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Modelling silvipastoral systems in dry rangelands

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Summary: Spread sheet based models for silvipasture based on *A. tortilis*, *A. amara*, and *H. binata* trees; *C. ciliaris*, *C. setigrus* grasses and a pasture legume *S. hamata* have been prepared by integration of prediction functions evolved on the basis of five year initial growth/ production data of components in the systems.
The growth period for optimum yield on the basis of current annual increment and mean annual increment curves of collar diameter for *A. tortilis*, *A. amara* and *H. binata* associated silvipastoral systems would be 11, 8 and 8 years respectively. Comparison of predicte outputs at different growth stages in the systems show that *H. binata* associated system gave the maximum tonnage followed by *A. tortilis* and *A. amara* respectively.

Key-words: spreadsheet, silvipastoral system, tree/ grass biomass

INTRODUCTION

The increasing land degradation in India(158 m ha) resulted in increasing gap of demand and supply of forage, firewood and timber besides the problem of environment. The problem is more intense in arid and semiarid areas where in response to monsoon climate, the protected areas show a savanna type revegetation used by grazing animals.

Silvipastoral system of farming is considered as the low input technology to meet the shortage of fuel wood, forage and green leaf fodder from degraded lands (Patil & Pathak, 1977). System modelling helps in understanding the needs of inputs to optimize the desired output and the system sustainability. Silvipasture research is in progress at I.G.F.R.I., Jhansi since 1971 and multidisciplinary approach has been adopted to understand the production (primary and secondary), utilization and sustainability in ecological and bioeconomic frame work. This paper presents spread sheet based silvipastoral models of three tree species with grasses.

MATERIAL AND METHODS

Site : The research area is situated at 25°27' N, 78°37' E and at an altitude of 275 m above msl on alfisols in an undulating terrain with neutral pH, 900 mm mean annual rainfall, mean maximum and minimum temperatures of 32.5°C and 17.7°C with as high as 46.3°C and as low as 1.5°C during summer and winter months respectively.

The trees viz; *Acacia tortilis*, *Albizia amara*, and *Hardwickia binata* interplanted with grasses viz; *Cenchrus ciliaris*, *Cenchrus setigrus* and a legume *Stylosanthes hamata* were established during 1982.

Five year growth data (Height, collar diameter(CD) and diameter at breast height(dbh)) and biomass at the 5th year and annual grass production (DM t/ha) were utilized for the study.

Type of growth/ biomass prediction equations for tree (allometric relationships for biomass, asymptotic curve for increament in CD and double asymptotic curve for height - diameter) and stochastic model for under storey grass production in the three silvipastoral systems have been evolved and integrated on a spreadseet **lotus 123** (Khan & Pathak, 1990-91 and Thomas *et al* 1991).

RESULTS AND DISCUSSIONS

The prediction equations evolved are as under:

1. Diameter growth models:

A. tortilis

Growth in collar diameter(dy)=
$0.7078\ (0.7402)^{CD}\ (CD)^{1.1016}$, $R^2 = 0.744$

A. amara

$dy = 1.1131\ (0.6599)^{CD}\ (CD)^{1.4948}$, $R^2 = 0.74$

H. binata

$dy = 1.227\ (0.6195)^{CD}\ (CD)^{1.638}$, $R^2 = 0.81$

The optimum growth period on the basis of current and mean annual increments(CAI and MAI) of diameter (CD) in *A. tortilis, A. amara,* and *H. binata* were found to be 11, 8, and 8 years respectively.

2. Height -diameter models:

A. tortilis

$Ht = 20\ EXP(-4.1911\ EXP(-0.3426\ (CD)^{0.758}))$, $R^2 = 0.983$

A. amara

$Ht = 20\ EXP(-4.2937\ EXP(-0.4125\ (CD)^{0.447}$, $R^2 = 0.526$

H. binata

$Ht = 20\ EXP(-5.132\ EXP(-0.39619\ (CD)^{0.492}$, $R^2 = 0.896$

3. Tree biomass allometric evolved are:

A. tortilis

Timber biomass= $0.0811\ (CD)^{2.219}$, $R^2 = 0.834$
Branch wood biomass= $0.0174\ (CD)^{2.809}$, $R^2 = 0.784$
Leaf biomass= $0.003\ (CD)^{2.468}$, $R^2 = 0.57$

A. amara

Timber biomass= $0.04318\ (CD)^{2.2027}$, $R^2 = 0.981$
Branch wood biomass= $0.0252\ (CD)^{1.931}$, $R^2 = 0.808$
Twig biomass= $0.01658\ (CD)^{2.495}$, $R^2 = 0.888$

H. binata

Timber biomass= $0.1539\ (CD)^{1.967}$, $R^2 = 0.895$
Branch biomass= $0.0038\ (CD)^{2.863}$, $R^2 = 0.71$
Leaf biomass= $0.0026\ (CD)^{2.439}$, $R^2 = 0.57$

4. Forage Production

Taking potential yield of plot, tree height and random variation (15% expected variation from mean), predicted forage yields show a declining trend with age (Fig 1, 2 & 3).

Prediction of above ground biomass(AGB) in tree and associated grasses at 10, 12, and 15 year rotation have been worked out(Table 1). The predictions made at different stages of the system show that among the three systems the *H. binata* associated silvipastoral systems was giving the maximum tonnage.

