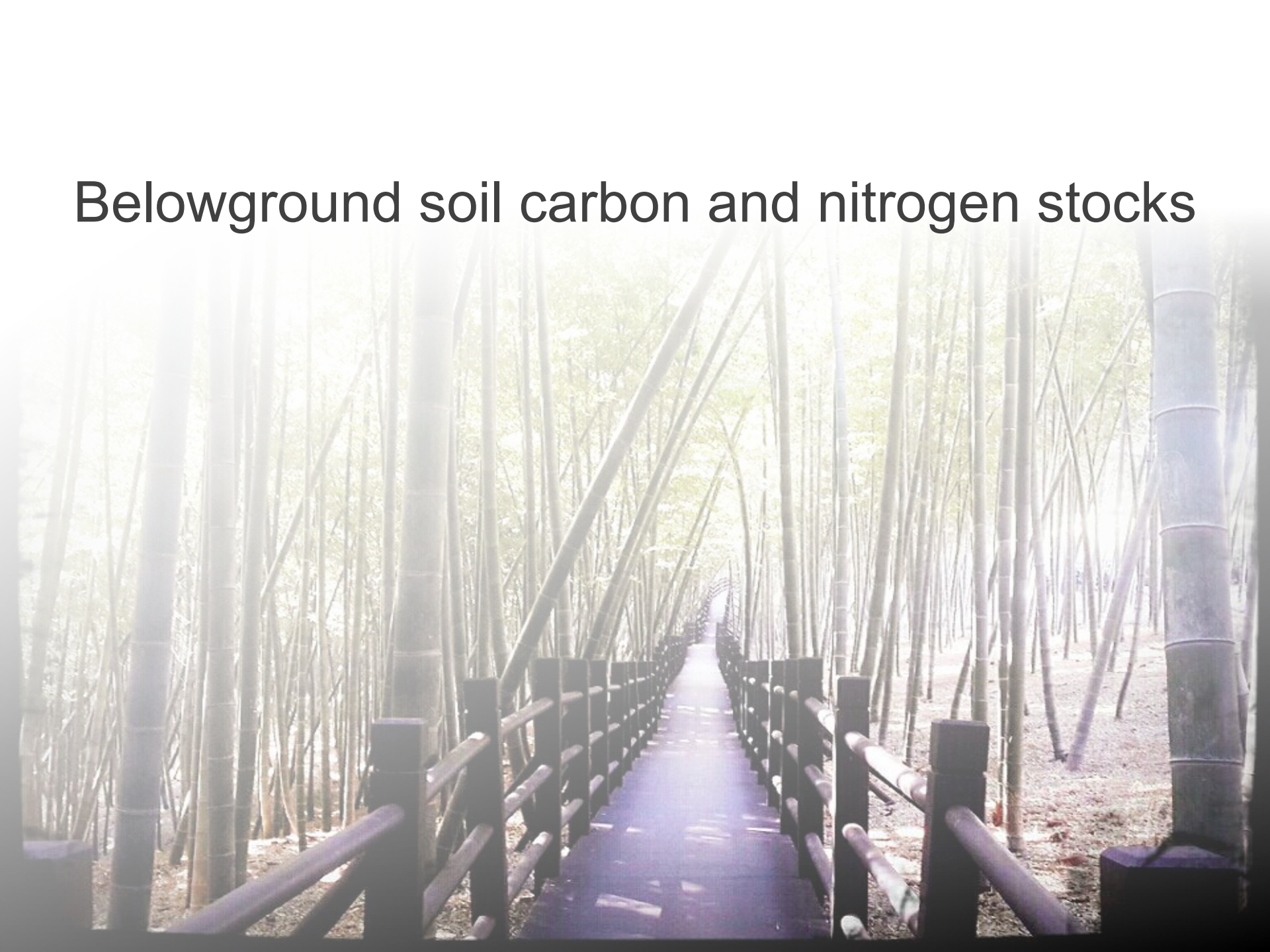




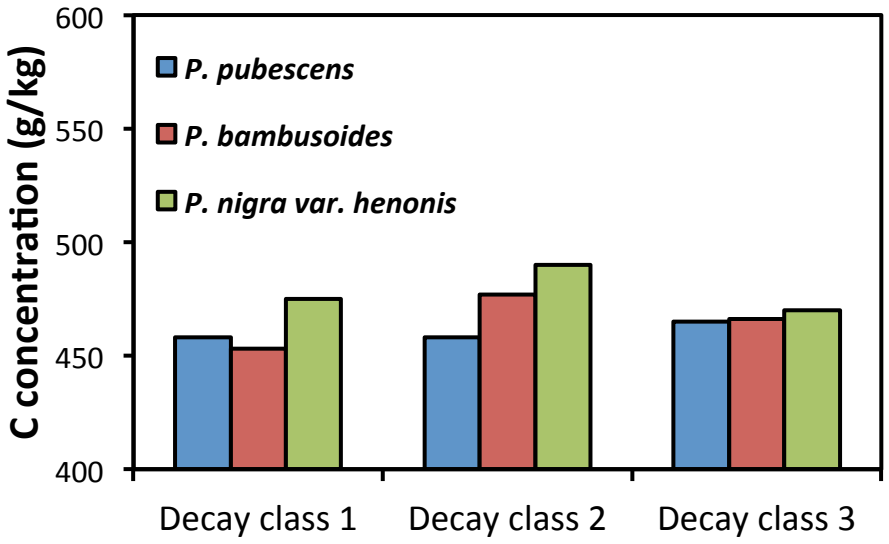


