YIELD MODELING FOR THE NATURAL STANDS OF KAWAYAN TINIK (*Bambusa blumeana* J.A. & J.H. Schultes) IN ILOCOS NORTE

Joselito I. Rosario

Structure of Presentation

- ☺ Background
- ☺ Objectives
- ☺ Methodology
- ☺ Results and Discussion
- ☺ Conclusions

BACKGROUND

Importance of Bamboo

- Widely regarded as one of the most important non-timber forest products in Asia
- In the Philippines, it is an essential community resource and local source of income.

Importance of Bamboo

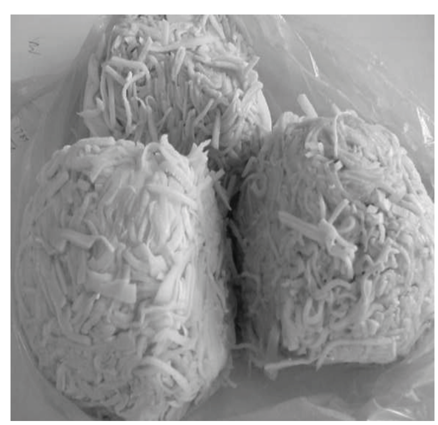
- Offer significant and increasing employment and income generating opportunities and foreign exchange earnings

- A 1996 study in the Ilocos Region showed that the total sales from culms and shoots for the year was PHP22 million.

- DENR (2003): bamboo furniture export in 2000 was reported to be about $3.18 million.

Importance of Bamboo

- Expanding bamboo shoot export market



- Food and health products from bamboo shoots: favored not only in bamboo-producing countries, but also in N. American and W. European countries.

Importance of Bamboo

- "Poor man's tree"?
- Not anymore, it is becoming a high-tech, industrial raw material and substitute for wood.

http://www.philippines.hvu.nl/housing1.htm

- New technologies that use bamboo as raw material are being developed and commercialized.
  - ✓ Panel products, laminated wood substitutes, bamboo plywood, etc.

Importance of Bamboo

- It has very significant role in the environment due to its tremendous growth
- Considered highest producer of biomass, thus high CO_2 fixation potential.

Uses of Kawayan tinik

- One of the major bamboo species used commercially for construction and in furniture manufacture in the country

Uses of Kawayan tinik

- Used for handicraft manufacture and considered as best species for shoot production.
- It is being considered as a raw material in the manufacture of bamboo-based products with special properties, most of which were developed as substitute for timber
- It is planted along rivers and creeks to prevent soil erosion; around houses in rural areas as windbreaks

Threats/Problems

- Growth in processing technologies and markets for products from kawayan tinik resulted to:
  - ☞ increase in the demand for bamboo poles resulting to overcutting and overexploitation
    - ☞ more pressure on the dwindling stands; and
    - ☞ increase in prices of poles
- Virtucio and Roxas (2003): self-sufficiency rating for kawayan tinik in Region I is 32% of the total demand.

Needs

- Effective and sound management of kawayan tinik requires knowledge on its growth and production.
- Bamboo and Rattan Commodity Team (2002): "There is a dearth of complete and up-to-date information on the extent and geographic distribution of existing stands in the country".

Needs

- Resource assessment is necessary, but inventory could be expensive.
- Counting the number of culms in a clump is time consuming and tedious.
- A quick and dependable estimation of culm, shoot and biomass yields is required for more practical management of natural kawayan tinik stands in the province.

Possible Solution

- A regression equation: clump diameter and some environmental factors as predictors can make the estimation of yield of bamboo clumps relatively easier and faster.
- Measuring the clump diameter could be relatively easier and faster thus reducing cost of inventory.
- Incorporating easily measurable environmental factors into the model could allow greater flexibility to the model.

GENERAL OBJECTIVES

- Contribute to the effective management of natural stands of kawayan tinik in Ilocos Norte for sustained production of poles (culms) and shoots.

