Biomass generation and Carbon fixation in Guadua Bamboo: *Guadua angustifolia* Kunth

HORMILSON CRUZ RIOS

BACKGROUND OF THE INVESTIGATION

DATE: 1993 – 2001 = 22 years ago.

REASON: Quantify Biomass production to generate bio-energy
Quantify Carbon sink

COMMENTARIE: Little interest at that time.

PRESENT: CO2 – Biomass – Bio-energy: Important topics in the world

APPLICABILITY: Sustainable business: Environment + society + incomes

LOCATION OF MEXICO

UBICATION: North América

BAMBOOS: 36 native species
Many introduced

MEXICO: Bamboo is growing now in many aspects

BACKGROUND OF THE INVESTIGATION

COMPANY:
Agromod, S.A de C.V

INVESTIGATION AREA:
International Research Center For Tropical Agriculture.

CHARACTERISTICS OF *Guadua angustifolia* KUNTH

- Native from Colombia, Venezuela, Ecuador and Panamá

- Until now, the most important bamboo in América

- *Guadua angustifolia* was introduced to Mexico in 1992.

CHARACTERISTICS OF *Guadua angustifolia* KUNTH

- Tropical Bamboo

- *Giant bamboo*

- *11.57 cms in diameter*

- *19.67 ms lenght*

OBJECTIVE OF THE INVESTIGATION

Quantify in *Guadua angustifolia*:

1. Grow

2. Biomass production

3. Carbon secuestration in commercial plantations
   Different localities in Mexico during seven years in the field.

and

5. Relate the results with applications for conducting business in bio-renewable energies

ESTABLISHMENT OF THE INVESTIGATION

IN TWO COMMERCIAL PLANTATIONS THE RESEARCH WAS STABLISHED.

AREA: 1200 Ha. The biggest *Guadua angustifolia* plantation worldwide

1 Reforma, Chiapas.

- Commercial Plantation
- Fertilization: dynamic nutrients extraction
- Distance: 6m x 6m
- 3 repetition.
- Area of repetition: 20 Ha
- Clumps were marked to be removed
- Every year until year seven.

2 Tapachula, Chiapas.

- Commercial Plantation
- Fertilization: dynamic nutrients extractios
- Distance: 6m x 6m
- 2 repetition.
- Area of repetition: 20 Ha
- Clumps were marked to be removed
- Every year until year seven.

The results of Reforma as Tapachula were averaged to obtain final results

LOCATIONS OF THE INVESTIGATION

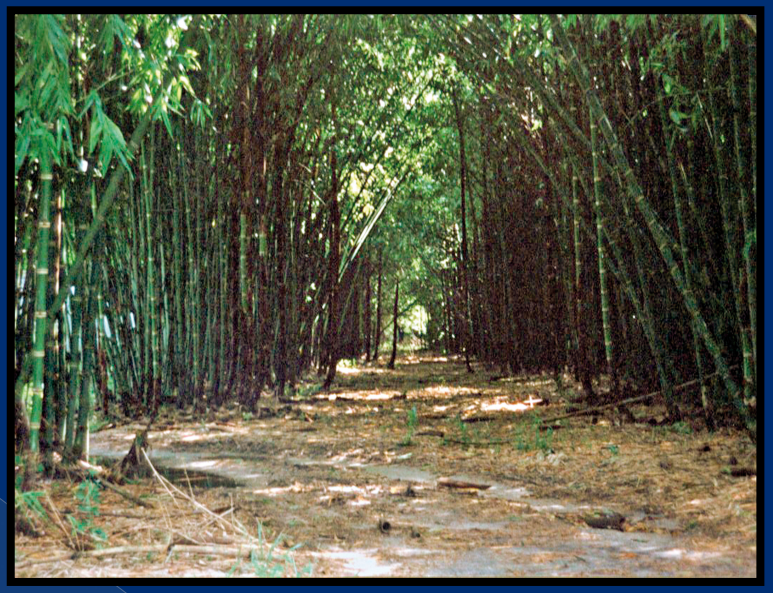
1 Reforma, Chiapas.

