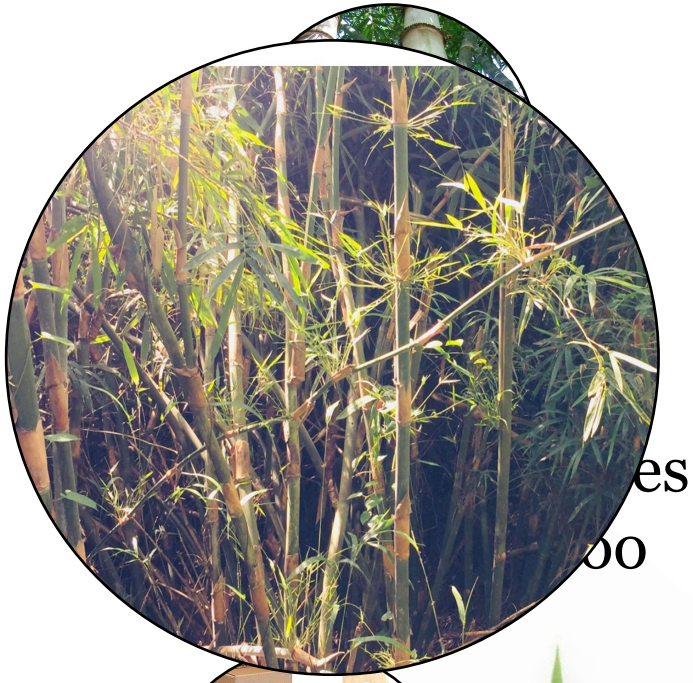
Potential Utilization of Climbing Bamboo Species in the Philippines

Elvina O. Bondad
Oliver S. Marasigan
Marina A. Alipon
Shereyl A. Daguinod

m
count



es
oo

Most of the bamboo species utilized in the Philippines were erect species

Fifth in number of plant species and maintains 5% of the world`s flora

Climbing bamboos lack information regarding their properties

100 bamboo species across 39,000–53,000 ha of plantation

3rd largest bamboo exporter in the world

BAGONG PILIPINAS

Objective of the study

To determine the possible end-uses of climbing bamboo in the Philippines based on their physical and mechanical properties

Methodology

Twelve species of climbing bamboo from seven provinces in Luzon Island, Philippines were sampled, with five mature culms aged 4–5 years collected per species, each segmented into bottom, middle, and top portions.

Species *Collected*

COMMON NAME	SCIENTIFIC NAME	COLLECTION SITE
Bolo	*Cyrtochloa fenixii*	Nueva Era, Ilocos Norte
Baitu	*Cyrtochloa hirsuta*	Brgy. San Pablo, Dinalupihan, Bataan
Luzon bikal	*Cyrtochloa luzonica*	Masinloc, Zambales
Bikal baboy	*Cyrtochloa major*	Brgy. San Pablo, Dinalupihan, Bataan
Puser	*Cyrtochloa puser*	Batiwtiw, Tayum, Abra
Bukawe	*Crytochloa toppingii*	Brgy. Aldea, Tanay, Rizal
Bagtok	*Cephalostachyum mindorense*	Brgy. Inhobol, Mamburao, Occidental Mindoro
Yaho	*Cephalostachyum mindorense*	Brgy. Inhobol, Mamburao, Occidental Mindoro
Bikal	*Dinochloa acutiflora*	Brgy. Tala, Rizal, Laguna
Tagisi	*Dinochloa dielsiana*	Masinloc, Zambales
Elmer bikal	*Dinochloa elmeri*	Masinloc, Zambales
Baguisan	*Dinochloa pubiramea*	Batiwtiw, Tayum, Abra