SPECIFIC OBJECTIVES

- Assess the culm, shoot and biomass yield per clump of the natural stands of kawayan tinik in the two geographic districts of the province;
- Determine the variations in the yield of kawayan tinik stands growing in four physiographic locations, *i. e.,* backyards and agricultural lands, brushlands/hilly areas, along creeks/streams and along secondary roads;

SPECIFIC OBJECTIVES

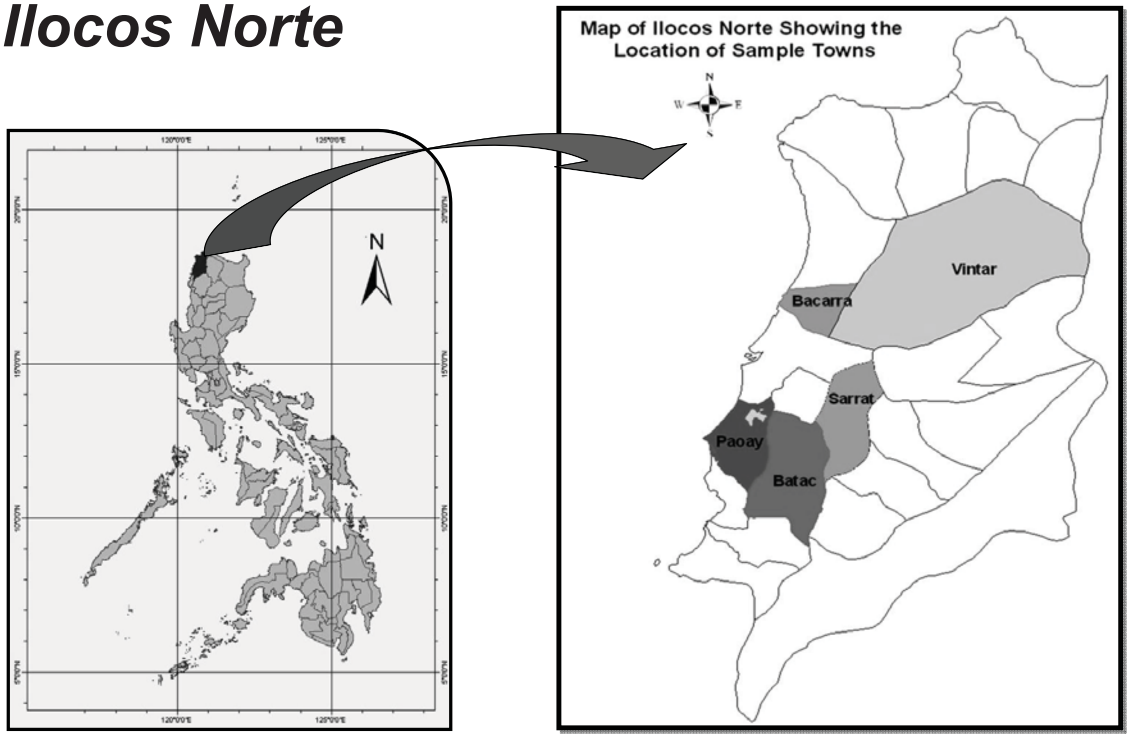
- Assess the effects of slope, elevation and aspect on the culm, shoot and biomass yields of natural stands of kawayan tinik; and

- Develop prediction equations based on clump diameter, physiographic variables such as slope, elevation and aspect, and soil characteristics such as OM, pH, K and P levels.

