Influences of tree species and forest management on carbon and nutrient distribution in plantation forests

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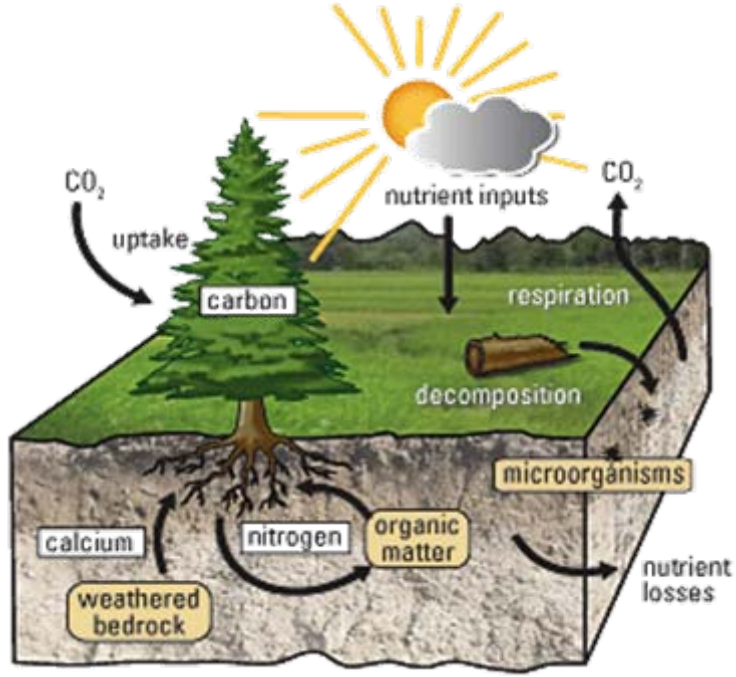
ValWood



Introduction

Nutrients

- resources for plant growth and plant nutrition
- balanced nutrient budget is a main criteria for sustainability of forest production systems (Jacobson et al. 2003)



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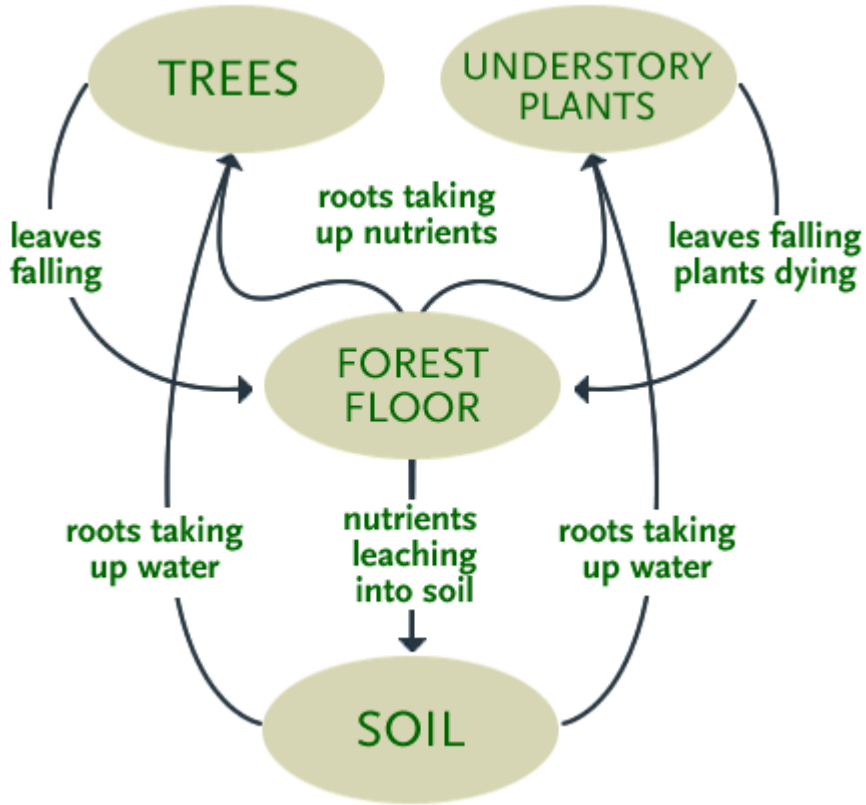
Introduction

Influences



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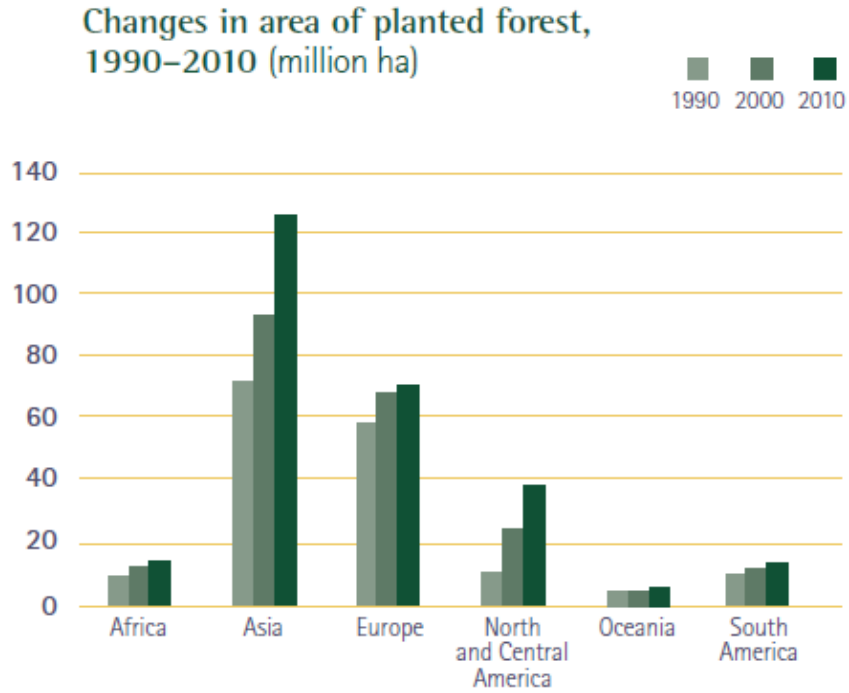
- directly and indirectly
- natural and human induced



Introduction

Plantation forests in China

- man-made forest with more or less intensified management for production purposes (FAO, 2001)
- Global FRA 2010:
  - total 264 million hectares
  - in Asia 35 % of total forest area
  - increase in China (3 M ha / a)



Introduction

Even aged stands - Advantages

- comparable low maintenance costs
- market orientation
- quality factors
- no competition with other species
- short time use
- reforestation (fast growing)