Properties Determined

Physical Properties

Moisture Content
Relative Density

Shrinkage
Properties

Mechanical Properties

Static
Bending

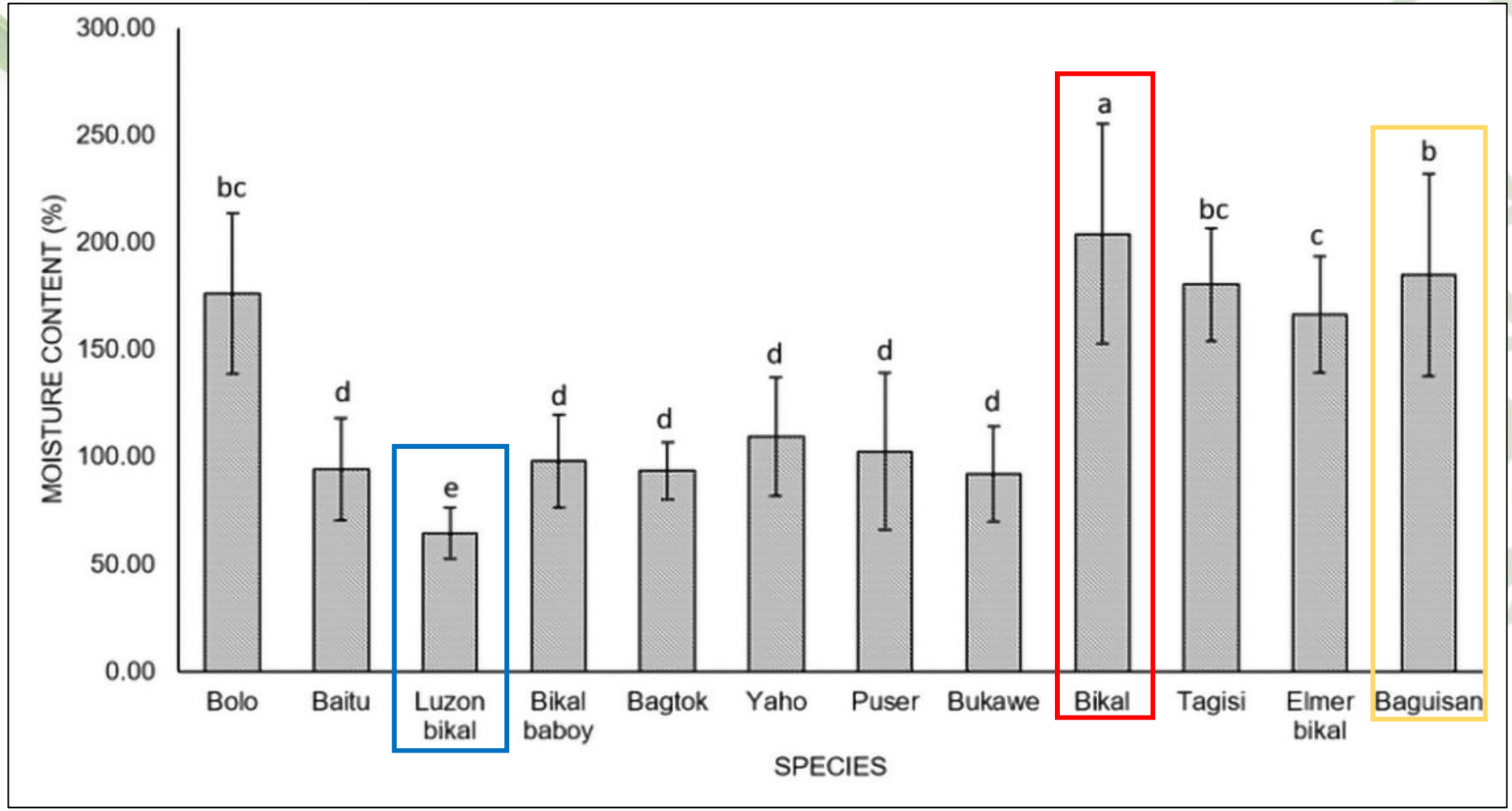
Compression
Shear strength

Statistical Analysis

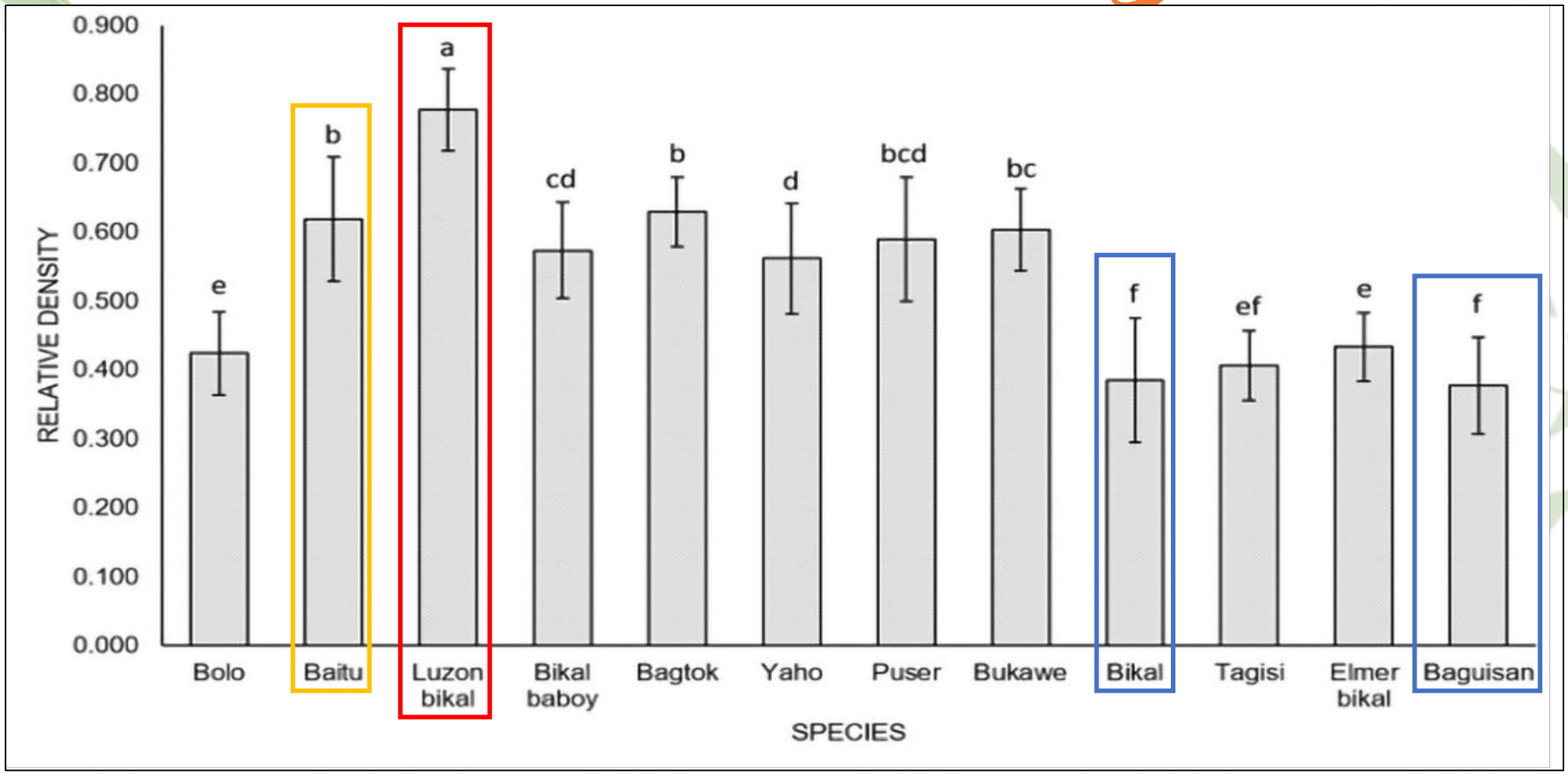
A two-factor factorial analysis of variance in a randomized complete block design was performed at a 95% confidence level. Further analysis was conducted using Tukey's honestly significant difference test.