METHODOLOGY

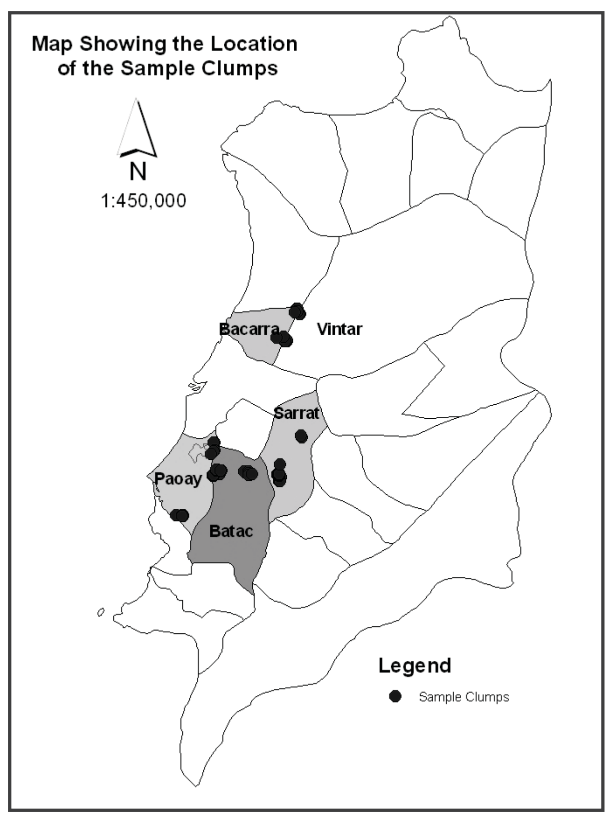
STUDY SITE

Ilocos Norte



LOCATION OF SAMPLE STANDS

- Province was stratified into 2 geographic zones: District I & District II.
- Distribution of natural stands obtained thru' secondary sources; verified by reconnaissance survey
- Representative town and barangay/zone were located
- Sample clumps selected in 4 physiographic locations



Four Physiographic Locations

- *Along roads*

Four Physiographic Locations

- *Along creeks*

Four Physiographic Locations

- ***Backyards***

Four Physiographic Locations

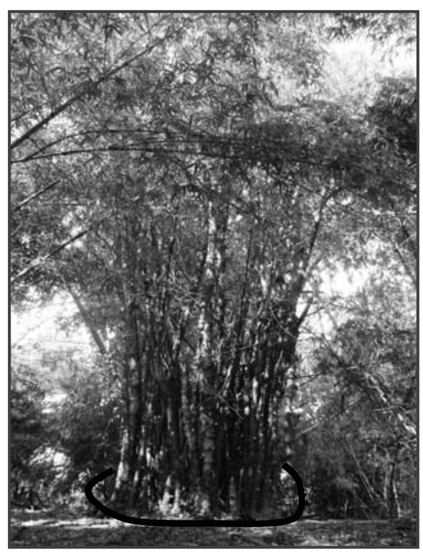
- ***Hilly areas***

Data Gathering

Measurement of Sample Clumps

- 5 randomly selected sample clumps per physiographic location.
- Parameters measured:
- ☯ Clump diameter at ground level
- ☯ Number of shoots and culms
- ☯ Diameter of culms and shoots
- ☯ Height of culms and shoots
- ☯ Total biomass yield
- ☯ Shoot biomass yield

- A clump is a group of culms and shoots that originally developed from a single mother plant.



- Shoots are those that are still encased in sheaths
- Culms are those that have already developed leaves and branches.

Culm and Shoot Diameter

- Culm diameter was measured on the second internode from the ground
- Shoot diameter was measured 20 cm from the ground

Data Gathering

- ***Measurement of Biomass Yield***

☯ 2 sample clumps per physiographic location/ representative town/zone.

☯ 2 samples each for young and mature culms and new shoots per sample clump.

☯ Branches and leaves were separated from each culm.

Data Gathering

- ***Measurement of Biomass Yield***
  - Fresh weights of each tissue type were measured
  - Subsamples from each tissue type were collected and oven-dried for MC estimation.
  - Estimates of dry weight: base on the fresh weights and MC's of various tissue-types.

Data Gathering

- ***Physiographic Variables***

Slope, aspect and elevation of each sampling site were obtained.

- ***Edaphic Factors***

✓ 2 composite soil samples per sampling location

✓ Brought to soils lab and analyzed for: pH, OM, P, and K

Data Analysis

- Comparison of the clump level variables using GLM procedure of SPSS; 2 districts and 4 physiographic locations were used as factors

- Multiple Regression analysis:

✓ Done for the whole province; 4 physiographic locations

✓ Independent variables: clump diameter, aspect, slope, elevation, pH, OM, P, and K

✓ Number of culm, number of shoots, and biomass yield per clump as response variables.