Introduction

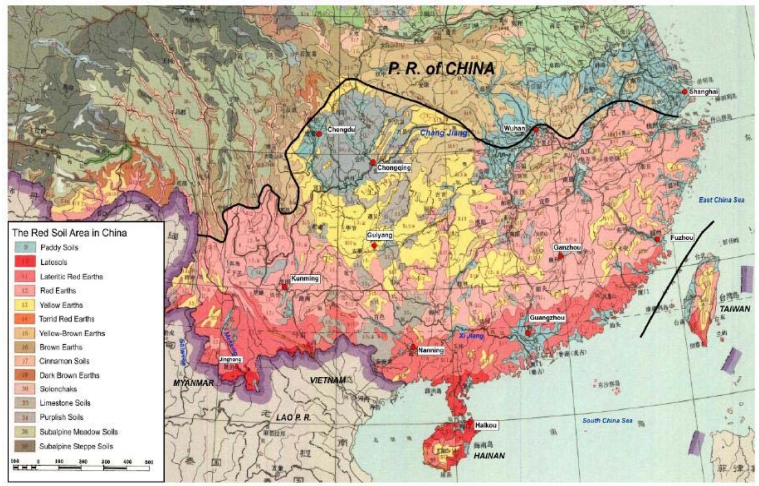
Even aged stands – Potential risks

- diseases (pests, fungi)
- climate responses (wind, fire)
- economical risks
- **clear cutting strategy**
- **increase of erosion risks**
- **loss of nutrients over time**
- range of **microorganisms** that support plant growth is limited (lower MBC)

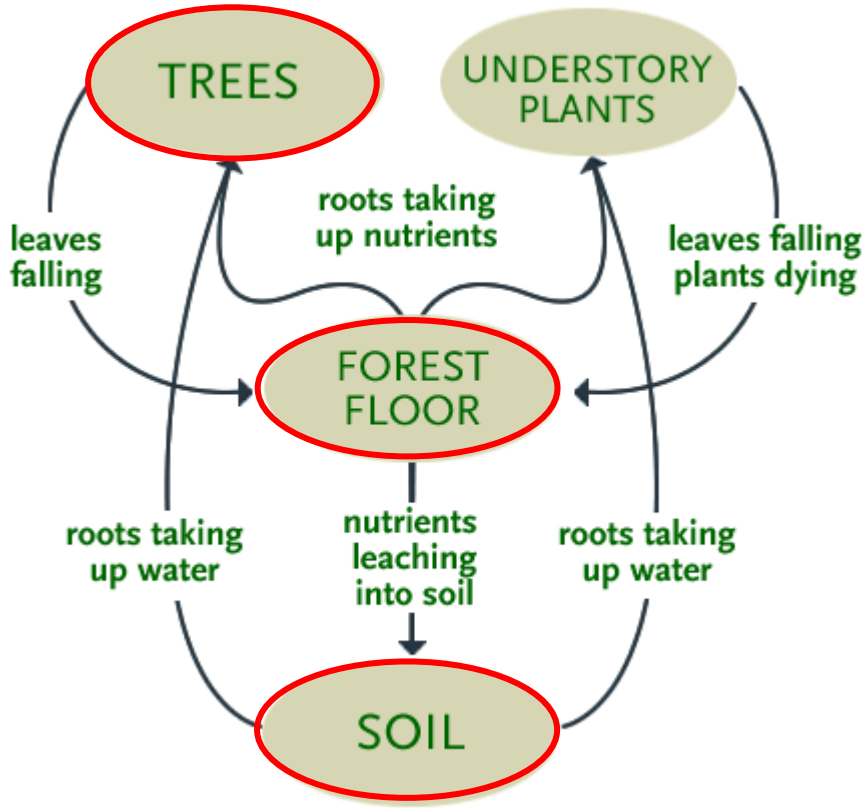
Introduction

Red Soil Region - Characteristics

- **low content of N, P and K**
- soil pH is in the range 4.5 to 5.5
- high amount of low activity clay (LAC)
- CECeff very low
- Al toxicity
- low content of **organic matter**
- limited range of **microorganisms**



Influences on nutrient pools



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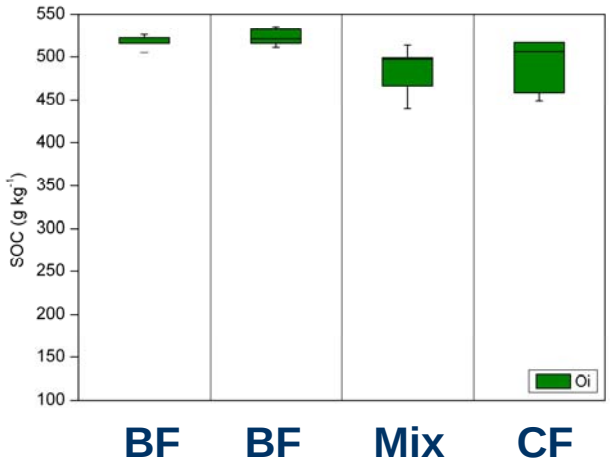
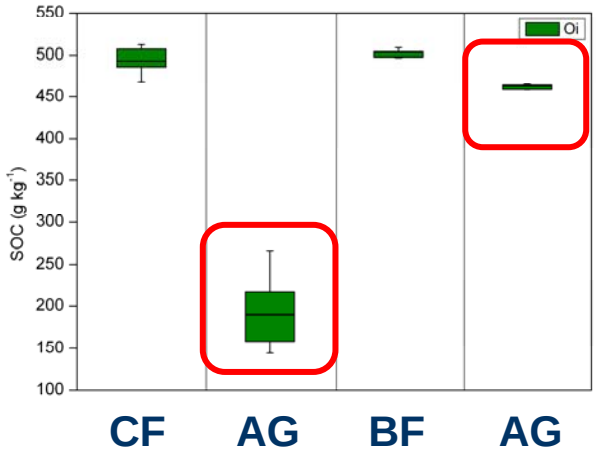
- BF broadleaved stands
- Mix mixed stands
- CF coniferous stands
- AG agriculture