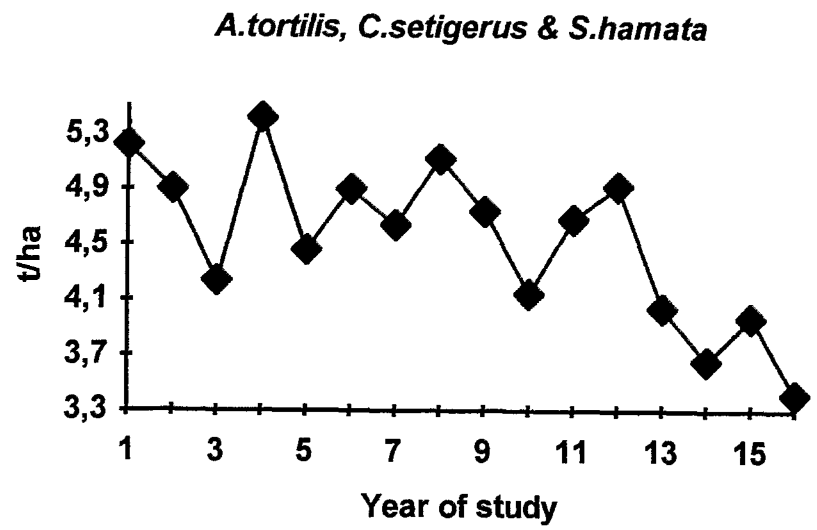

Figure 1: Dry grass yield. A. tortilis *silvipastoral system*

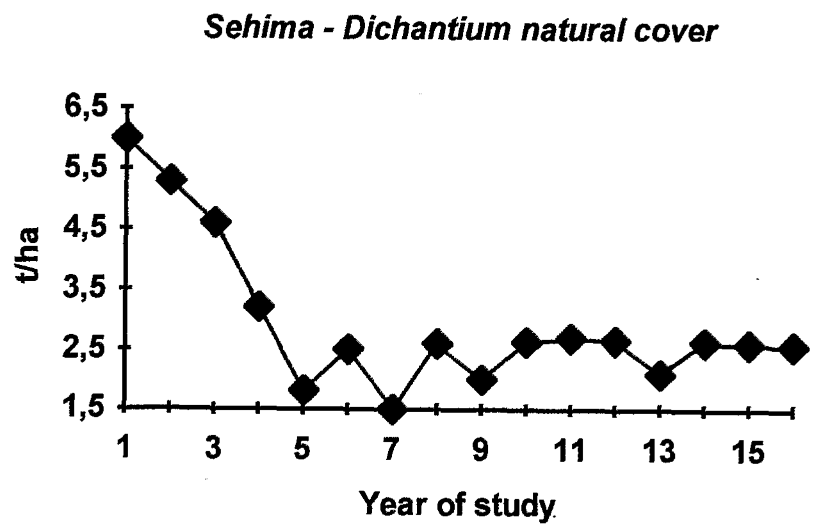

Figure 2: Dry grass yield. A. amara *silvipastoral system*

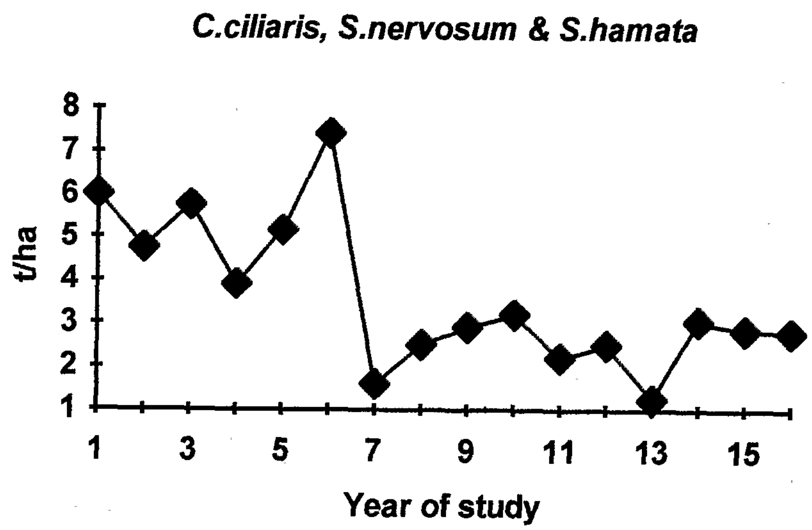

Figure 3: Dry grass yield. H. binata *silvipastoral system*

Table 1. Predicted AGB of tree/ grass production in different silvipastoral system

Tree species	10 year rotation		12 year rotation		15 year rotation	
	Tree AGB (t/ha)	Forage production (t/ha/yr)	Tree AGB (t/ha)	Forage production (t/ha/yr)	Tree AGB (t/ha)	Forage production (t/ha/yr)
A. tortilis	3.16	4.92	5.25	4.88	8.28	4.54
A. amara	4.14	3.36	5.46	3.14	6.85	3.01
H. binata	5.27	3.86	6.71	3.74	8.16	3.63

Khan *et al* (1994) have discussed and cofirmed the prediction made through such models for three different habitats in *A. tortilis* based silvipastoral system by harvesting trees at a later date. Thus through modelling effort the spread sheet based information can be utilized for a specific site for planning the system sustainability to the benefit the users.

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REFERENCES

Patil B.D., Pathak P.S., 1977. Energy plantations and silvipastoral systems for rural areas. *Invention Intelligence, 12: 75-87.*

Khan T.A., Pathak P.S., Gupta S.K., 1994. Modelling *Acacia tortilis* based silvipastoral system using system analysis methodologies. *J Range Mgmt & Agroforestry : 15(2) pp 203-210.*

Khan T.A., Pathak P.S., 1990-91. Annual Report IGFRI, *Jhansi, pp 75- 81.*

Thomas T.H., Suntud Sangkur, Willis R.W., 1991. *Agroforestry in Asia and the Pacific* (Eds. W. Mellink, Y.S.Rao and K.G. MacDicken) pp 251-277 RAPA Publication 1991/5 FAO, Bangkok 251-277.