Results *and* Discussion

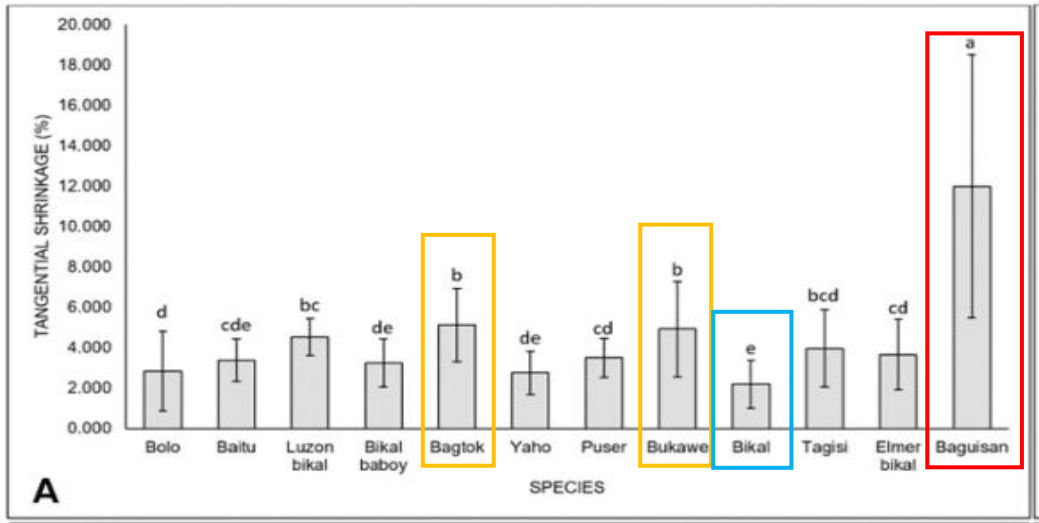
Moisture *Content*

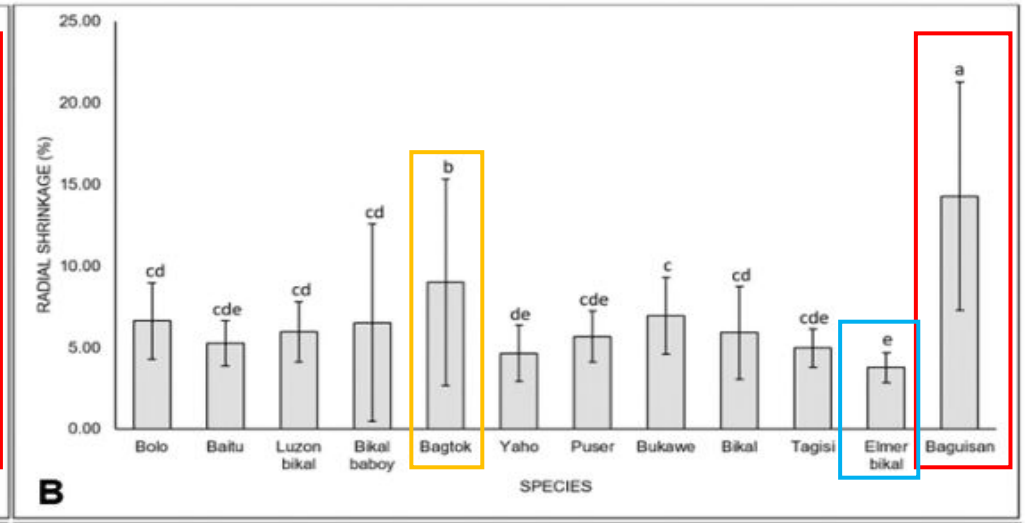


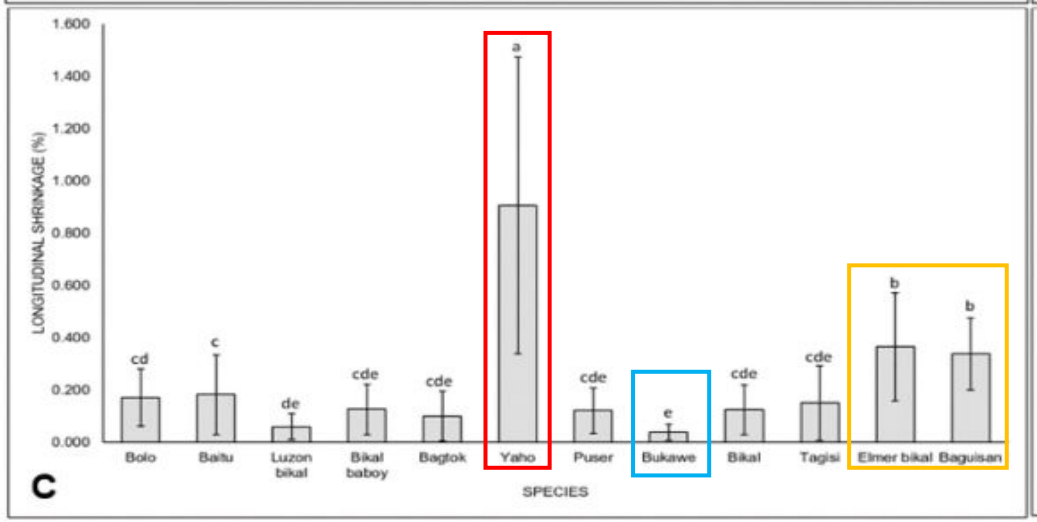
Relative *Density*

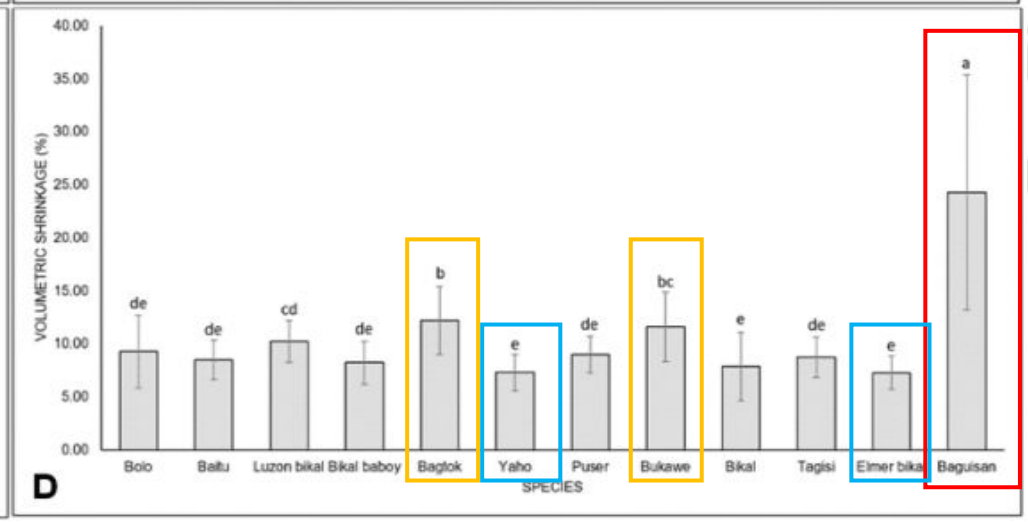


Shrinkage *Properties*









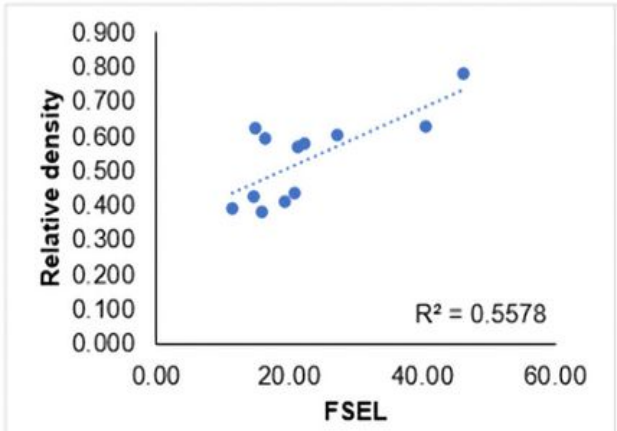
Mechanical Properties

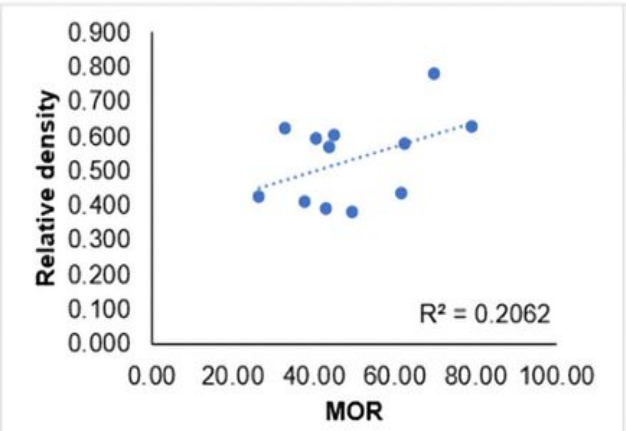
Mechanical properties		*Bolo*	*Baitu*	*Luzon bikal*	*Bikal baboy*	*Bagtok*	*Yaho*	*Puser*	*Bukawe*	*Bikal*	*Tagisi*	*Elmer bikal*	*Baguisan*
Static bending	FSEL (MPa)	14.71^{gh}	15.20^{fgh}	46.48^{a}	22.38^{cd}	40.69^{b}	21.57^{de}	16.32^{efgh}	27.42^{c}	11.54^{h}	19.72^{defg}	20.69^{def}	16.22^{efgh}