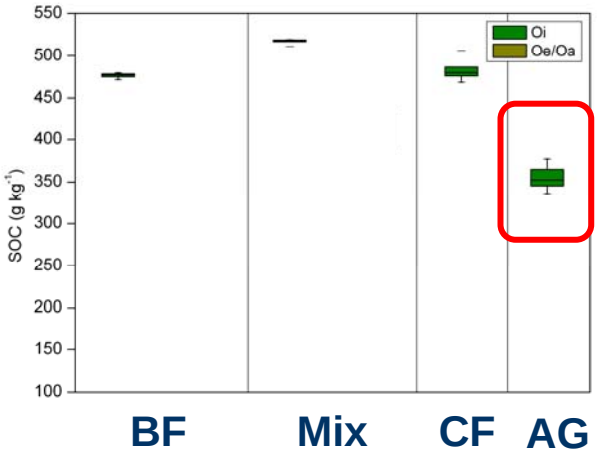


Tree species influences – carbon

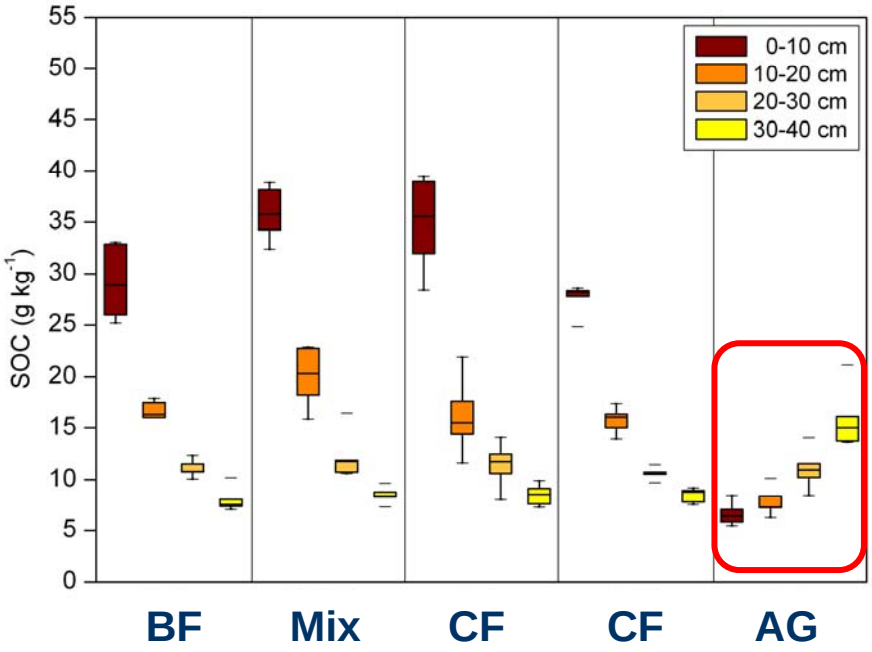
forest floor





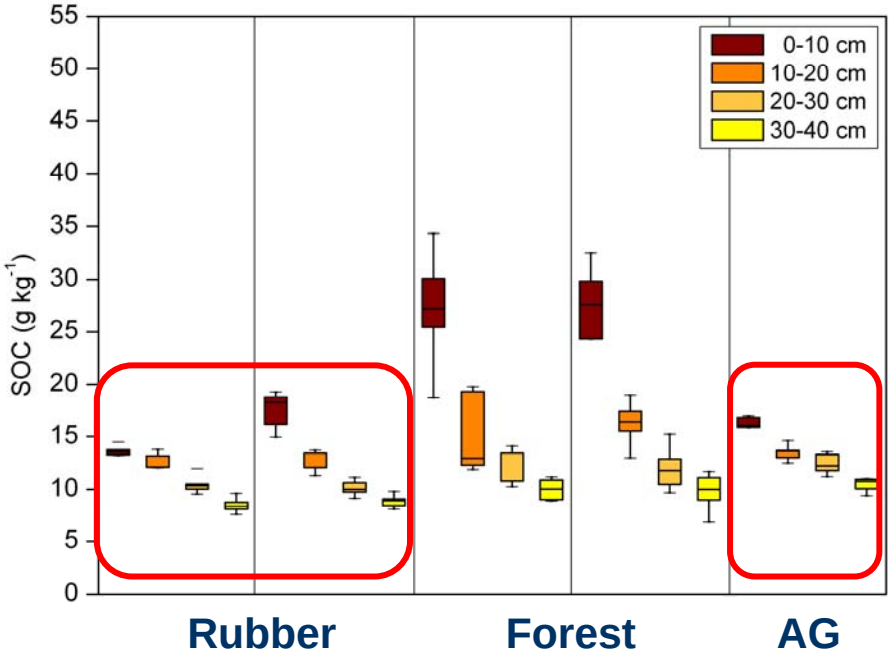


Tree species influences – carbon



Fubo

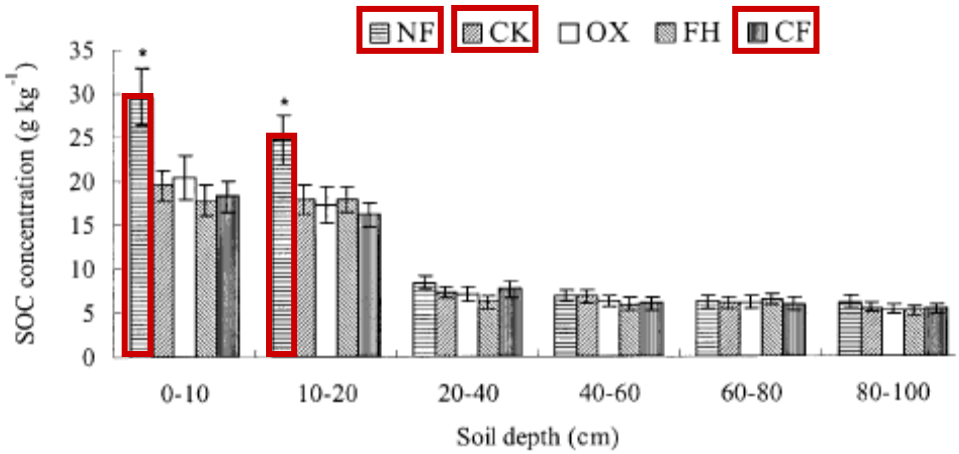
mineral soil



Xishuangbanna

Tree species influences

SOC contents in different plantations



NF, natural forest

CK, *Castanopsis kawakamii* plantation;

CF, *Cunninghamia lanceolata* plantation;

The conversion from natural forest to both broadleaved and coniferous plantations led to a reduction in total ecosystem C pools.

Chen et al., 2005 (Fujian)

Tree species influences - nitrogen

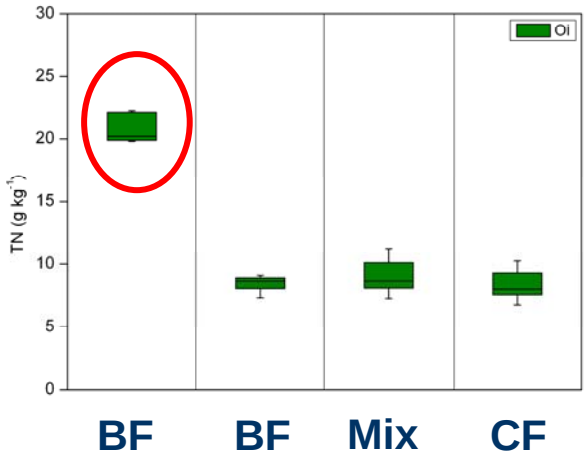
literature

- Conifers need less N than broadleaf nonlegumes, because they use N more efficiently
- Leguminous plants require more N compared with nonlegumes (McKey 1994; Vitousek et al. 2002; Houlton et al.2008; Inagaki 2009).
- Legumes have an ‘‘N-demanding life style’’ because, regardless of whether they fix atmospheric N2, leaf N concentrations were higher than that of nonlegumes (McKey 1994; Inagaki 2009).