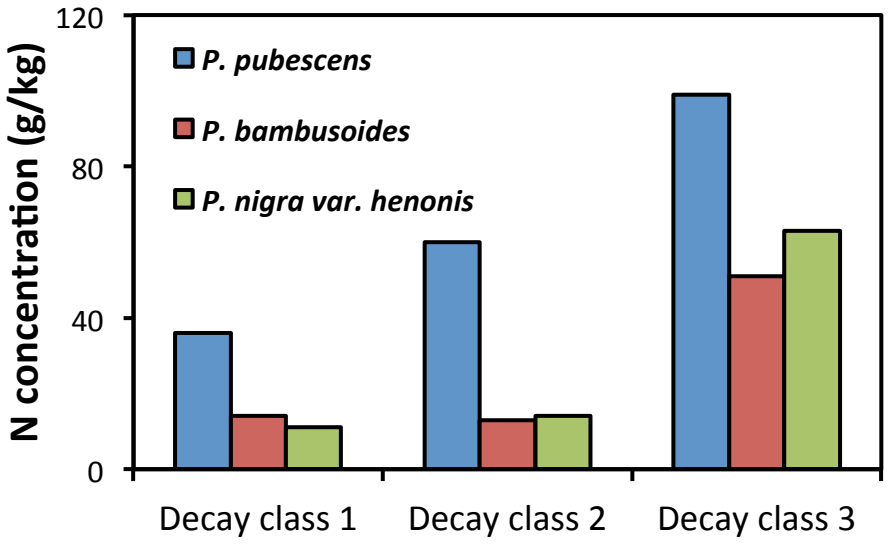


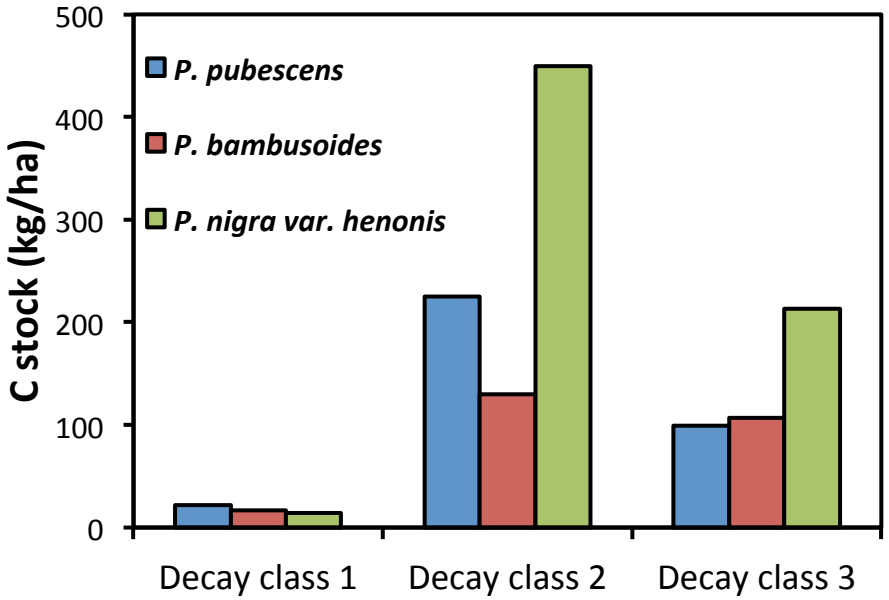
Belowground soil carbon and nitrogen stocks