	MOR (MPa)	26.64^{g}	33.40^{fg}	70.07^{b}	62.52^{bc}	79.05^{a}	44.30^{de}	40.97^{def}	45.01^{de}	43.07^{de}	37.86^{ef}	61.69^{c}	49.64^{d}
	MOE (GPa)	4.69^{de}	8.31^{b}	11.50^{a}	11.12^{a}	11.36^{a}	8.56^{b}	8.21^{b}	7.45^{bc}	4.02^{e}	3.85^{e}	5.97^{cd}	5.70^{cde}
Compression parallel-to-grain (MPa)	With node	22.81^{e}	35.59^{cd}	56.11^{a}	36.88^{bcd}	42.66^{b}	31.19^{d}	39.09^{bc}	34.95^{cd}	16.90^{f}	15.99^{f}	25.27^{e}	15.11^{f}
	Without node	20.69^{f}	33.13^{d}	58.52^{a}	39.46^{bc}	44.60^{b}	30.81^{de}	40.91^{bc}	36.34^{cd}	20.31^{f}	15.86^{fg}	27.20^{e}	13.82^{g}
Shear strength (MPa)	With node	8.72^{cd}	10.16^{bc}	9.93^{bc}	7.76^{de}	13.22^{a}	9.35^{c}	10.94^{b}	10.29^{bc}	5.07^{f}	6.90^{e}	7.51^{de}	1.62^{g}
	Without node	6.29^{cde}	7.53^{abc}	6.08^{de}	6.55^{cde}	8.68^{a}	7.44^{bc}	7.19^{bcd}	8.35^{ab}	5.40^{e}	5.40^{e}	6.35^{cde}	1.79^{f}

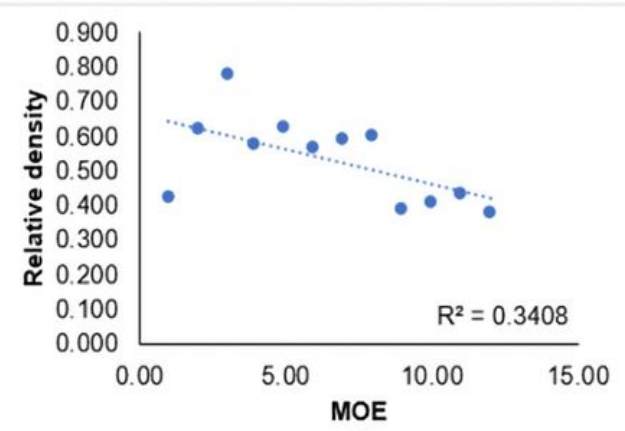
Note: means with the same letter are not significantly different (a, g – highest, lowest value).

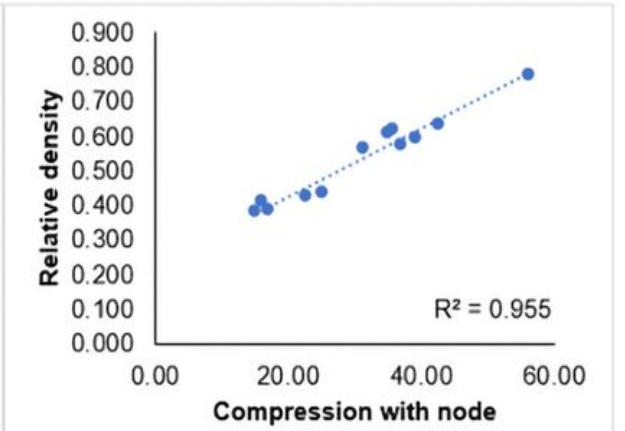
Relationship of

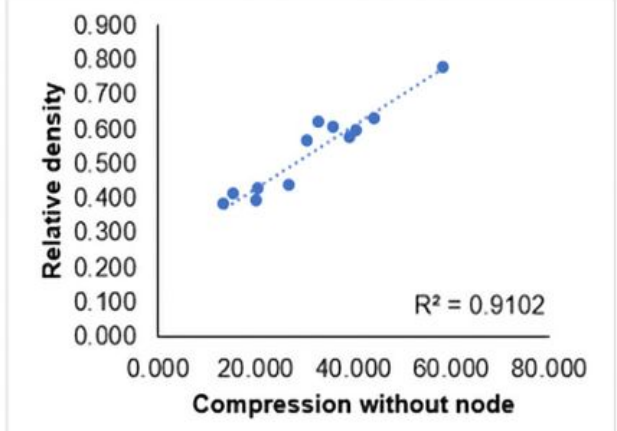
Relative Density & Mechanical Properties

