Survival and growth of selected fodder species in Dhading, Kabhra and Sindhupalchok districts

Rekha Kharel[1], S. M. Amatya[1] and R. Basukala[1]

[1]Department Of Forest Research and Survey, Babarmahal, Kathmandu

Abstract

A study on "Strategies for the improved production of fodder during the dry season using participatory research techniques" was carried out jointly by HMG Nepal' s Department of Forest Research and Survey (DFRS), Nepal Agroforestry Foundation (NAF) and Natural Resource Institute (NRI) of UK since September 1997. The study concentrated on five mid-hill sites of three districts (Dhading, Sindhupalchowk, and Kavrepalanchok). Ten farmers from each site were selected to take an active part in the study. The selection of participating farmers was based on a set of criteria formulated jointly by farmers and the research team. An initial survey of farmer practices showed that farmers have certain preferences regarding fodder tree species. A total of six fodder trees were found to be preferred by the participating farmers; of which three were indigenous and three exotic.

Guazuma ulmifilia showed the highest survival rate although it was only planted at one site, Gauthale. The best survival rates overall for Ipil 86% and Badahar 88% are found in Gauthale followed by Gajuri Chhap Ipil (79%) and Badahar (71%). Kimbu (64%) and Bhatamese (57%) had the highest survival at Ange. An ANOVA comparing average growth of tree species across four villages shows that only Ipil has a significant difference.

Introduction

A study on "Strategies for the improved production of fodder during the dry season using participatory research techniques" has been carried out jointly by HMG Nepal's Department of Forest Research and Survey (DFRS), Nepal Agroforestry Foundation (NAF) and Natural Resource Institute (NRI) of UK since September 1997. The study concentrated on 5 mid-hill sites over three districts (Dhading, Sindhupalchowk, and Kavrepalanchowk). Ten farmers from each site were selected to take an active part in the study. The selection of participating farmers was based on a set of criteria formulated jointly by farmers and the research team.

An inception report carried out before commencement of the project stated that planting fodder trees on private farmland was a viable option for meeting the green forage requirement for livestock. Hence, promotion of planting fodder trees on private farmland for green forage was one of the components of this study.

Farmers identified need for increased cultivation of fodder on-farm as an important response to livestock feed needs and requested assistance in obtaining seeds of preferred species. It was proposed that in addition to planting over a small area of land they plant the same species at the same spacing, in recommended positions along the terrace riser. This would enable a more structured analysis of the performance of different species at different altitudes, aspects and on different soil types. In selecting the species for these on-farm trials, farmer selected a total of 6 fodder species.

Methodology

A meeting was carried out in each village to discuss research plot design. Several options were suggested and considered during the discussion. It was decided to make a 20 metre long plot on each farmer's terrace riser. The details of fodder trees planted by farmers at each site are given in Annex-2. Plantation design was based on farmer's interest and the species available in nurseries at each research site. Past experiences on species growth in the locality were also considered. NAF and DFRS personnel selected the research plots in May 1999. All research plots were measured. Farm plans were made showing the research sites. According to each individual farmer's request, fodder tree seedlings were distributed to them through the local NGOs. Due to the poor performance of some home nurseries, particularly in Chankhubesi site of Kavre district, some seedlings were obtained from outside. Grass seeds were collected from Nepal Agroforestry Seed Cooperative Limited office in Kavre district. Tanki seedlings were collected from Chalnakhel nuresry, Lalitpur district. Table 1 gives the number of seedlings distributed to the five study sites. All other seedlings used in the plots were obtained from individual farmers' private nurseries.

Table-1: Number of seedlings distributed to participating farmers:

Species	Study Sites					Total
	CB	AG	TA	GA	GC	
Kimbu ***(Morus alba)***	50	17	-----	-----	-----	67

Ipil Ipil ***(Leucaena diversifolia)***	160	------	-----	-----	-----	160
Badahar ***(Artocarpus lakoocha)***	60	80	-----	-----	-----	380
Tanki ***(Bahunia pupurea)***	45	-----	-----	-----	-----	45
Total	315	97	------	100	140	652

Before the actual plantation work, a one-day field training was conducted in each site by NAF and DFRS staff with help from leader farmers. The pre-designed plans were followed for planting fodder trees and grasses on the farmland. The planting patterns for all five sites are presented in Figures 1 to 5.

