Management and Utilisation of Mulberry for Forage in Japan

1. Productivity of mulberry-pasture association system and nutritive value of mulberry

N. Kitahara, S. Shibata and T. Nishida

Department of Grassland Management, National Grassland Research Institute, Japan

Introduction

The pastures in Japan are mainly composed of temperate species such as orchard grass, tall fescue, timothy, white clover, etc., which are native of the Asia Minor/South Europe region. The climatic conditions of Japan, unlike Europe, are not always suited to the growth of these temperate grasses and pastures based on them create some problems. One of the most serious concerns is seasonal forage production, remarkably uneven compared to Europe. Summer forage production in particular decreases to an extreme low due to high summer temperatures. Consequently, there is insufficient forage for grazing animals from summer to autumn in general.

On the other hand mulberry (*Morus* sp.) was once widely planted for sericulture purposes in Japan. But since the industry has been on the decline for the last few decades, there are a lot of abandoned mulberry farms all over the country. There is an opportunity to utilise those farms for other purposes, especially for mixed pastures.

In view of the above situation, the authors started research on the use of mulberry in temperate grass pastures in order to reduce the summer-autumn forage shortage and to find alternative uses to the abandoned sericulture farms.

The productivity of mulberry-pasture mixtures and the nutritive value of mulberry leaves and shoots are presented in this paper.

Materials and methods

This trial was carried out from 1997 to 1999 on a volcanic ash soil at the National Grassland Research Institute (Nishinasuno, Tochigi) located at 36° 55' latitude north, 139° 55' longitude east and at 320m above sea level.

The mulberry varieties were Shinkenmochi (*M. bombycis*) and Aobanezumi (*M. alba*). Mulberry-pasture association was established as follows: Mulberry was planted at a spacing of 3m-between rows and 0.7m between plants (4,762 plants/ha) in spring of 1996. A mixture of five temperate species: orchard grass, tall fescue, perennial ryegrass, red top and white clover, was sown among mulberries rows the following autumn. The association was compared with a sward of those species and with mulberry in pure stand. The design was a randomised complete block with three replications. In all three treatments plot size was 84m^2(7m x×12m). Four mulberry rows, two of each mulberry variety, were used in both the association and the pure stand. Harvest times were for 1997: 30 April, 10 June, 11 August, 3 October and 10 November; for 1998: 30 April, 9 June, 10 August, 5 October and 5 November; and for 1999: 30 April, 11 June, 9 August, 6 October and 2 November. As mulberry began sprouting at the end of April and stopped shooting about the middle of October, it was harvested three times during from June to October. Mulberry plants were trimmed at 1m high when they were planted and the new shoots harvested by cutting approximately 1cm above old shoots. Swards were cut at 5cm above ground. Fertiliser was applied at the rate of 68kg/ha/year of each N, P and K.

Forage production and nutritive value was determined in the three treatments. Forage samples from September were used to determine crude protein, Acid Detergent Fibre (ADF), Neutral Detergent Fibre (NDF), ash, Organic cellular Content (OCC), Organic Cell Wall (OCW), High Digestible Fibre Fraction (Oa), Low Digestible Fibre Fraction (Ob), Ca, P, Mg, and K. The K/(Ca+Mg) ratio was calculated.

Results and Discussion

Productivity of mulberry-pasture association

Table 1 shows the results of the DM production of three treatments from 1997 to 1999.

Since, mulberry is a very palatable forage for cattle (Kitahara, 1999) and both new shoots and leaves are well consumed, therefore, mulberry production data shown also includes shoots.

Excellent yearly DM production of mulberry-pasture association was obtained in all three years. DM production of the mulberry-pasture mix was 13%, 32% and 57% above the grass alone in 1997, 1998 and 1999, respectively, due to the contribution of mulberry. In general, grassland productivity in Japan decreases with time. This was the case in this experiment for the temperate sward, which yield remarkably decreased from 1997 to 1999. On the contrary, the productivity of the mulberry-pasture association did not drop. This interesting result seems to be due to protective shading effect of mulberry on the grass sward. Seasonal forage production in the mulberry-pasture association was considerably well distributed compared with other treatments. Consequently, the mulberry-pasture association can be an alternative to solve the problem of the summer-autumn forage deficit in Japan.