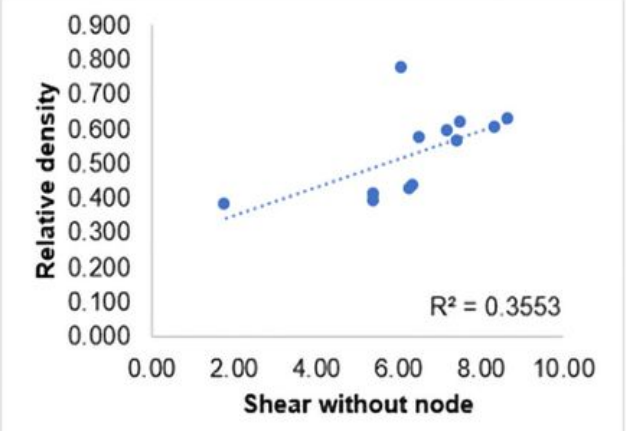


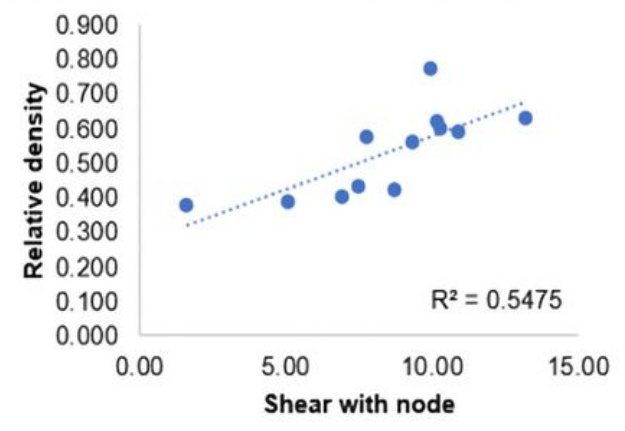












Physical Properties

Along the height levels

Physical properties	Height levels	*Bolo*	*Baitu*	*Luzon bikal*	*Bikal baboy*	*Bagtok*	*Yaho*	*Puser*	*Bukawe*	*Bikal*	*Tagisi*	*Elmer bikal*	*Baguisan*
Moisture content (%)	Bottom	191.10^{a}	103.88^{a}	69.50^{a}	100.29^{a}	88.39^{a}	122.51^{a}	122.13^{a}	93.40^{a}	219.18^{a}	167.80^{a}	165.43^{a}	205.21^{a}
	Middle	171.20^{a}	93.90^{a}	67.60^{a}	103.26^{a}	91.73^{a}	104.73^{a}	97.92^{a}	89.50^{a}	198.91^{a}	185.68^{a}	167.36^{a}	188.49^{a}
	Top	165.80^{a}	87.98^{a}	55.70^{b}	94.68^{a}	100.09^{a}	100.84^{a}	87.42^{a}	93.00^{a}	193.40^{a}	187.05^{a}	166.14^{a}	160.83^{a}
Relative density	Bottom	0.39^{a}	0.58^{a}	0.78^{a}	0.57^{a}	0.64^{a}	0.53^{a}	0.54^{a}	0.61^{a}	0.36^{a}	0.43^{a}	0.44^{a}	0.36^{a}
	Middle	0.43^{a}	0.52^{a}	0.76^{a}	0.56^{a}	0.64^{a}	0.58^{a}	0.60^{b}	0.61^{a}	0.39^{a}	0.40^{a}	0.43^{a}	0.37^{a}
	Top	0.45^{a}	0.66^{a}	0.78^{a}	0.58^{a}	0.61^{a}	0.58^{a}	0.63^{b}	0.59^{a}	0.40^{a}	0.39^{a}	0.44^{a}	0.41^{a}
Tangential shrinkage (%)	Bottom	3.51^{a}	4.03^{a}	4.65^{a}	3.30^{a}	5.66^{a}	2.65^{a}	3.78^{a}	6.19^{a}	2.90^{a}	3.80^{a}	3.27^{a}	16.13^{a}
	Middle	3.44^{a}	3.40^{ab}	4.28^{a}	3.01^{a}	4.60^{a}	3.03^{a}	3.45^{a}	4.79^{a}	2.01^{a}	3.93^{a}	3.25^{a}	11.87^{ab}
	Top	1.55^{a}	2.74^{b}	4.61^{a}	3.30^{a}	5.13^{a}	2.59^{a}	3.27^{a}	3.81^{a}	1.70^{a}	4.17^{a}	4.48^{a}	7.99^{b}
Radial shrinkage (%)	Bottom	7.80^{a}	5.07^{a}	5.17^{a}	6.52^{a}	8.88^{a}	5.14^{a}	5.56^{ab}	7.41^{a}	6.18^{a}	5.39^{a}	3.99^{a}	17.59^{a}
	Middle	6.88^{ab}	5.60^{a}	6.15^{a}	8.07^{a}	11.79^{a}	4.29^{a}	4.90^{b}	7.30^{a}	5.63^{a}	4.64^{a}	3.30^{a}	15.75^{ab}
	Top	5.22^{b}	5.11^{a}	6.57^{a}	4.97^{a}	9.00^{b}	4.54^{a}	6.57^{a}	6.19^{a}	5.91^{a}	4.86^{a}	3.99^{a}	9.51^{b}
Longitudinal shrinkage (%)	Bottom	0.16^{a}	0.18^{a}	0.08^{a}	0.12^{a}	0.07^{a}	0.96^{a}	0.12^{a}	0.04^{a}	0.20^{a}	0.19^{a}	0.34^{a}	0.32^{a}
	Middle	0.20^{a}	0.12^{a}	0.02^{a}	0.13^{a}	0.13^{a}	1.10^{a}	0.15^{a}	0.03^{a}	0.09^{a}	0.10^{a}	0.32^{a}	0.37^{a}
	Top	0.15a	0.24a	0.07a	0.15a	0.10a	0.65a	0.09a	0.05a	0.08a	0.17a	0.43a	0.33a
Volumetric shrinkage (%)	Bottom	11.02a	9.18a	9.57a	8.86a	14.02a	7.65a	9.13a	13.16a	8.80a	8.98a	7.14ab	30.54a
	Middle	10.06a	9.07a	10.16a	7.64a	11.40a	7.19a	8.19a	11.80ab	7.29a	8.39a	6.44b	25.52ab
	Top	6.68b	7.12b	10.89a	8.11a	11.14a	7.02a	9.64a	9.76b	7.50a	8.84a	8.18a	16.68b