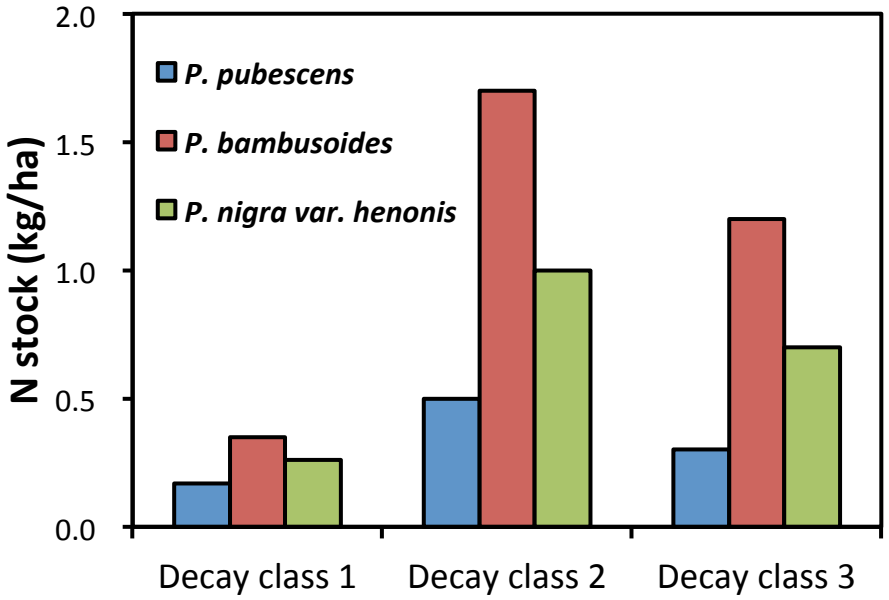


Concentration and stocks of dead bamboo

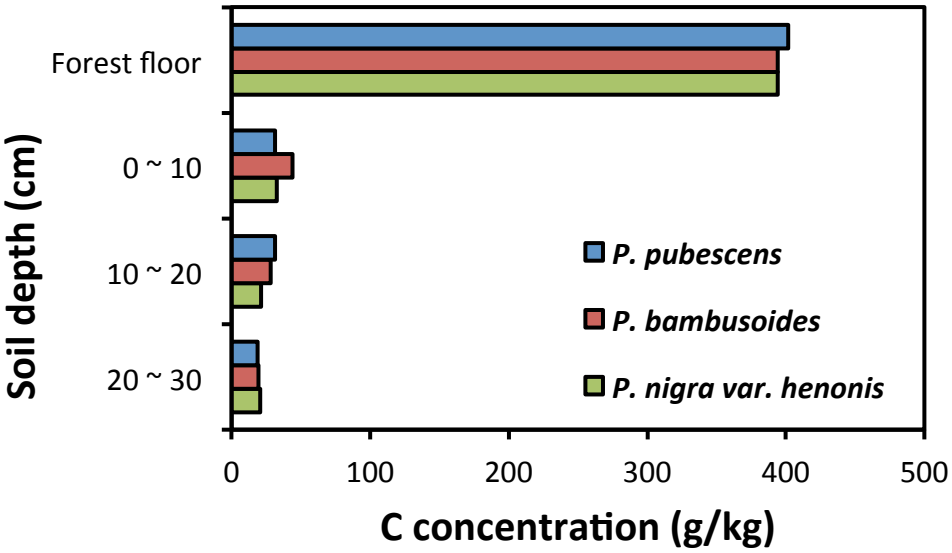


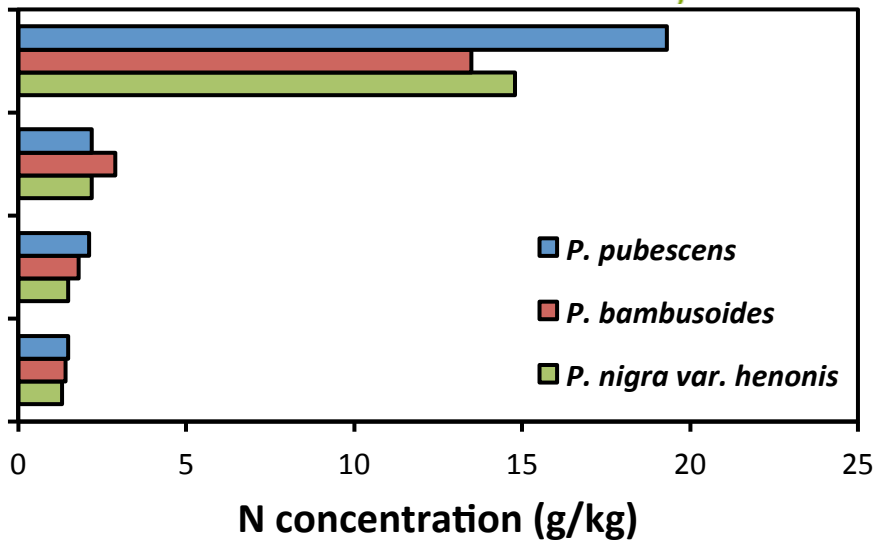


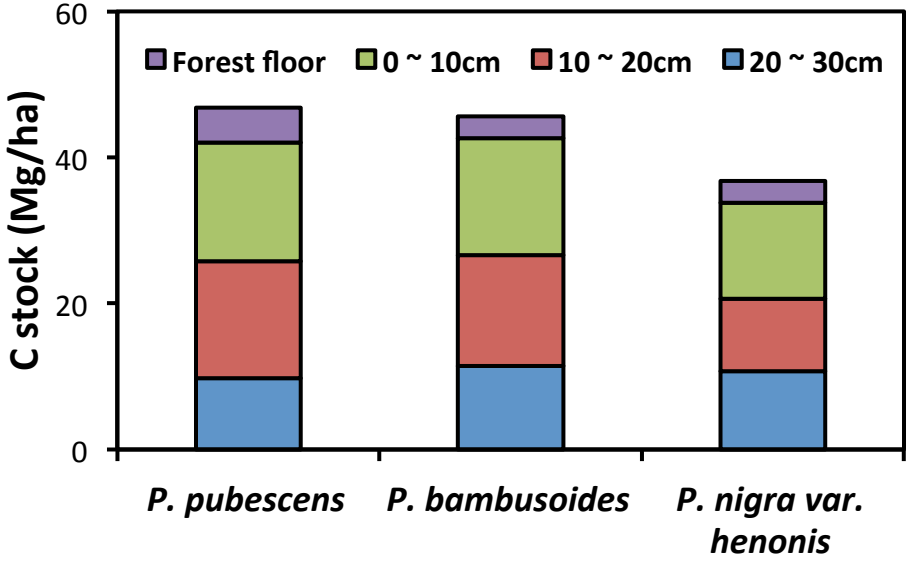


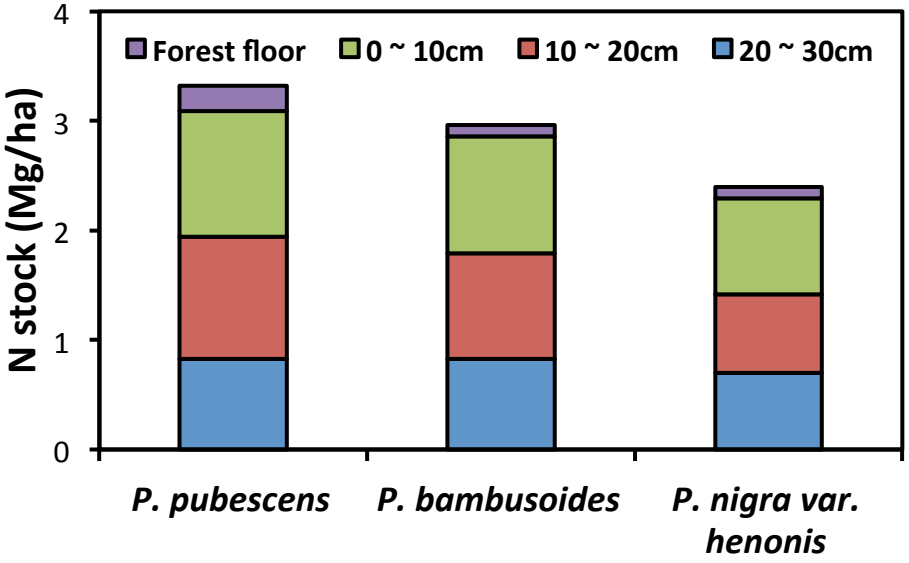


Concentration and stock of soil depth









Summary

- The most suitable equation model to estimate biomass from three bamboo plantations in a local level was a linear-quadratic model ($Y=aD+bD^2$). Aboveground and belowground biomass were highest for *P. pubescens,* followed by *P. bambusoides* and *P. nigra* var. *henonis* plantations.