DISTANCE: 500 kM

2 Tapachula, Chiapas.

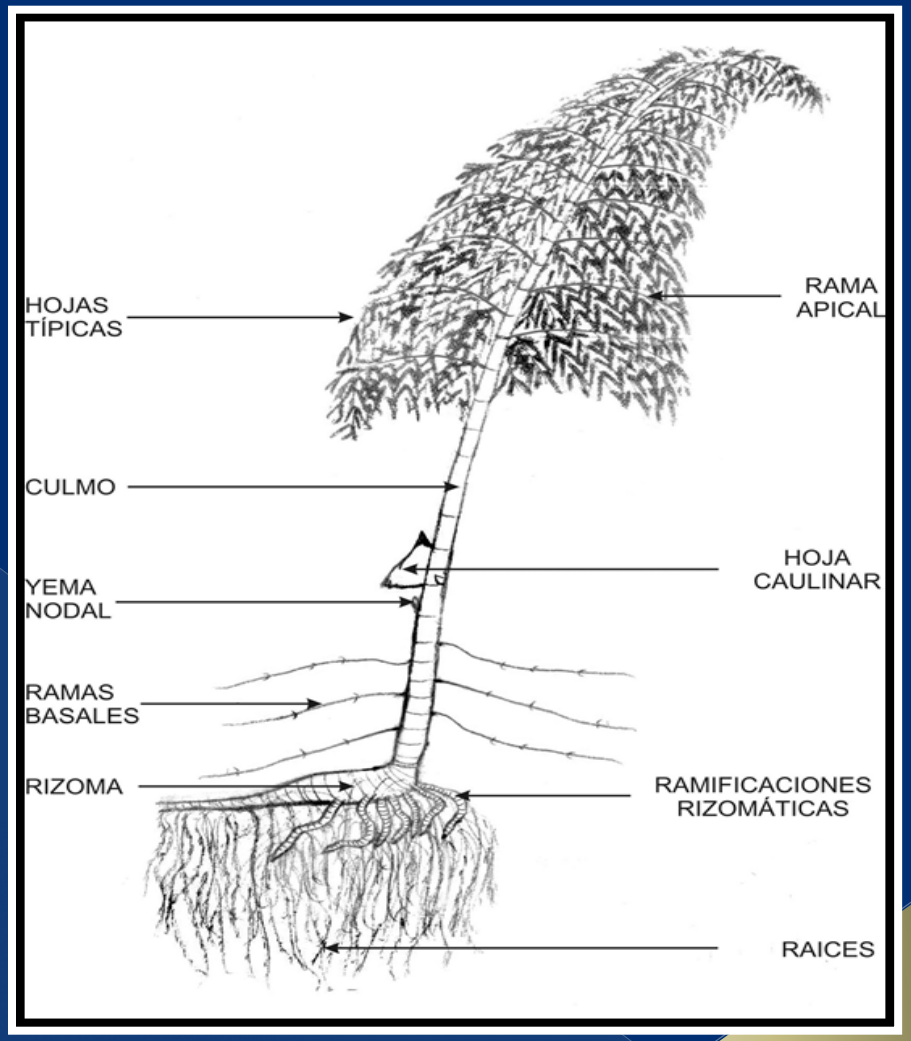
ESTABLISHMENT OF THE INVESTIGATION

AREA: 1200 Ha. The biggest *Guadua angustifolia* plantation worldwide



METODHOLOGY OF THE INVESTIGATION

CLUMP: Reunion of plants



BAMBOO PLANT: an individual component of the forest.

METODHOLOGY OF THE INVESTIGATION

FOR CALCULTING GROW OF THE CLUMPS.

1. In every marked clump, every year during seven years in the field was:

2. Counted and recorded the number of plants forming the clump

3. Registered the highest lenght of the culm

4. Registered the larger diameter of culm.

METODHOLOGY OF THE INVESTIGATION

FOR CALCULATING BIOMASS.

1. First year: clumps scored with 1 year old per repetition were pulled entirety out the soil.

2. The clumps were dismembered in plants and in every one of them were separated their organs.

3. Wet weight was recorded for roots, rhizomes, culms, cauline leaves, branches and typical leaves.

4. Then, was obtained the total wet weight per organ, plant, clump, and repetition.

5. Wet biomass was obtained in every repetition in Reforma and Tapachula and finally the average of biomass per year during seven years

METODHOLOGY OF THE INVESTIGATION

FOR CALCULATING CARBON SEQUESTRATION.

1. Wet weight was recorded for organs, plant and clump by repetition and locality

2. vegetative samples were gathered of each organ component.

3. These were taken to a laboratory. Dry weight by organ, plant, clump, repetition and locality was obtained.

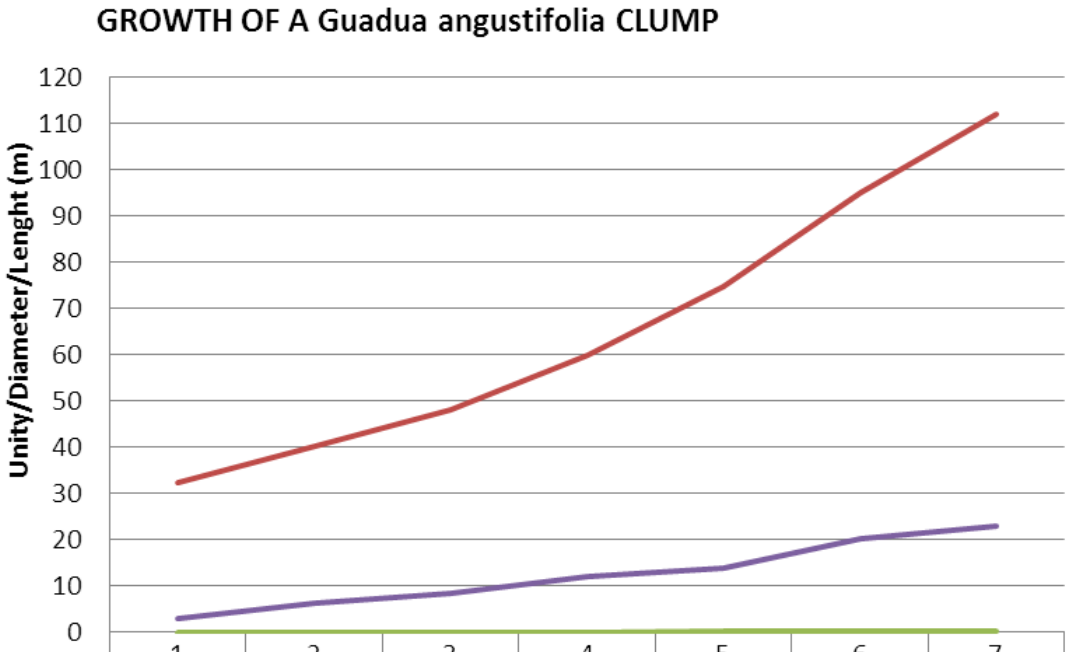
4. The wet samples were placed in an oven at 80 degrees Celsius and were weighed periodically until the weight was stabilized.