Note: means with the same letter are not significantly different (a, b – highest, lowest value).

Mechanical Properties

Along the height levels

Mechanical properties	Height levels	*Bolo*	*Baitu*	*Luzon bikal*	*Bikal baboy*	*Bagtok*	*Yaho*	*Puser*	*Bukawe*	*Bikal*	*Tagisi*	*Elmer bikal*	*Baguisan*
FSEL (MPa)	Bottom	15.71^{a}	19.13^{a}	51.97^{a}	22.34^{a}	46.98^{a}	25.78^{a}	22.47^{a}	30.11^{a}	13.02^{a}	21.51^{a}	21.60^{a}	14.93^{a}
	Middle	14.30^{a}	12.60^{b}	44.43^{b}	21.18^{a}	43.71^{a}	19.19^{a}	16.03^{a}	25.83^{a}	9.45^{a}	18.20^{a}	19.32^{a}	15.19^{a}
	Top	14.12^{a}	13.98^{b}	43.04^{b}	23.64^{a}	31.39^{a}	19.77^{a}	10.47^{a}	26.62^{a}	12.16^{a}	19.48^{a}	21.16^{a}	18.56^{a}
MOR (MPa)	Bottom	30.40^{a}	39.38^{a}	83.91^{a}	69.58^{a}	97.09^{a}	60.08^{a}	49.74^{a}	56.42^{a}	50.75^{a}	39.70^{a}	62.88^{a}	45.63^{a}
	Middle	26.19^{a}	30.79^{a}	63.87^{b}	59.90^{a}	80.93^{a}	35.53^{b}	33.81^{a}	39.68^{b}	38.47^{a}	36.32^{a}	60.20^{a}	49.82^{a}
	Top	23.35^{a}	30.04^{a}	62.43^{b}	58.08^{a}	59.15^{b}	37.30^{b}	39.37^{a}	38.94^{b}	40.01^{a}	37.58^{a}	62.01^{a}	53.47^{a}
MOE (GPa)	Bottom	4.94^{a}	8.04^{a}	11.90^{a}	14.06^{a}	12.69^{a}	9.94^{a}	8.49^{a}	7.81^{a}	3.75^{a}	3.92^{a}	5.87^{a}	4.47^{b}
	Middle	5.04^{a}	8.94^{a}	11.85^{a}	10.15^{a}	12.10^{a}	7.70^{a}	8.04^{a}	6.88^{a}	4.14^{a}	3.70^{a}	6.07^{a}	5.55^{b}
	Top	4.09^{a}	7.98^{a}	10.76^{a}	9.18^{a}	9.31^{a}	8.05^{a}	8.11^{a}	7.68^{a}	4.18^{a}	3.95^{a}	5.98^{a}	7.06^{b}

Note: means with the same letter are not significantly different (a, b – highest, lowest value).