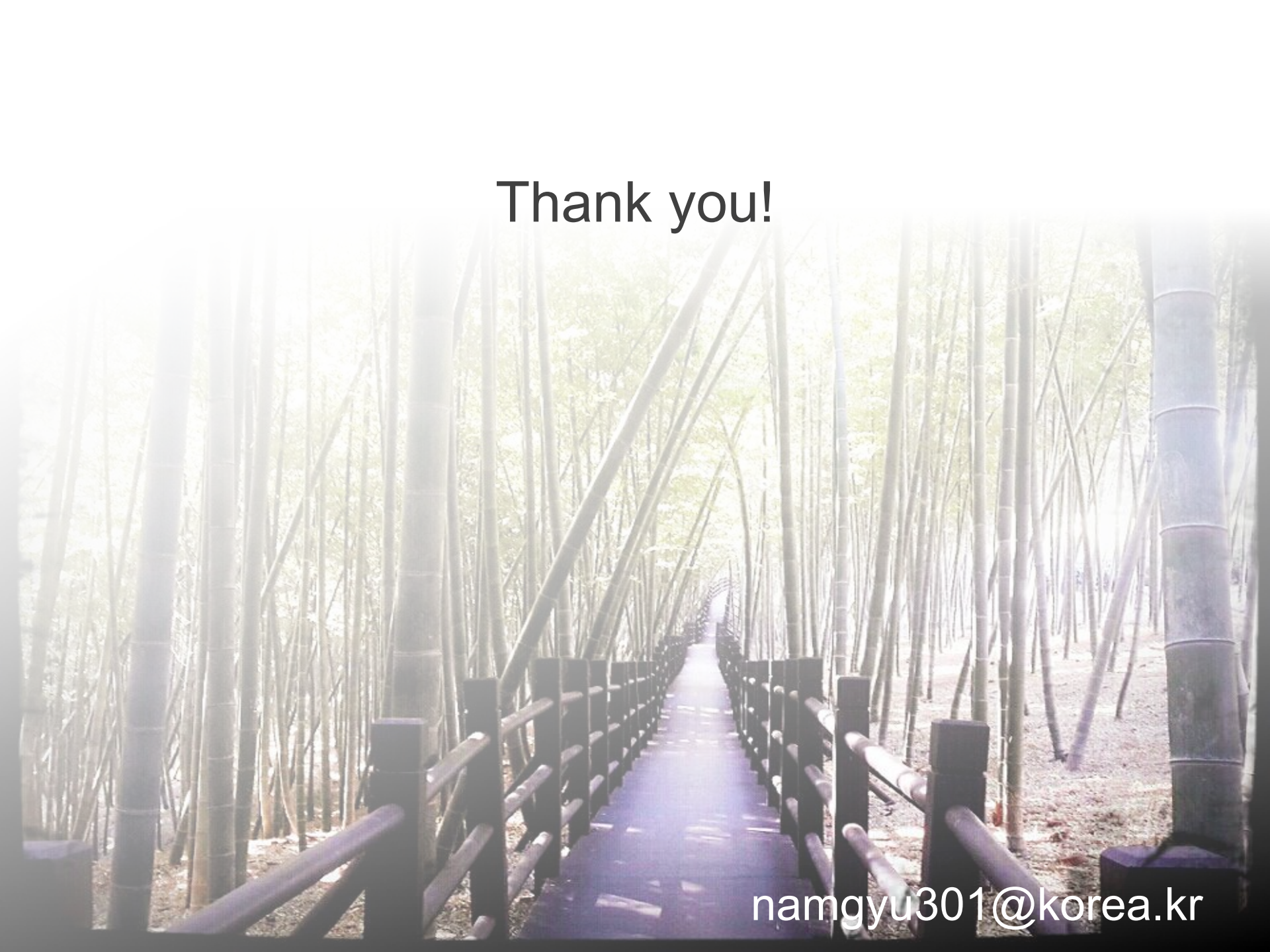
- Carbon concentration and stocks in the forest floor, dead bamboo and mineral soil were not affected by different bamboo plantation development. However, N concentration and stocks in forest floor and dead bamboo were different among the three bamboo plantations of fertilizer application.

Summary

- The result indicates that inherent growth characteristics of different bamboo species are the most important factor to determine bamboo productivity in a local scale.

- Forest management systems such as fertilizer application may be crucial in determining the N stocks of the forest floor and dead bamboo in different bamboo plantations.

Thank you!



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