5. This final data is crucial to know the Carbon fixed by organ , plant and clump depending of the year of age.

6. This process was repeated every year until seven year old of the plantation

RESULTS AND DISCUSSIONS

GROW OF THE CLUMPS



	1	2	3	4	5	6	7
# Stems/Clump	32.4	40.1	48	60	74.6	95	111.9
Thickest diameter (m)	0.0192	0.036	0.0469	0.0702	0.0943	0.11	0.135
Greatest Length (m)	2.83	6.25	8.53	12.1	13.9	20.3	23

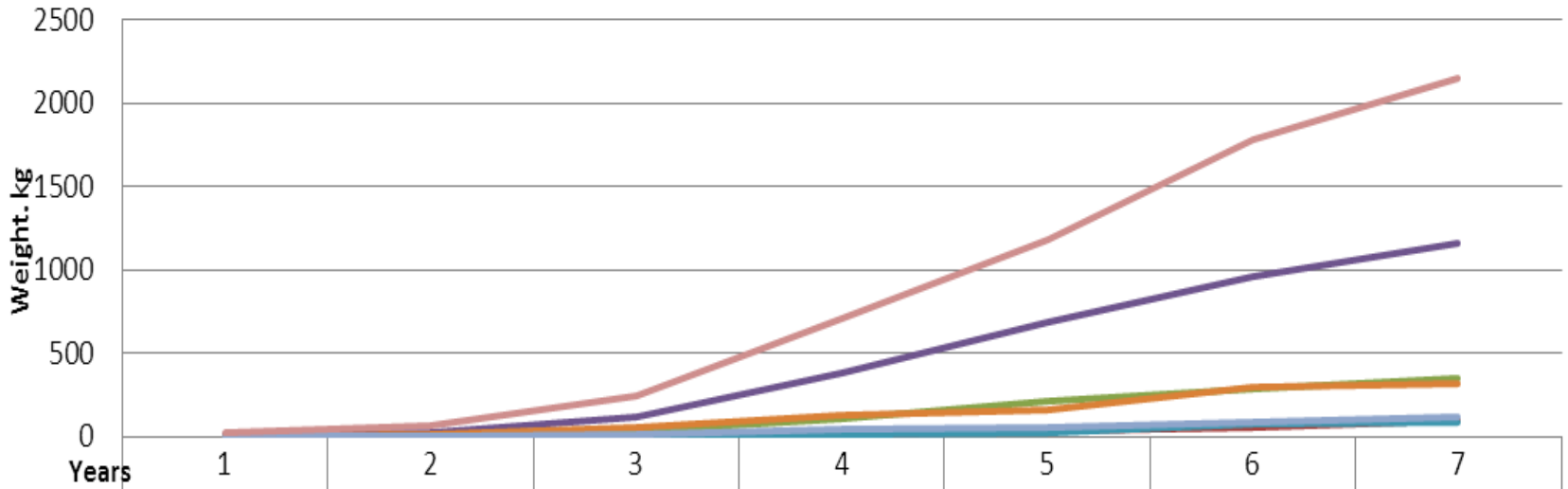
1. Stems: 111.9 stems /clump. 30,996 stems/ha with many different diameter classes.

2. Diameter: the 60% of the stems have less than 7 cm. Average 13.5 cms 7 years old

3. Length: start strong when it is 4 years old. Average 23.2 m 7 years old

RESULTS AND DISCUSSIONS

BIOMASS: average green weigh



Years	1	2	3	4	5	6	7
Roots	1.53	9.35	15.9	19.1	38.1	60.1	97
Rhizomes	3.98	7.3	33.9	114.2	216	293.4	350
Culms	10.9	30.5	125.5	383.3	688	959	1159.7
Cauline leaves	1.38	2.68	5.7	13.8	29.3	81	90
Branches	3.69	13.8	56.6	128.3	158.2	299.3	323.7
Typical leaves	1.08	4.13	13.9	47.4	56.2	92.9	125
Total/clump	22.56	67.76	251.5	706.1	1185.8	1785.7	2145.4