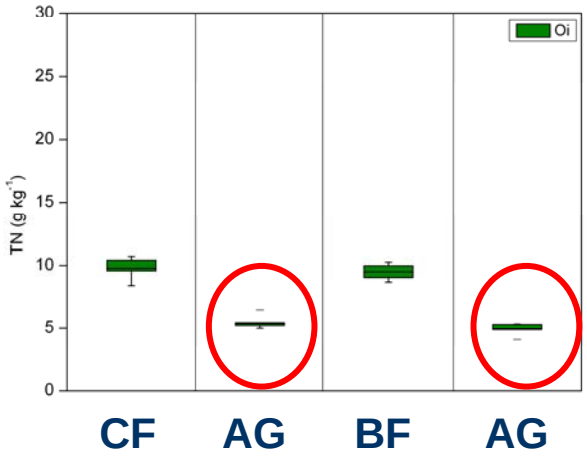


Tree species influences – nitrogen

forest floor



Baiyun



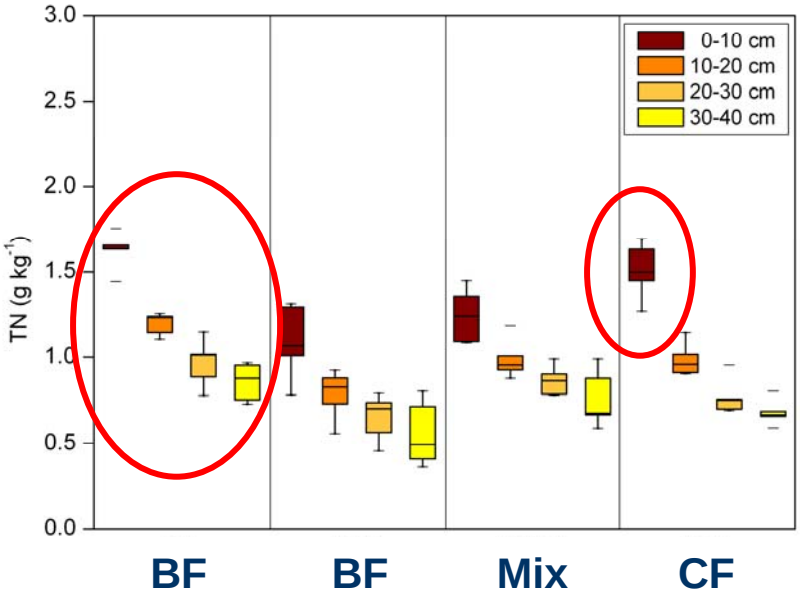
Fubo & Shaoping

Guangxi



Tree species influences – nitrogen

mineral soil



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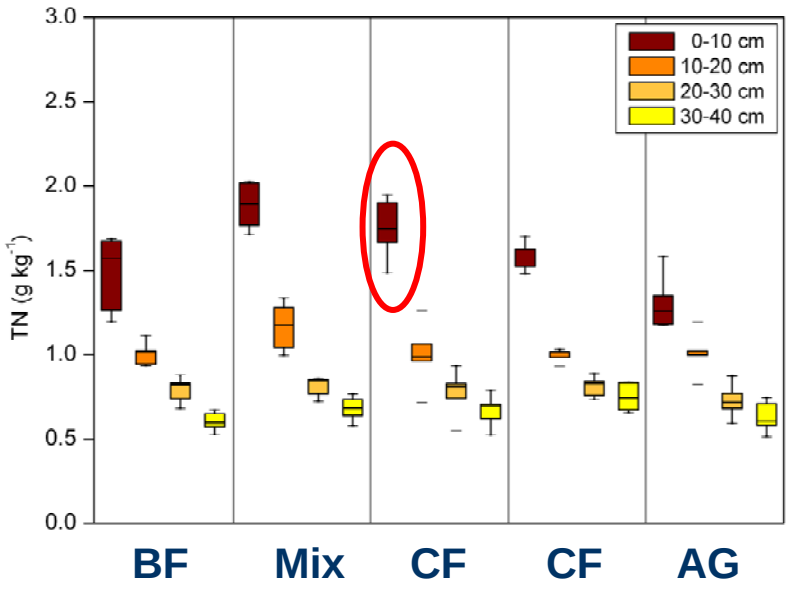
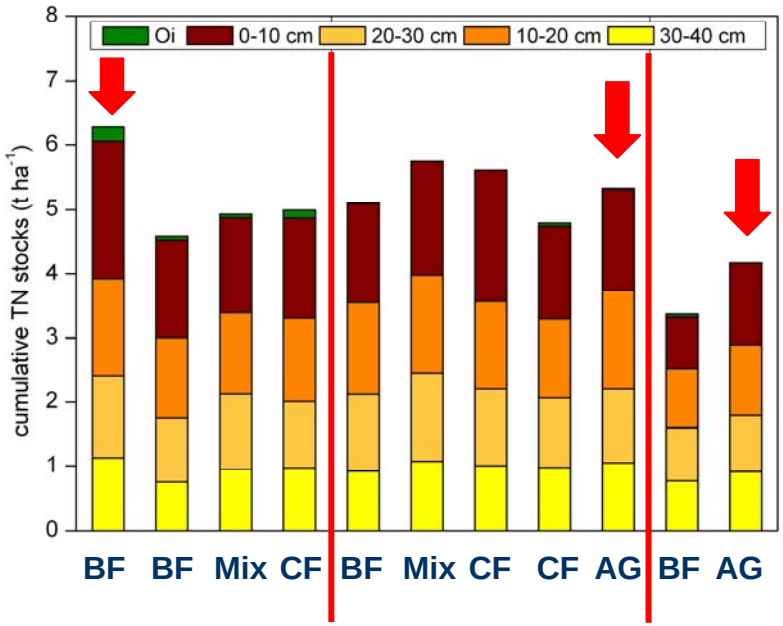


Fubo

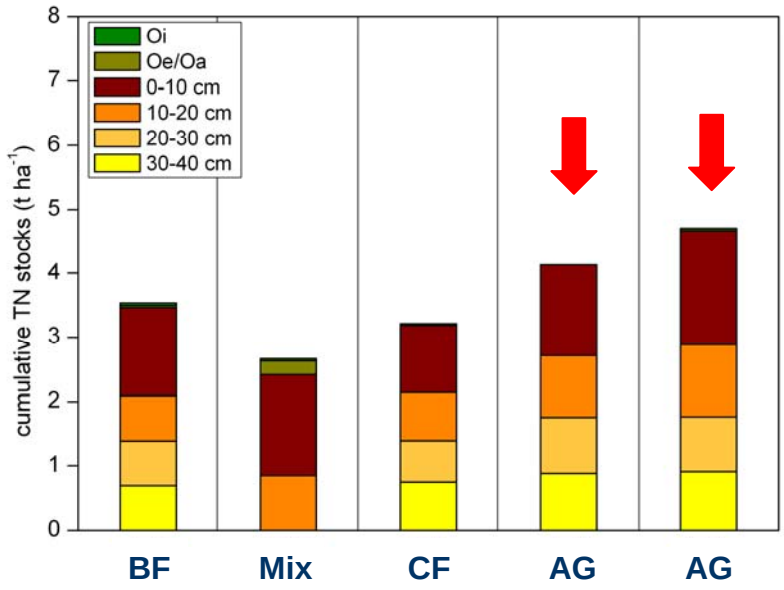
Tree species influences – nitrogen stocks



Baiyun

Fubo

Shao-ping



Ankang (Shaanxi)

Management influences on nutrients?