Mechanical Properties

Along the height levels

Mechanical properties	Height levels	*Bolo*	*Baitu*	*Luzon bikal*	*Bikal baboy*	*Bagtok*	*Yaho*	*Puser*	*Bukawe*	*Bikal*	*Tagisi*	*Elmer bikal*	*Baguisan*
Compression parallel-to-grain (with node) (MPa)	Bottom	22.45^{a}	36.17^{a}	52.15^{a}	41.07^{a}	43.48^{a}	31.42^{a}	38.48^{a}	37.01^{a}	16.33^{a}	16.56^{a}	24.51^{a}	12.39^{b}
	Middle	26.35^{a}	35.13^{a}	57.72^{a}	35.97^{a}	47.92^{a}	29.72^{a}	42.42^{a}	35.45^{a}	17.34^{a}	16.17^{a}	24.74^{a}	15.34^{ab}
	Top	19.65^{a}	35.47^{a}	58.47^{a}	33.61^{a}	36.58^{a}	32.44^{a}	36.39^{a}	32.39^{a}	17.05^{a}	15.26^{a}	26.56^{a}	17.62^{a}
Compression parallel-to-grain (without node)	Bottom	18.70^{a}	26.79^{b}	54.54^{b}	42.35^{a}	46.87^{a}	29.09^{b}	38.27^{b}	34.46^{a}	18.49^{a}	15.28^{a}	24.63^{a}	12.32^{a}
	Middle	20.94^{a}	34.95^{a}	50.78^{b}	37.59^{a}	44.92^{a}	29.22^{b}	44.41^{a}	38.39^{a}	20.85^{a}	14.67^{a}	26.36^{a}	13.30^{a}
	Top	22.46^{a}	37.67^{a}	70.26^{a}	38.47^{a}	42.03^{a}	34.13^{a}	40.07^{b}	36.17^{a}	21.59^{a}	17.63^{a}	30.63^{a}	15.85^{a}
Shear strength (with node)	Bottom	7.94^{a}	10.56^{a}	9.40^{a}	7.95^{a}	12.19^{b}	9.29^{a}	12.50^{a}	10.17^{a}	4.90^{a}	7.49^{a}	7.89^{a}	1.75^{a}
	Middle	9.58^{a}	10.61^{a}	10.56^{a}	8.03^{a}	14.64^{a}	8.99^{a}	11.78^{a}	10.93^{a}	5.22^{a}	7.22^{a}	6.67^{a}	1.58^{a}
	Top	8.62^{a}	9.62^{a}	9.84^{a}	7.31^{a}	12.84^{ab}	9.79^{a}	8.55^{a}	9.79^{a}	5.09^{a}	6.02^{a}	7.99^{a}	1.56^{a}
Shear strength (without node)	Bottom	5.15^{a}	7.80^{a}	8.07^{a}	6.94^{a}	8.99^{a}	6.96^{a}	7.48^{a}	7.67^{a}	5.21^{a}	5.65^{a}	6.25^{a}	1.79^{a}
	Middle	7.14^{a}	7.99^{a}	5.37^{a}	6.21^{a}	8.56^{a}	7.62^{a}	8.04^{a}	8.78^{a}	5.46^{a}	5.75^{a}	6.23^{a}	1.83^{a}
	Top	6.59^{a}	6.81^{a}	4.81^{a}	6.52^{a}	8.48^{a}	7.76^{a}	6.05^{a}	8.62^{a}	5.54^{a}	4.81^{a}	6.58^{a}	1.78^{a}

Note: means with the same letter are not significantly different (a, b – highest, lowest value).

Potential *Applications*

STRENGTH CLASSIFICATION	COMMON NAME	SCIENTIFIC NAME	POTENTIAL USES
High Strength	Baitu	*Cyrtochloa hirsuta*	Suited for application where a large diameter is not required such as construction, high-grade furniture, and flooring where both strength and durability are required
	Luzon bikal	*Cyrtochloa luzonica*	
	Bikal baboy	*Cyrtochloa major*	
	Puser	*Cyrtochloa puser*	
	Bukawe	*Crytochloa toppingii*	
	Bagtok	*Cephalostachyum mindorense*	

Potential *Applications*

STRENGTH CLASSIFICATION	COMMON NAME	SCIENTIFIC NAME	POTENTIAL USES
Medium Strength	Bolo	*Cyrtochloa fenixii*	Suitable for high-grade furniture, paneling, and musical instruments
	Tagisi	*Dinochloa dielsiana*	
	Elmer bikal	*Dinochloa elmeri*	
Moderately low strength	Bikal	*Dinochloa acutiflora*	Suitable for pulp and paper, and low-grade furniture where strength is not of critical importance
	Baguisan	*Dinochloa pubiramea*	

Conclusion

The study suggests that the Philippine bamboo industry could utilize climbing bamboo as raw materials for various products.

Baitu, Luzon bikal, bikal baboy, bagtok, yaho, puser, and bukawe – potential alternatives for construction, high-grade furniture, and flooring, requiring strength and durability without large diameters.

Bolo, tagisi, and elmer bikal can be utilized for high-grade furniture, paneling, and musical instruments.

Bikal and baguisan are recommended to be used for pulp and paper and low-grade furniture

In utilizing this species, consideration of height levels is necessary.

Bamboohay!

Thank you very much.

Oliver S. Marasigan
Forest Products Research and Development Institute – Philippines
oliver.marasigan@fprdi.dost.gov.ph