Species under trial: The following trees and grasses were tested

Trees	**Grasses**
A. Ipil (*Leucaena diversifolia K-156*)	F. NB 21 (*Pennisetum sp.)*
B. Kimbu (*Morus alba)*	G. Molasses (*Melinis minutiflora*)
C. Tanki (*Bauhinia purpurea*)	H. Dinanath (*Pennisetum Pedicillstun*)
D. Badahar (*Artocarpus lakoocha*)	I. Stylo (Stylosanthes guianensis)
E. Bhatmase (*Flemingia congesta*)	J. Velvet bean (*Mucuna pruriens*)
K. Guazuma (*Guazuma ulmifolia*)	

Design of on-farm experiments at the five research sites

Gauthale (Dhading district)
Species preferred by farmers:
Trees: Ipil, Kimbu, Bhatmase, Badahar, Gauzuma
Grasses; NB21, Molasses
Ipil was very much preferred by farmers and for many this was the only species that they have so far planted on their farmland. Part of the objective of the experimental plots was to encourage more diversified planting, and to introduce farmers to different species. Dinanath and velvet bean showed promise in Gajurichhap.

A F E F A F K F A F E F A F K F A F E F A (TOP)
X x X x X x X x X x X x X x X x X x X x X
Stylo xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

Molasses xxxxxxxxxxxxxxxxxxxxxxxxxxx Dinanath xxxxxxxxxxxxxxxxxxxx

X X X X X X X X X X X BASE)
B B D B B B D B B B D

Figure 1: ***Diagram of planting pattern, Gauthale, Dhading district***

Gajurichhap (Dhading district)
Species preferred by farmers:
Trees; Ipil, Rai Khanyu, Bhatmase, Kimbu
Grasses; NB21, Velvet bean, Molasses, Dinanath

A F E F A F E F A F E F A F E F A F E F A (TOP)
X x X x X x X x X x X x X x X x X x X x X
Stylo xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

Molasses xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

X X X X X X X X X X X (BASE)
B B D B B D B B D B B

Figure 2: ***Diagram of planting pattern, Gajuri Chhap, Dhading district***

Chankhubesi
Species preferred by farmers:
Trees: Kutmiro, Gogan, Khanyu, Kangiyo, Timila, Koiralo
Grasses: Molasses, NB 21, Stylo

A F A F A F A F A F A F A F A F A F A F A (TOP)
X x X x X x X x X x X x X x X x X x X x X
Stylo xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

Molasses xxxxxxxxxxxxxxxxxxxxxxxxxxxxVelvet Beanxxxxxxxxxxxxxxxxxxxx

X X X X X X X X X X X (BASE)
B B C B B D B B C B B

Figure 3: ***Diagram of planting pattern, Chankhubesi Kavrepalanchowk district***

Ange (Sindhupalchowk District)
Species preferred by farmers for planting:

Trees: Ipil, Bhatmase, Kimbu
Grasses: NB 21, Molasses, Stylo

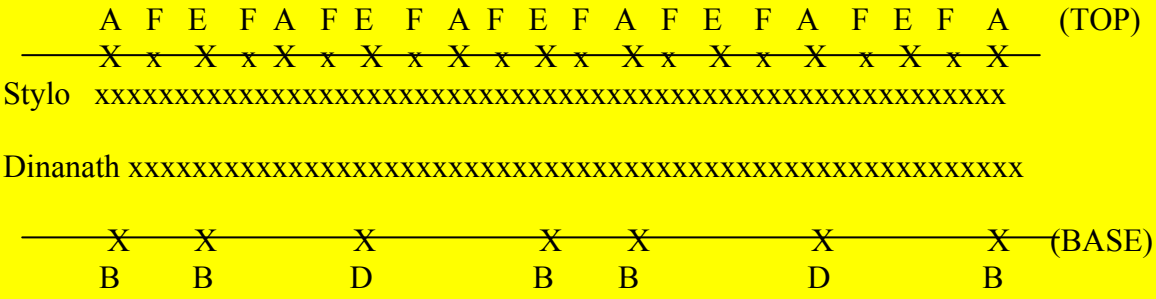

Figure 4: ***Diagram of planting pattern, Ange, Sindhupalchowk district***

Tawari (Kavre district)