RESULTS AND DISCUSSIONS

BIOMASS: Average green weigh

POSITION	ORGAN	KG/CLUMP	TON/HA	%	% ACUMULATED
1	CULMS	1,160	322	54	54
2	RHIZOMES	350	97	16	70
3	BRANCHES	323	90	15	85
4	TYPICAL LEAVES	125	35	6	91
5	ROOTS	97	27	5	96
6	CAULINE LEAVES	90	25	4	100
TOTAL		**2,145**	**596**	**100**	

1. The culms contribute 54.06% of the total green weight.
2. Rhizomes at 16.3%.
3. Culms + rhizomes = 70.4% of the plant's total green weight
4. A clump produces wet biomass of 2145.4 kg by the end of the seventh year. 2.14 ton.
5. One ha under this investigation conditions produces 596tons/ha.
6. The average of wet biomass produced by year is 85 ton/ha .

RESULTS AND DISCUSSIONS

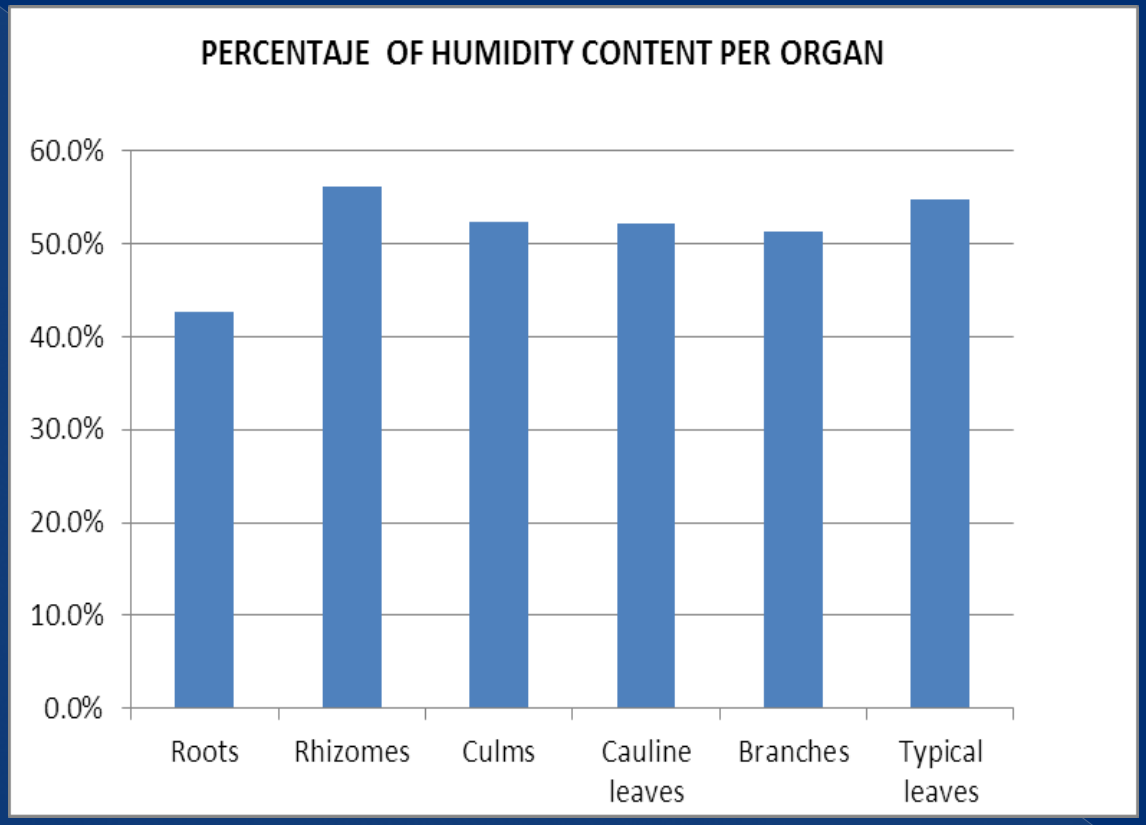
CARBON SEQUESTRATION: Humidity contains by organ