Table 1. The productivity of mulberry and temperate sward in the three treatments (kg of DM/10a)

1997	**30/04**	**10/06**	**11/08**	**03/10**	**10/11**	**Total**
Association:						
Sward	531	394	223	162	69	1,380
Mulberry:						
Leaves		83	86	71		239
Shoots		26	38	23		86
Subtotal		109	124	94		325
Total	531	503^{a}	347^{a}	256^{a}	69	1,706^{a}
Sward	588	434^{a}	232^{b}	203^{a}	57	1,514^{a}
Mulberry pure stand						
Leaves		111	152	86		349
Shoots		48	84	24		156
Total		160^{b}	236^{b}	110^{b}		505^{b}
1998	**30/04**	**09/06**	**10/08**	**05/10**	**05/11**	**Total**
Association:						
Sward	228	213	192	172	36	841
Mulberry:						
Leaves		43	72	58		173
Shoots		14	21	16		51
Subtotal		57	93	74		224
Total	228	271^{Aa}	285^{Aa}	246^{Aa}	36	1,065^{a}
Sward	181	203^{Bab}	196^{Bab}	183^{Ba}	44	807^{b}
Mulberry pure stand:						
Leaves		90	126	51		267
Shoots		32	50	15		97
Total		122^{Cb}	177^{Bb}	66^{Cb}		364^{c}

1999	30/04	11/06	09/08	06/10	02/11	Total
Association:						
Sward	128	286	183	85	39	722
Mulberry:						
Leaves		31	84	101		216
Shoots		7	34	35		75
Subtotal		38	118	136		291
Total	128	324^{Aa}	301^{A}	221^{Aa}	39	$1,013^{a}$
Sward	121	194^{Bab}	206^{B}	93^{Bb}	32	647^{b}
Mulberry pure stand						
Leaves		63	111	94		268
Shoots		18	39	24		82
Total		82^{Cb}	150^{B}	118^{Bab}		350^{c}

Statistical comparisons were among treatments within same year. Values with the same letter do not differ (A<0.05, a<0.01).

None of the mulberry plants were killed by the three-times per year defoliation during the experiment

Nutritive value of mulberry leaves and shoots

Table 2 shows the nutritive value of mulberry leaves and shoots compared with temperate sward and Table 3 the comparative mineral content.

The characteristics of the nutritive component of mulberry were as follows: The contents of crude protein and OCC in the leaves were high, but those of ADF and NDF were low compared with the sward. Mulberry leaves were more digestible than the sward. On the other hand, the contents of ADF, NDF and OCW in the mulberry shoots were relatively high. This shows that mulberry shoots might have low digestibility. As the ratio of DM

production of mulberry leaves to the shoots is 3:1, whole nutritional quality of the mulberry foliage, likely to be consumed by cattle, seems to be high.

Table 2. The nutritive value of mulberry leaves and shoots compared with temperate species

	CP	ADF	NDF	Ash	OCC	OCW	Oa	Ob
Mulberry								
Leaves	25.8	21.0	31.6	11.8	51.8	36.5	10.0	26.5
Shoots	12.1	45.6	60.5	8.8	32.8	58.5	9.4	49.1
Sward	20.4	27.9	53.5	11.6	34.0	54.4	12.3	42.1

Harvesting month: September 1997. The mulberry variety = Shinkenmochi.

Table 3. Mineral content of mulberry leaves and shoots compared with the temperate sward

	Ca	P	Mg	K	K/(Ca+Mg)
Mulberry					
Leaves	2.98	0.44	0.43	2.84	0.41
Shoots	1.01	0.37	0.36	3.78	1.21
Sward	0.28	0.37	0.30	4.99	3.29

Harvesting month: September 1997. The variety of mulberry is Shinkenmochi.

With regard to mineral content, Ca, P and Mg in mulberry leaves were higher than in the sward. K content and K/(Ca+Mg) in mulberry leaves were markedly lower than in grass.

Grass tetany is one of the important diseases during grazing season. The disease has generally been related to low Mg, high K, and high K/(Ca+Mg) equivalent ratios in the forage (Karlen *et al.*, 1978). Gross (1973) reported that generally accepted values of less than 0.2% Mg, more than 2.5% K, and K/(Ca+Mg) equivalent ratios greater than 2.2 could cause forage to be tetany prone. It is apparent that mulberry has the good mineral component to prevent grass tetany.

Conclusion

This study has demonstrated that the productivity of mulberry-pasture association is very high with even seasonal distribution compared with a sward of temperate species. The nutritive value of mulberry leaves was very high, and moreover, mineral content was excellent. Mulberry-pasture system seems to be a promising grazing method. But it is logical that further studies on this system be conducted since there are still many unsolved practical problems.

References

Gross, C.F. 1973. Managing magnesium-deficient soils to prevent grasstetany. Proc. 28th Annu. Meeting Soil Conserv. Soc. Am., Hot Springs, Ark., p88-92.

Karlen, D.L.; Ellis,R. Jr.; Whitney, D.A. and Grunes, D. L. 1978. Influence of soil moisture and plant cultivar on cation uptake by wheat with respect to grass tetany. Agronomy Journal 70:919-921.

Kitahara, N. 1999. Some cases of available roughage in the riverbank and abandoned arable land. Dairy Journal 4:22-24.