Management influences

Soil preparation

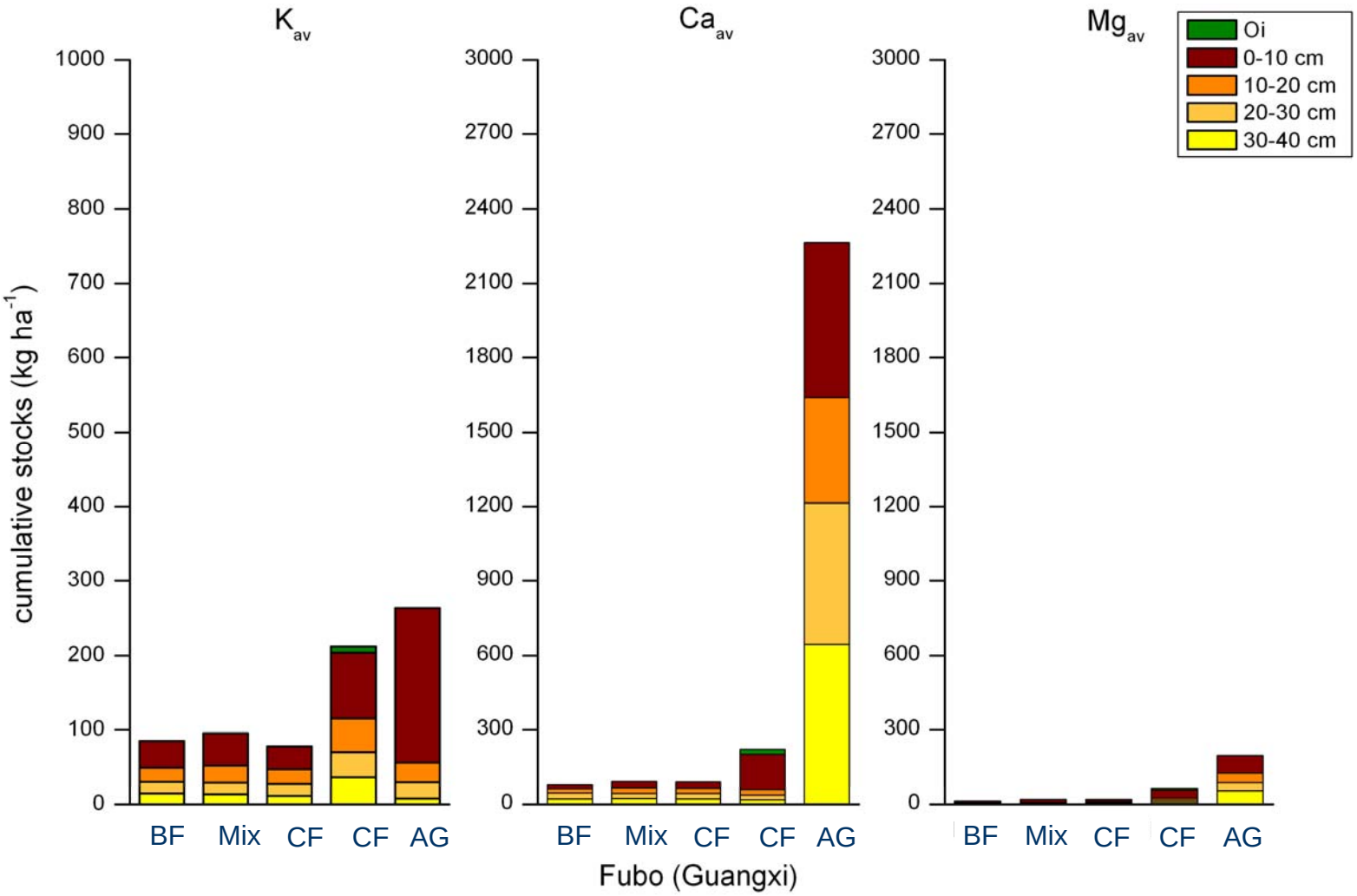
Fertilisation

Undergrowth removal

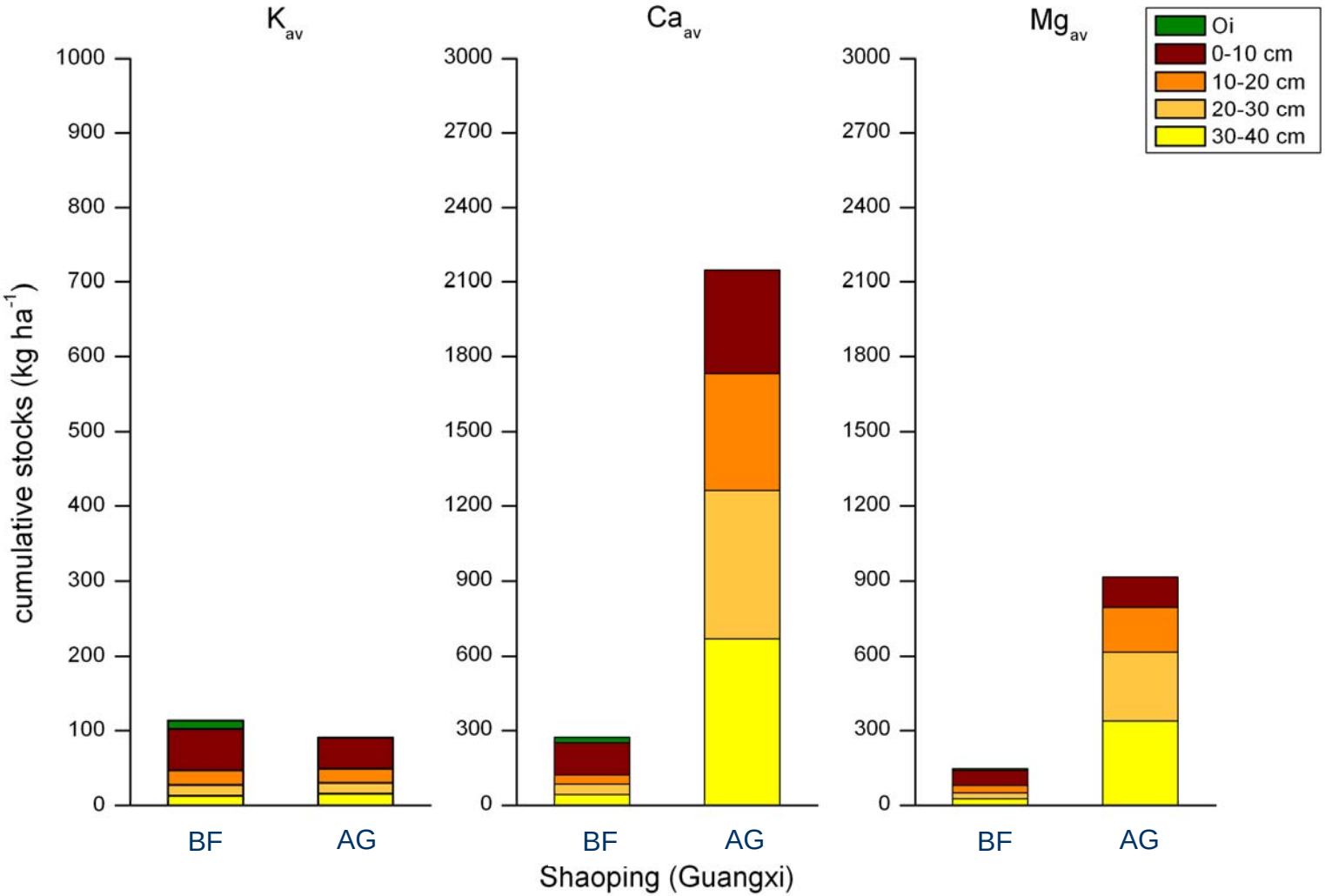
Thinning

Harvesting

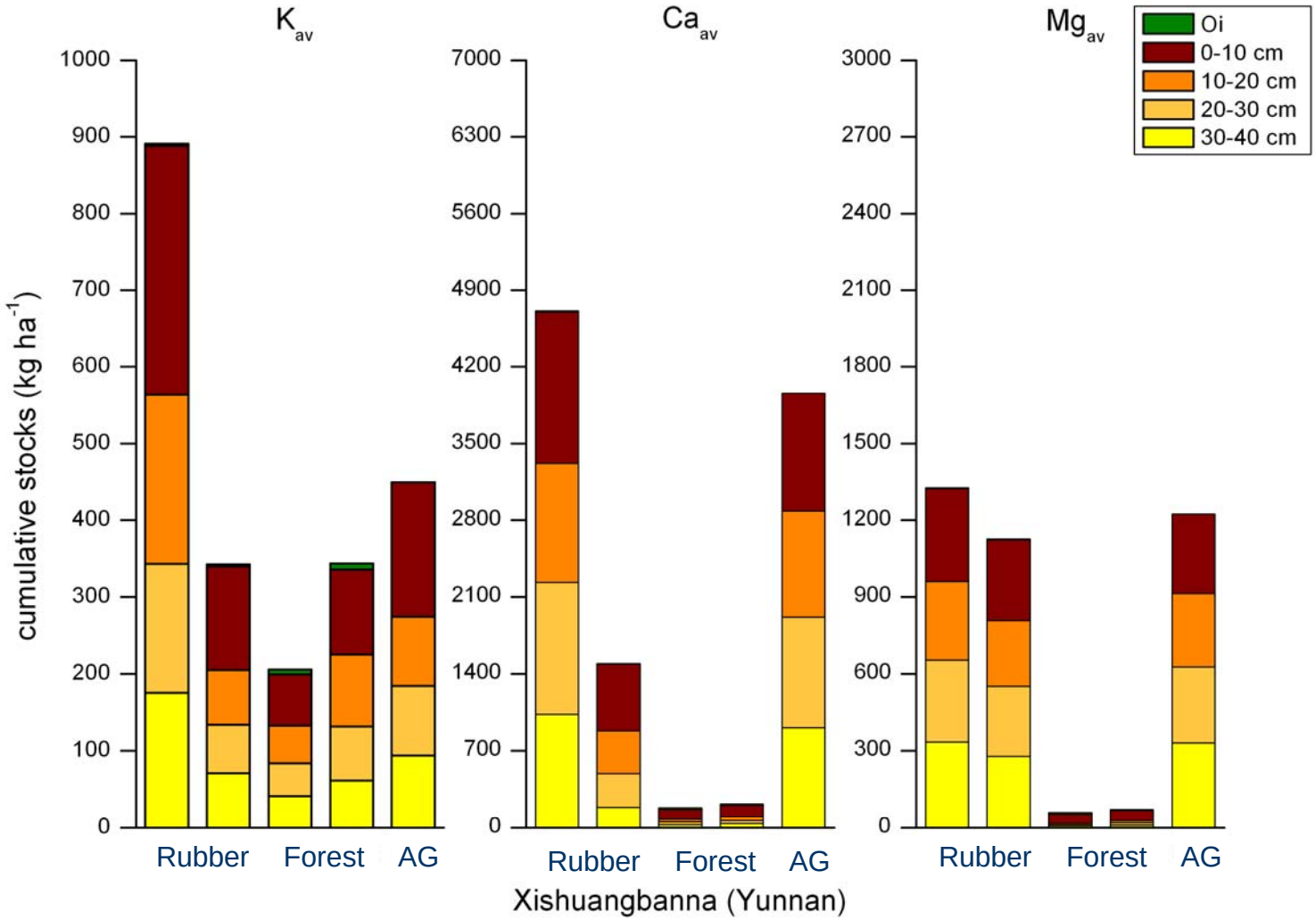
Management influences - fertilisation



Management influences - fertilisation



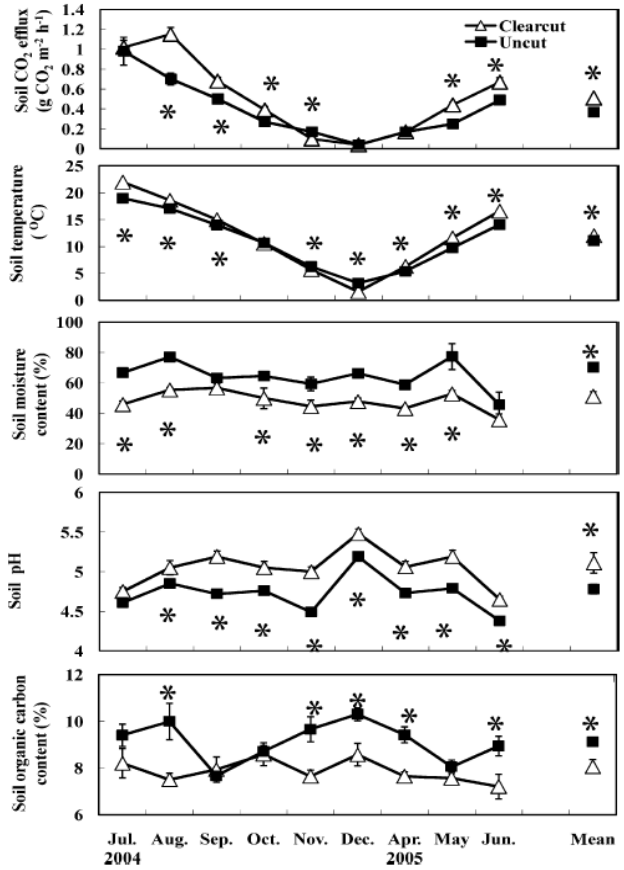
Management influences - fertilisation



Management influences - harvest

- Timber extraction with heavy machinery can increase the risk of **surface erosion** (Nussbaum et al., 1995; Woodward, 1996, Baharuddin et al., 1996, Malmer, 1996)
- Type of harvesting and site preparation methods employed (manual clearing alone, residue burning, tractor yarding), affect the magnitude and timing of soil loss (Sidle et al., 2006, good overview for Southeast Asia)
- Logging disturbance highly variable and site specific (Kreutzweiser et al. 2008)