POSITION	ORGAN	%
1	RHIZOMES	56.1
2	TYPICAL LEAVES	54.7
3	CULMS	52.3
4	CAULINE LEAVES	52.2
5	BRANCHES	51.3
6	ROOTS	42.6

1. The humidity contains is necessary for getting dry matter or dry weigh

RESULTS AND DISCUSSIONS

CARBON SEQUESTRATION: Humidity contains by organ

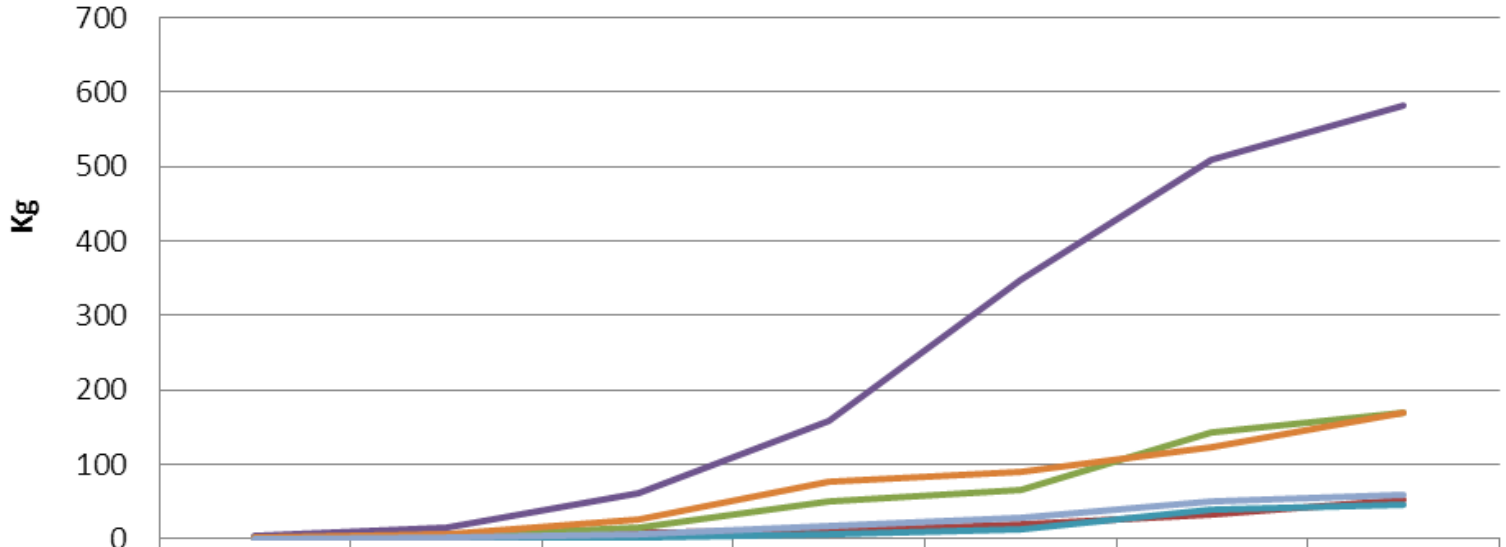


1. Rhizomes, 56.1% are the part of a plant with the highest contents of moisture.
2. Typical leaves have 54.7%.
3. Culms, 52.3%.
4. Cauline leaves, 52.2%.
5. Branches, 51.3%
6. Roots are the plant organs with the least amount of moisture. 42.6%.

RESULTS AND DISCUSSIONS

CARBON SEQUESTRATION: Dry matter per organ, plant, clump per year

CONTENTS OF DRY MATTER PER ORGAN AND YEAR. (Kg)



	1	2	3	4	5	6	7
Roots	1.07	5.13	9.01	11.1	20.1	32.8	53.5
Rhizomes	1.9	3.28	14.7	49.8	65.9	142.4	169.1
Culms	4.61	14.3	61.8	158.2	347.4	509.3	581.3
Caluline leaves	0.71	1.29	2.72	6.13	13.3	39.1	45.1
Branches	1.52	6.18	25.4	76.5	90.3	122.8	170.2
Typical leaves	0.44	1.82	6.13	17.7	27.7	50.5	59