Data Analysis

- Multiple Regression analysis:

✓ Different functional forms of the independent variables such as the variable itself, logarithm of the variable and inverse of the variable were tried in the analysis.

✓ A model was selected based on the goodness of fit (indicated by the p-value in the ANOVA), and the adjusted R^2.

Validation of the Models

- Using t-test and the independent test clumps, each model was validated by comparing the predicted and observed values for each dependent variable.

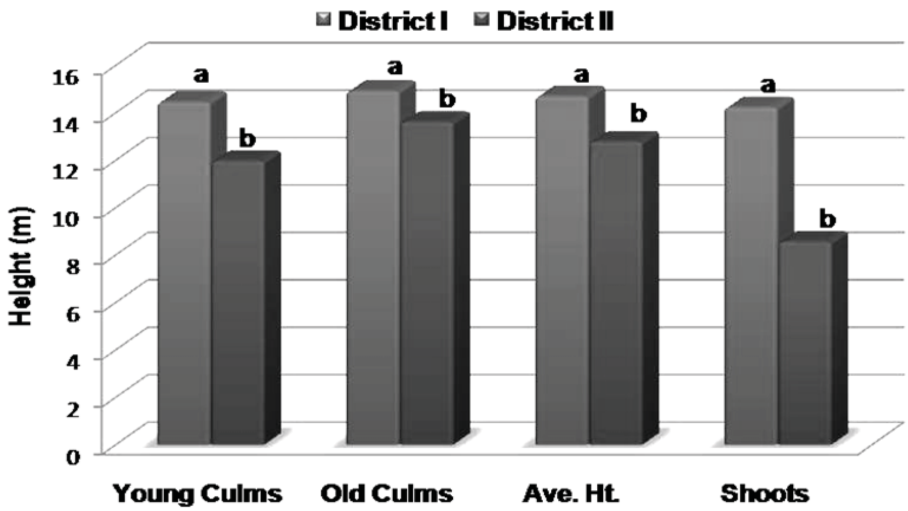
RESULTS & DISCUSSION

Influence of Geographic Zone

- *Kawayan tinik* clumps in the first and second districts had comparable diameter.
- Diameter of clumps in District I ranged from 1.26 – 3.21 m while 1.53 – 2.92 m for those in District II

Influence of Geographic Zone

- Height of culms and shoots in the first and second districts were significantly different.



Influence of Geographic Zone

- Significant variations on the diameter of young culms and on the average culm diameter

- Young culms: District I – 8.0 cm; District II – 7.5 cm
- Ave. dia.: District I – 8.0 cm; District II – 7.6 cm

Influence of Geographic Zone

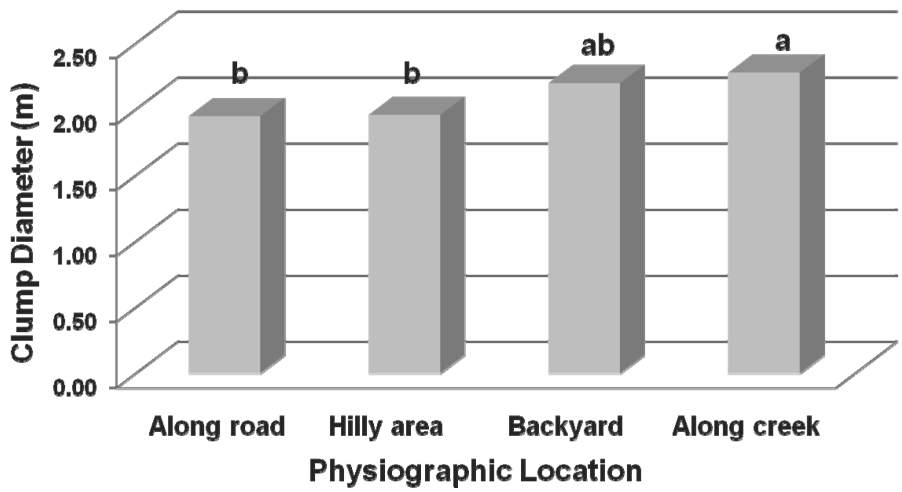
- Diameter of old culms and shoots were not significantly different
- No marked differences on the number of young and old culms and the total number of culms produced per clump
- District I: 22 culms per clump (59% are old culms, e.g., ≥ 3 years)
- District II: 21 culms per clump (57% are old culms).