Management influences - harvest



CO_2 efflux rates higher after clear cut

soil temperature higher after clear cut

soil moisture content lower after clear cut

soil pH higher after clear cut

soil organic C lower after clear cut

Kim, 2008 (Korea)

Management influences - harvest

- **Extraction of nutrients**

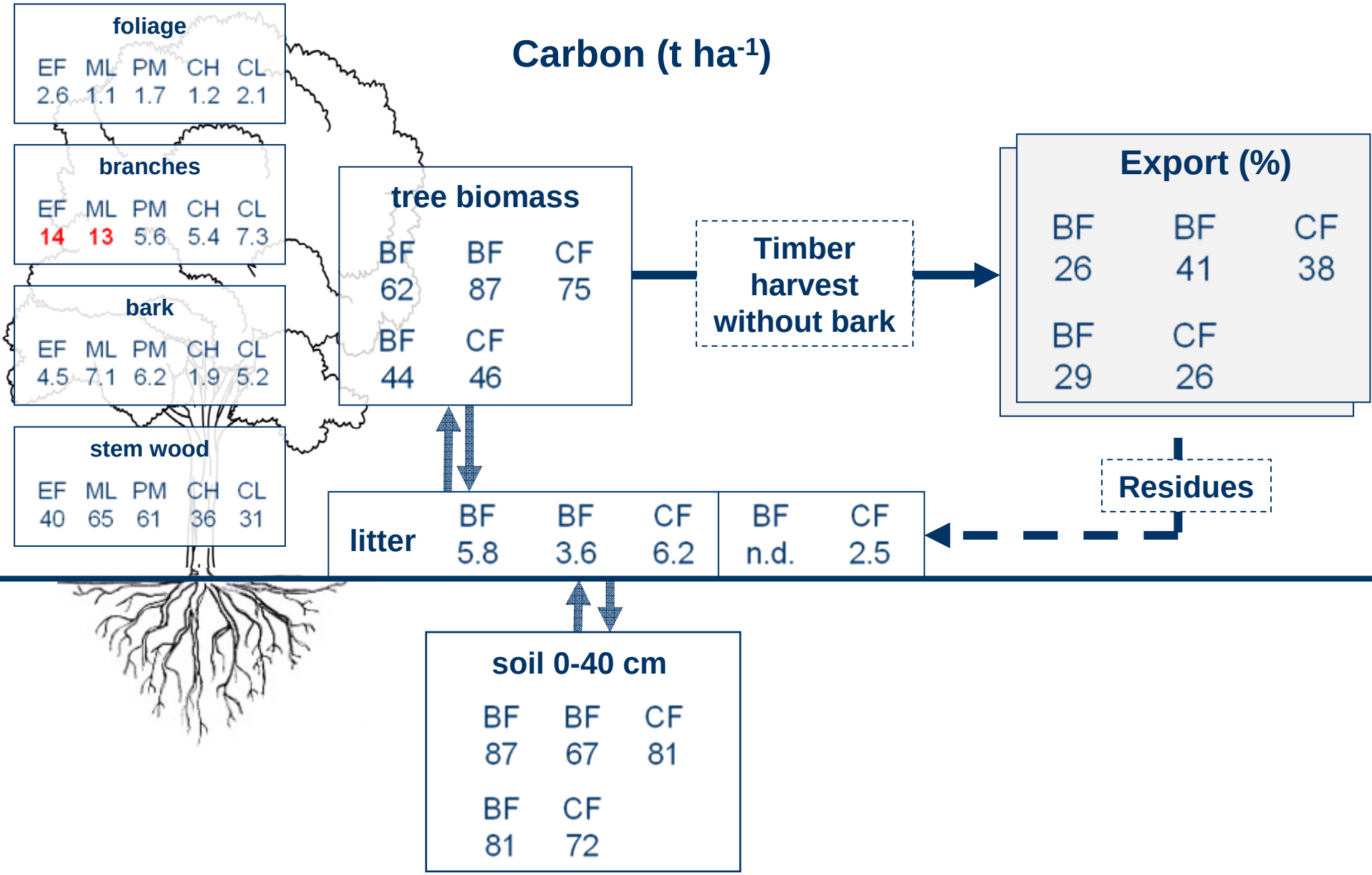
Yang et al., 2005 (Fujian):