RESULTS AND DISCUSSIONS

CARBON SEQUESTRATION: Dry matter per organ, plant, clump per year

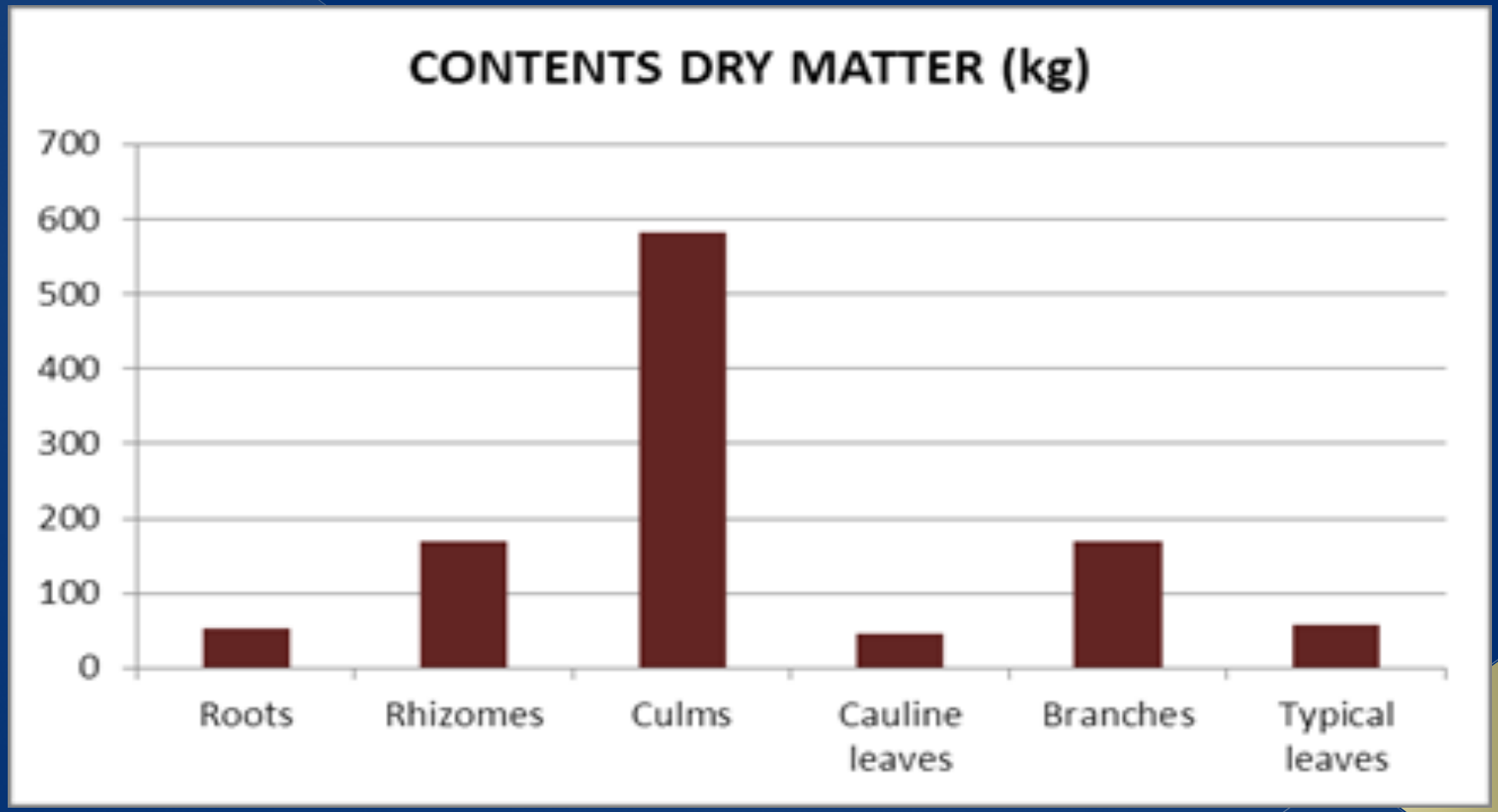
POSITION	ORGAN	KG/CLUMP	TON/HA	%	% ACUMULATED
1	CULMS	581.3	161.60	53.9	53.9
2	BRANCHES	170.2	47.32	15.8	69.7
3	RHIZOMES	169.1	47.01	15.7	85.4
4	TYPICAL LEAVES	59.0	16.40	5.5	90.9
5	ROOTS	53.5	14.87	5.0	95.8
6	CAULINE LEAVES	45.1	12.54	4.2	100.0
TOTAL		**1,078**	**299.74**	**100**	