Influence of Geographic Zone

- More shoots were produced in clumps growing in District II (12 shoots $clump^{-1}$) as compared to those located in District I (9 shoots $clump^{-1}$)
- Geographic zone had no effect on the culm and total biomass yields per clump
- Clumps in District I had significantly higher shoot biomass yield than those from District II (73.2 vs. 30.6 kg $clump^{-1}$).

Influence of Physiographic Locations

- Significant variations on the diameter of clumps growing on different physiographic locations



Bars marked with a common letter are not significantly different at 5% level of significance using DMRT.

Influence of Physiographic Locations

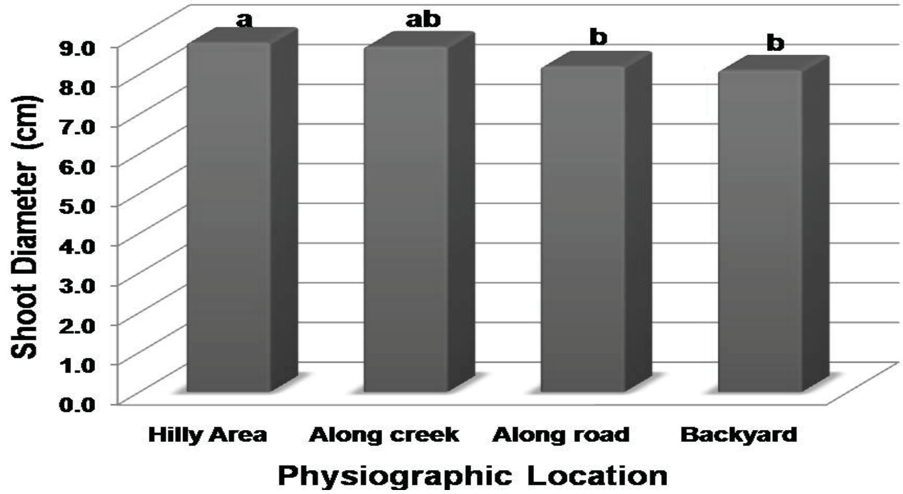
- Diameter of culms were not significantly different among kawayan tinik clumps growing in the four physiographic locations

Physiographic Location	Diameter of Culms (cm)		
	YC	OC	Average
Hilly Area	7.8	7.9	7.8
Along creek	7.9	8.0	7.9
Along road	7.4	7.7	7.6
Backyard	7.7	7.8	7.8
Significance	ns	ns	ns

ns = Not significant

Influence of Physiographic Locations

- Physiographic location has significant effects on the diameter of shoots



Bars marked with a common letter are not significantly different at 5% level of significance using DMRT.

Influence of Physiographic Locations

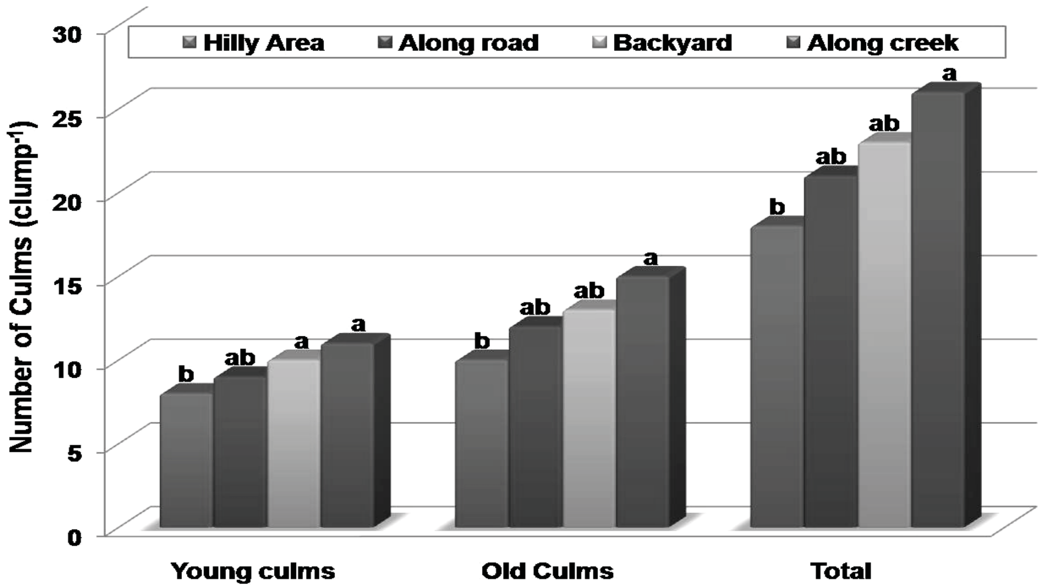
- No influence of physiographic location on the height of culms and shoots produced by clumps