113 t ha^{-1} C / 271 kg ha^{-1} N in stems with bark from **CF** = **44 / 3 %**

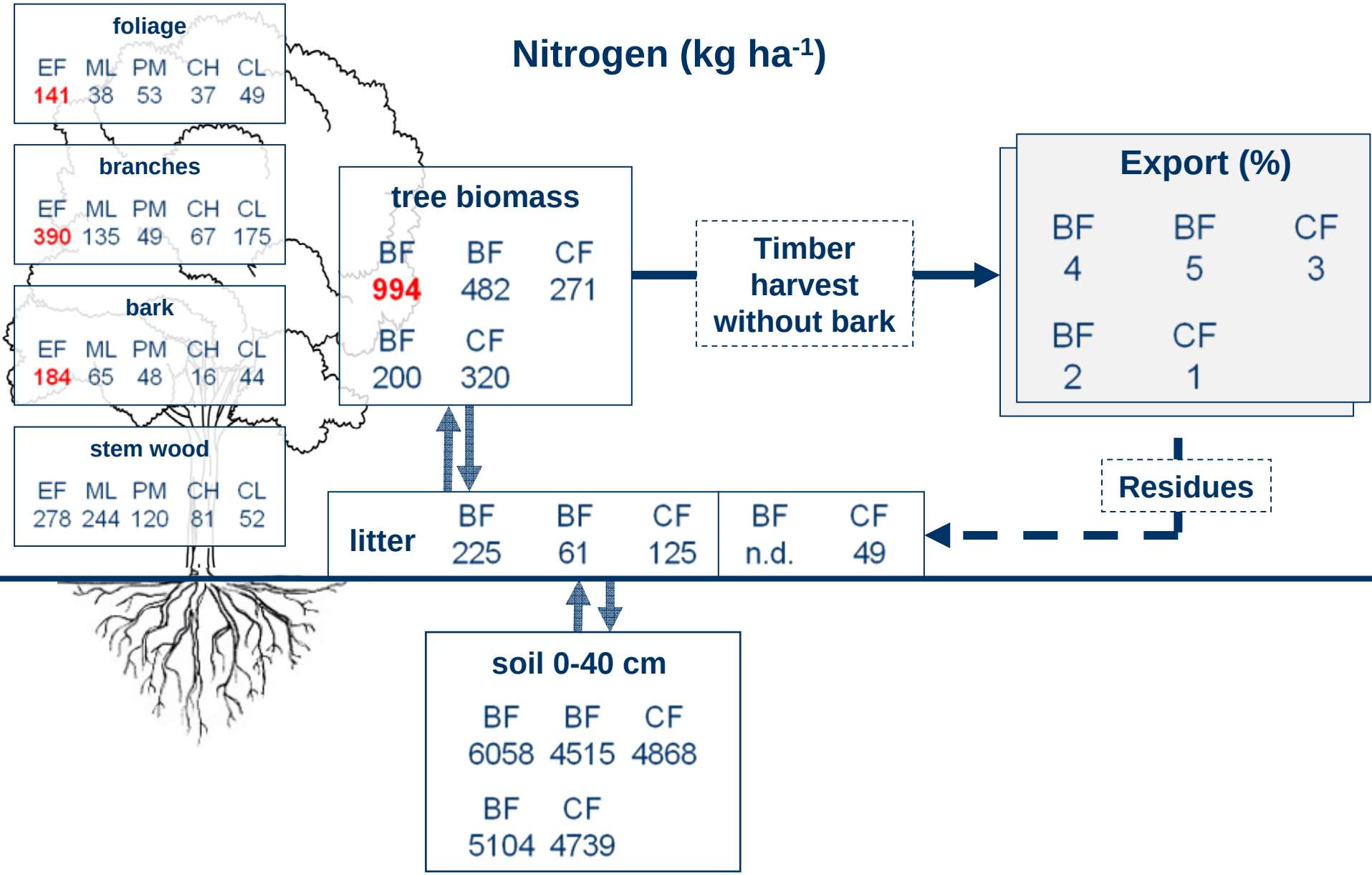
121 t ha^{-1} C / 370 kg ha^{-1} N in stems with bark from **BF** = **36 / 4 %**



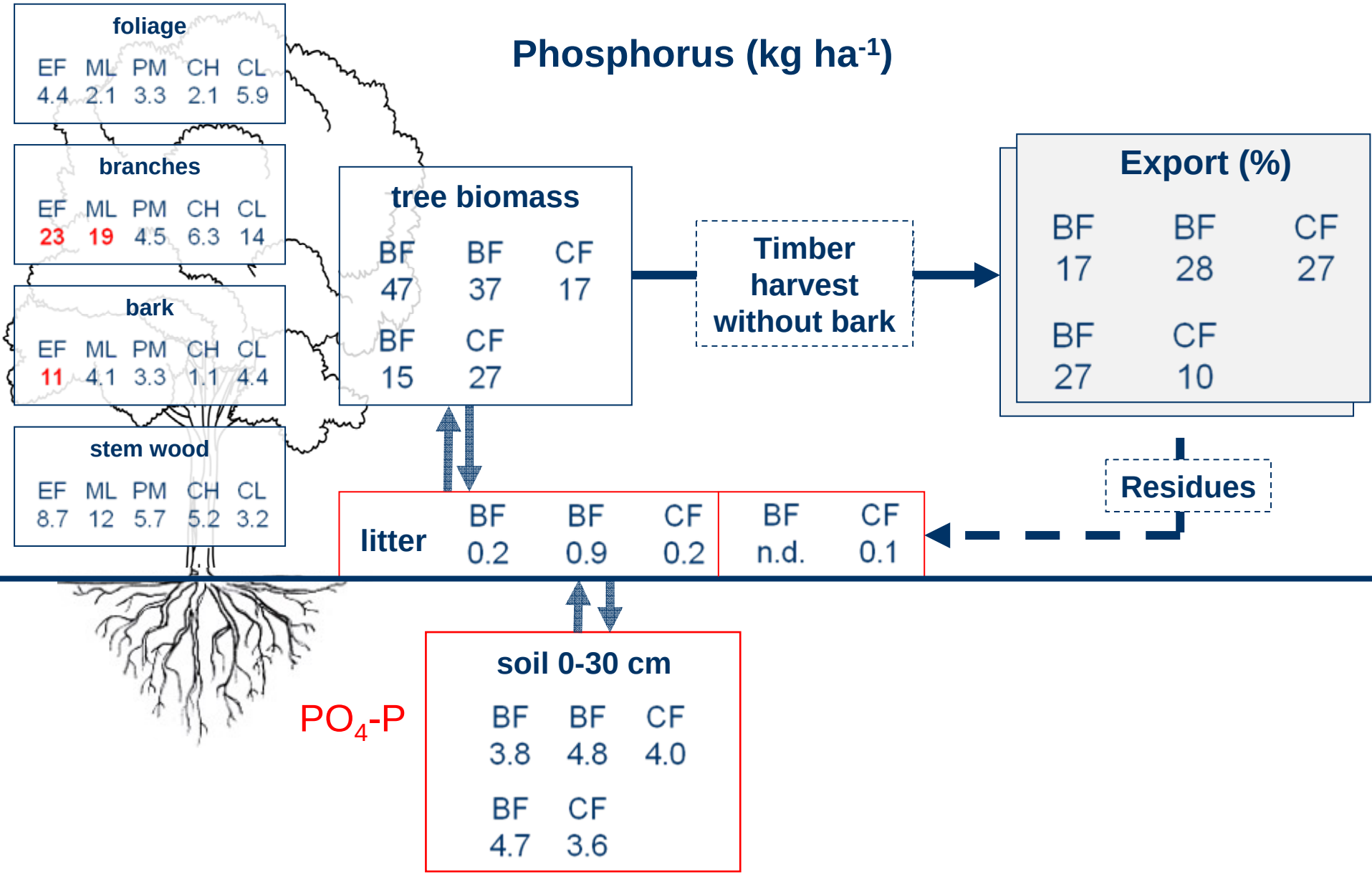
Carbon (t ha^{-1})


foliage
EF ML PM CH CL
2.6 1.1 1.7 1.2 2.1
branches
EF ML PM CH CL
14 13 5.6 5.4 7.3
bark
EF ML PM CH CL
4.5 7.1 6.2 1.9 5.2
stem wood
EF ML PM CH CL
40 65 61 36 31
tree biomass
BF BF CF
62 87 75
BF CF
44 46
Timber harvest without bark
Export (%)
BF BF CF
26 41 38
BF CF
29 26
Residues
litter
BF BF CF BF CF
5.8 3.6 6.2 n.d. 2.5
soil 0-40 cm
BF BF CF
87 67 81
BF CF
81 72

Nitrogen (kg ha^{-1})



Phosphorus (kg ha^{-1})



Soil fertility management

- Mixed plantations are favourable (complementary species)
- Adapted tree species
- Fertilisation should be adapted (P deficiencies)
- Adapted harvesting method



谢谢

Thank You!



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Tree species influences – carbon stocks