1. One clump generates 1078.2 kg of weight or dry matter over a seven-year period.

2. The average is 154.0 kg of dry matter per clump/year considering seven years period.

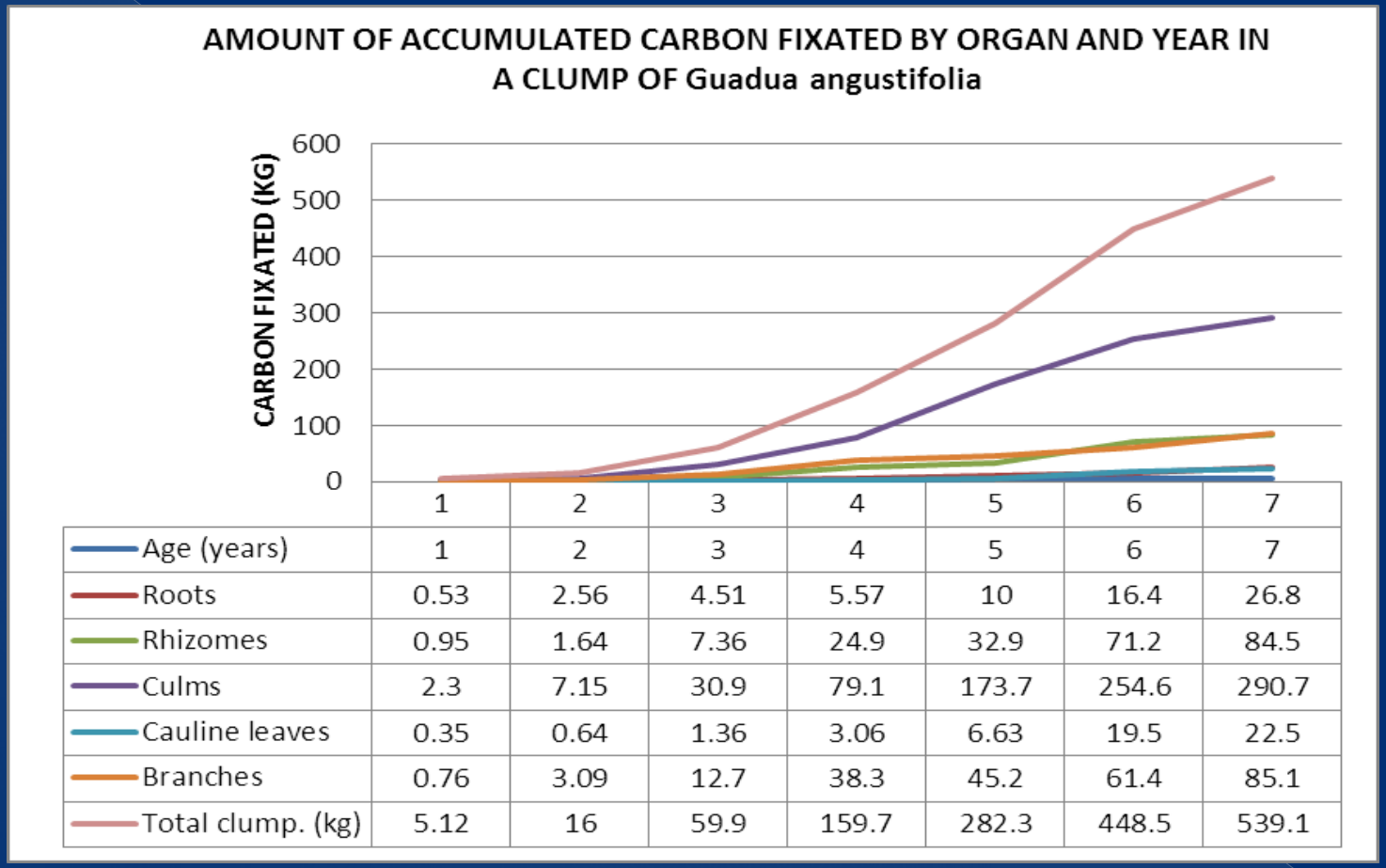
RESULTS AND DISCUSSIONS

CARBON SEQUESTRATION: Dry matter per organ, plant, clump per year



RESULTS AND DISCUSSIONS

CARBON SEQUESTRATION: Carbon fixated by organ, plant and clump



	1	2	3	4	5	6	7
Age (years)	1	2	3	4	5	6	7
Roots	0.53	2.56	4.51	5.57	10	16.4	26.8
Rhizomes	0.95	1.64	7.36	24.9	32.9	71.2	84.5
Culms	2.3	7.15	30.9	79.1	173.7	254.6	290.7
Cauline leaves	0.35	0.64	1.36	3.06	6.63	19.5	22.5
Branches	0.76	3.09	12.7	38.3	45.2	61.4	85.1
Total clump. (kg)	5.12	16	59.9	159.7	282.3	448.5	539.1

1. A clump fixates an accumulated total of 539.1 kg of Carbon by the end of year seven,.

2. The average for the year is of 77.01 kg of carbon per clump.

3. There is an accelerated increase in carbon fixation from the time of planting up to the fourth year of age,

RESULTS AND DISCUSSIONS

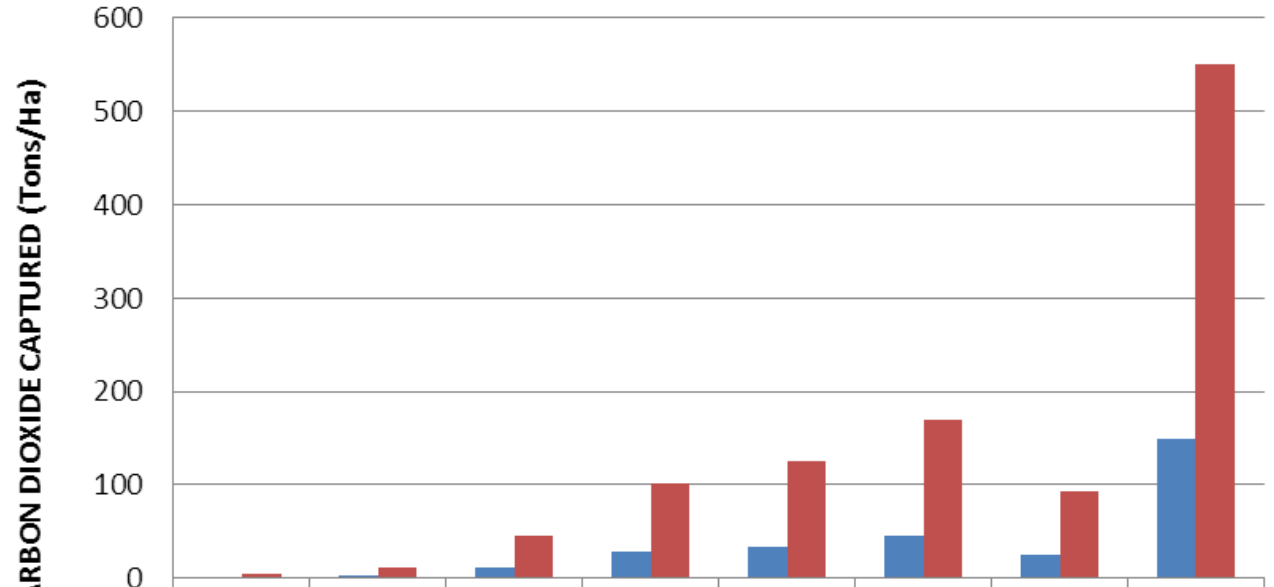
AMOUNT OF ACCUMULATED CARBON FIXATED BY ORGAN AND YEAR IN A PLANTATION OF Guadua angustifolia (Ton/Ha)								
DISTANCE: 6m x 6m.				**POPULATION DENSITY:** 278 clumps/ha				
AGE (years)	**ROOTS**	**RHIZOMES**	**CULMS**	**CAULINE LEAVES**	**BRANCHES**	**TYPICAL LEAVES**	**TOTAL TonC./Ha**	**Avg. acc./yr. in tonsC/ha**
1	0.15	0.26	0.64	0.1	0.21	0.06	**1.42**	**1.42**
2	0.71	0.46	1.99	0.18	0.86	0.25	**4.45**	**2.22**
3	1.25	2.05	8.6	0.38	3.53	0.85	**16.65**	**5.55**
4	1.55	6.92	21.98	0.85	10.64	2.46	**44.4**	**11.1**
5	2.79	9.16	48.29	1.84	12.56	3.85	**78.49**	**15.7**
6	4.56	19.8	70.79	5.43	17.07	7.02	**124.7**	**20.78**
7	7.44	23.5	80.81	6.27	23.66	8.2	**149.9**	**21.41**