Physiographic Location	Culm Height (m)			Height of Shoots (m)
	YC	OC	Average	
Along road	12.79	14.72	13.76	10.63
Hilly Area	12.31	13.86	13.09	10.89
Backyard	12.92	13.86	13.39	11.49
Along creek	14.75	14.60	14.67	12.26
Significance	ns	ns	ns	ns

ns = not significant

Influence of Physiographic Locations

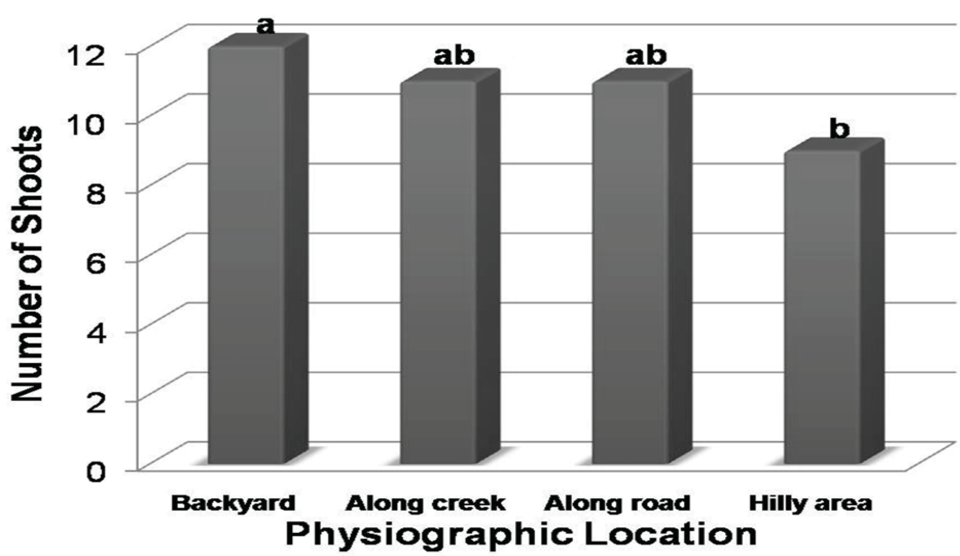
- Total number of culms; number of young and old culms



In each category in the x-axis, bars marked with a common letter are not significantly different at 5% level of significance using DMRT.

Influence of Physiographic Locations

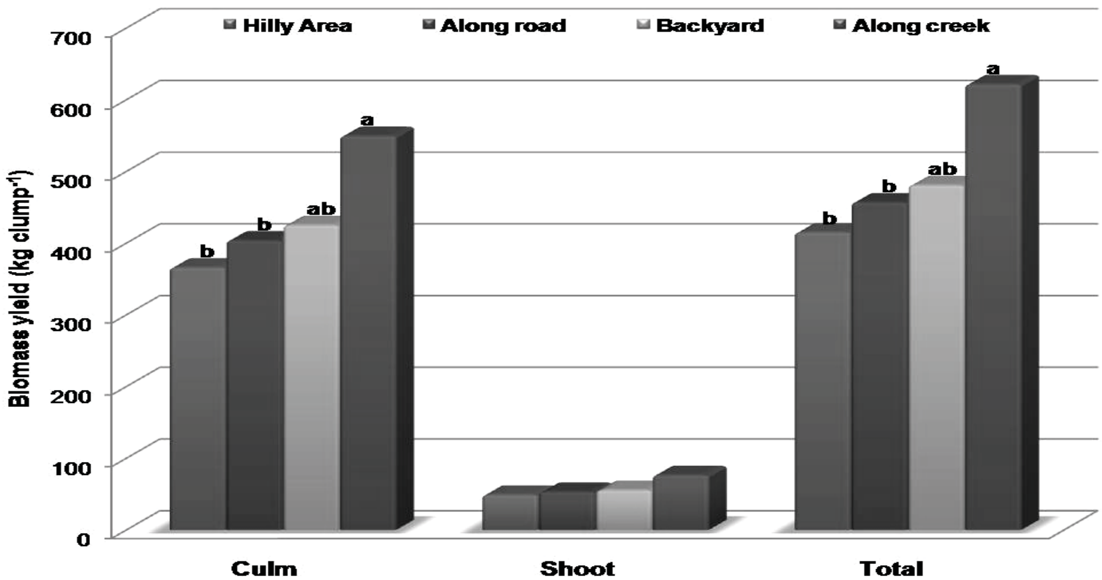
- Total number of shoots



Bars marked with a common letter are not significantly different at 5% level of significance using DMRT.

Influence of Physiographic Locations

- Culm, shoot and total biomass yield



In each category in the x-axis, bars marked with a common letter are not significantly different at 5% level of significance using DMRT.

Prediction Models

- The various yield variables were affected by the clump diameter and the edaphic and physiographic factors used as independent variables

- The effects of these factors vary with the physiographic locations where the kawayan tinik clumps were growing.

Prediction Models

Total Number of Shoots (TNS)

- For clumps growing ***along roads***, TNS was a function of the clump diameter, elevation, aspect and soil OM.

$$TNS = -0.026 + 3.962CLD - 4.056ASP + 0.363ASP^2 + 0.458Elev + 0.415OM^2 \quad (R^2 = 0.979)$$

- TNS ***along creeks*** was affected by the clump diameter and edaphic variables (soil pH, OM content, P and K).

$$TNS = 15.221 + 6.005CLD - 3.694pH + 17.25pH^2 + 6.425OM - 18.185OM^2 + 0.252P - 0.436P^2 + 0.002K \quad (R^2 = 0.997)$$

Prediction Models

Total Number of Shoots (TNS)

- On ***hilly areas***, the variables relevant in predicting TNS were clump diameter, elevation, pH, OM and K.

$$TNS = -10.818 + 3.398CLD - 4.766CLD^2 - 1.735ASP + 0.226SL - 0.019SL^2 + 0.085P - 0.004K + 3.107pH$$

$(R^2 = 0.944)$

- TNS on ***backyard areas*** was influenced by clump diameter, aspect, slope and elevation of the ground, and soil pH, K and P levels.

$$TNS = 8.4439 + 4.765CLD - 5.368CLD^2 - 0.0681Elev - 1.588pH + 4.314pH^2 + 4.331OM + 0.0002K^2$$

$(R^2 = 0.946)$

Prediction Models

Total Number of Culms (TNC)

- For clumps along roads, TNC was a function of clump diameter, aspect value, elevation and available P.

$$TNC = 9.216 + 7.158\,CLD - 1.03\,ASP^2 - 0.578\,P + 0.039\,P^2 + 0.017\,Elev \quad (R^2 = 0.780)$$

- Clump diameter, aspect, soil pH and available P determined the culm production along creeks

$$TNC = 38.506 + 13.002\,CLD + 0.867\,ASP - 7.747\,pH + 15.739\,pH^2 + 0.286\,P^2 \quad (R^2 = 0.934)$$

Prediction Models

Total Number of Culms (TNC)

- On backyard areas, TNC was a function of clump diameter, slope, elevation, avail. P and exch. K.

$$TNC = 14.604 + 6.362\,CLD^2 - 0.393\,SL - 0.017\,SL^2 + 0.432\,Elev - 0.06\,K + 0.001\,P^2 \quad (R^2 = 0.963)$$

- For clumps in hilly areas, TNC was affected by clump diameter, aspect, pH and available P.

$$TNC = -24.704 + 8.095\,CLD + 0.593\,ASP + 3.316\,pH - 0.367\,P + 0.029\,K \quad (R^2 = 0.888)$$

Prediction Models

Total Biomass (TB)

- TB of clumps along roads was a function of clump diameter, exchangeable K and available P.