1. This research indicates that by the seventh year the accumulated amount was 149.9 tonsC/ha,

2. Each hectare planted with Guadua angustifolia captures 21.41 tons C/year. In average.

RESULTS AND DISCUSSIONS

CARBON DIOXIDE CAPTURED ON A COMMERCIAL PLANTATION OF Guadua angustifolia Kunth



YEAR	1	2	3	4	5	6	7	TOTAL ACCUMULATED
TOTAL CARBON CAPTURED BY YEAR (Tons/Ha)	1.42	3.02	12.21	27.75	34.09	46.18	25.2	149.87
TOTAL CARBON DIOXIDE CAPTURED BY YEAR (Tons/Ha)	5.21	11.08	44.81	101.84	125.11	169.48	92.48	550.02

1. A commercial plantation of Guadua angustifolia will sequester 21.41 tons/C/ha/yr.,

2. Equivalent to 78.5 tons/CO2/ha/yr.

SUMMARY

1. GROW

1. **Culms:** 30996 /ha

2. **Diameter:** 13.5cm

3. **Lenght:** 23.20 m

2. BIOMASS

1. **Green weight:** 594.4 ton/ha

2. **Average:** 85.20 ton/ha/year

3. CARBON FIXATION

1. **C fixation:** 149.9 ton /ha

2. **Average:** 21.41 tonC/ha/year

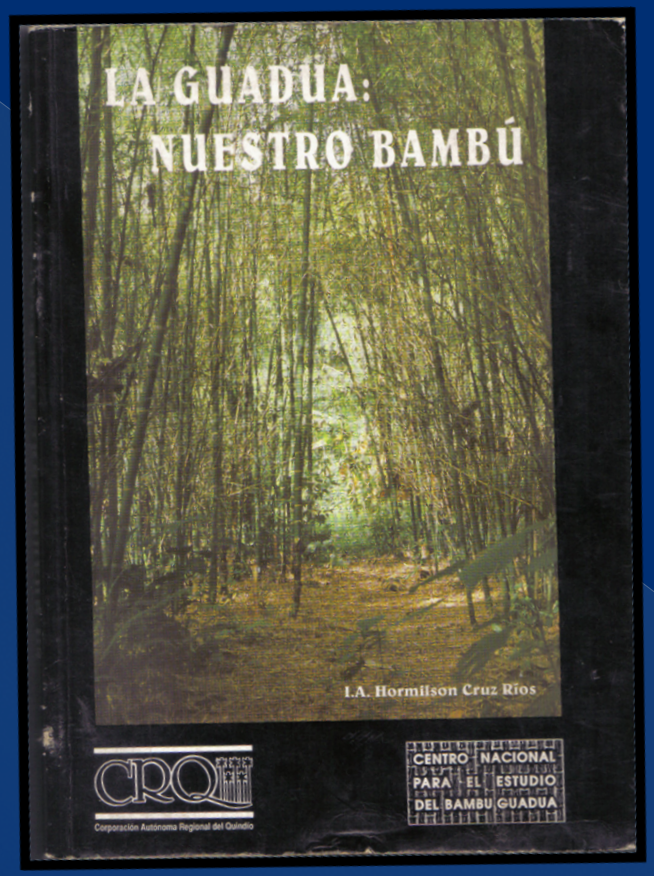
4. CO_2 CAPTURE

1. **CO_2 capture:**
78.5 tonCO2/ha/year

CONCLUSIONS

1- Now, Bamboo biomass is a good opportunity to do biorenewable projects.

2- We have two good dates about biomass production and Carbon Dioxide sequestration, but I do not what to do do, because , until now it has been impossible to sell at least one ton of CO2 in the carbon market.



HORMILSON CRUZ RIOS

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INVITATION

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Huatusco, Veracruz. 8 -12 de Marzo 2016.

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