$TB = -336.738 + 403.901CLD - 9.651P + 0.009K$ ($R^2 = 0.859$)

- For clumps along creeks, TB was determined by clump diameter, soil pH and aspect.

$TB = -1263.914 + 317.469CLD + 736.744CLD^2 + 26.171ASP^2 + 142.944pH$ ($R^2 = 0.916$)

Prediction Models

Total Biomass (TB)

- On backyard areas, clump diameter, aspect, OM, P, K and pH explained the variations on the TB of kawayan tinik.

$TB = -1966.334 + 176.272CLD – 171.585CLD^2 – 91.663ASP + 338.621pH + 282.702OM + 3.818P – 0.282K$ ($R^2 = 0.938$)

- TB on hilly areas was a function of clump diameter, slope, elevation and soil pH.

$TB = -1632.397 + 155.743CLD + 10.515SL – 0.304SL^2 + 0.102Elev^2 + 234.603pH – 295.648pH^2$ ($R^2 = 0.937$)

Prediction Models

Validation of the Models

- Results of the t-tests showed no significant differences between the predicted and observed values.
- These implied that the predicted and observed values were statistically similar.
- Hence, the equations were reliable in estimating the shoot, culm and biomass yields of kawayan tinik in the four physiographic locations.

CONCLUSIONS

- Clumps in District I produced taller and stouter culms, taller shoots and higher shoot biomass than those found in District II.
- No differences between the two districts in terms of clump diameter, diameter of old culms, diameter of shoots, number of culms, and total biomass yield per clump.
- These results suggest that clumps in District I are generally more productive than those located in District II maybe because of better growing conditions.

CONCLUSIONS

- Physiographic location had significant effects on clump diameter, diameter of shoots, number of shoots and culms produced per clump, and total and culm biomass yields.

- Height of culms and shoots, diameter of culms and shoot biomass did not show significant variations among physiographic locations.

CONCLUSIONS

- Clumps along creeks were the most productive (had the biggest diameter, produced the most number of culms and highest biomass yields) while those on hilly areas were the least productive.

- The apparent better productivity of clumps along creeks could be attributed to the availability of moisture throughout or almost throughout the year.

CONCLUSIONS

- The multiple regression analysis showed that clump diameter is an important factor in predicting the shoot, culm and biomass yield of kawayan tinik in Ilocos Norte.
- The yield parameters increased with increasing clump size but the rate of increase would tend to taper beyond an optimum clump diameter.
- This declining trend could be due to the effect of overcrowding or culm congestion.

CONCLUSIONS

- The edaphic and physiographic factors also helped explained the variations on the yield of kawayan tinik.
- Soil pH played a great role in predicting the yield parameters of kawayan tinik along creeks, on backyards and on hilly areas
- Yield parameters increased with increasing soil OM. The amount of soil OM is an indicator of soil fertility and productivity hence a strong positive correlation existed.

CONCLUSIONS

- Exch. K contributed to the prediction of: a) TNS along creeks, on backyards and on hilly areas, b) TNC on backyards and hilly areas; c) BY along roads and on backyards
- Available P also contributed to the total variations in: a) TNS along creeks and on backyards; b) TNC in all locations; c) BY along roads and on backyards;

CONCLUSIONS

- The yield of kawayan tinik tend to increase from relatively flat areas towards moderately sloping sites but would decline as the slope gradient gets steeper.
- This shows that growth and yield potentials of kawayan tinik decline at very steep slopes.
- The yield of kawayan tinik along roads, hilly areas and backyards tend to be lower on south facing slopes than north facing slopes.

Thank you..