Species preferred by farmers:
Trees: Badahar, Flemingia, Ipil, Kimbu
Grasses: Molasses, Sunhemp, NB21, Dinanth, Stylo

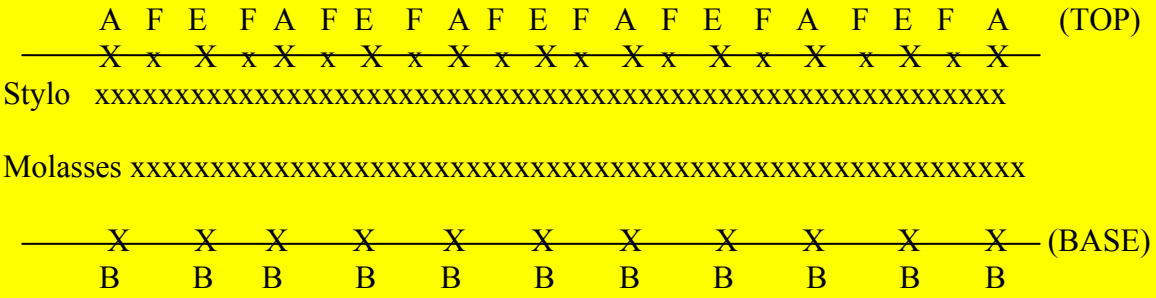

Figure 5: ***Diagram of planting pattern, Tawari, Kavrepalanchowk district***

The plantation work was carried out by the participating farmers themselves in close cooperation with NAF staff during the monsoon. Each group was responsible for one district in carrying out the

plantation work. Plantation was carried out at all sites in June, 1999. It is noteworthy to mention that all participating farmers have expressed their satisfaction and approval of the design, which could accommodate a variety of species in a limited space. However, there were some problems encountered during the plantation work such as in some cases it was difficult to plant exactly according to the design because of uneven terrace height and undulating landscape or rocks on the plantation sites.

A total of 2005 seedlings were planted over all five sites. ***Flemengia congesta*** was planted at all sites except Chankhubesi and ***Artocarpus lakoocha*** at all sites except Tawari. Similarly, ***Gauzuma ulmilofia*** was planted only at Gauthale and ***Bauhinia purpurea*** only at Chankhubesi. Table 2 shows the distribution of plantations in all the five sites.

Table 2: Distribution of plantation in all five sites.

Species	Research Sites					Total
	AG	CB	GC	GA	TA	
Ipil Ipil *(Leucaena diversif*olia)	111	178	125	150	130	694
Bhatamase *(Flemengia Conges*ta)	103	-----	85	67	80	335
Kimbu *(Morus alba*)	98	125	160	96	210	689
Badahar (*Artocarpus lakoocha*)	40	27	80	52	-----	199
Tanki (*Bahunia pupurea*)	-----	34	-----	-----	-----	34
Gauzuma (*Gauzuma ulmilofia*)	-----	------	------	54	------	54
Total:	352	364	450	419	420	2005

Results

Survival of the planted seedlings:

The survival of planted seedlings has been assessed four times. The first immediately after plantation, the second and third after each three months and the fourth during June 2000. The record of survival after 9 months showed that the survival percentage of ***Gauzuma ulmilofia*** was highest (94%) followed by ***Leucaena diversifolia***, ***Morus alba*****,** ***Artocarpus lakoocha***. Table 3 gives the survival percentage of planted seedlings in all the five sites.

Table 3. Survival percentage of planted seedlings (9months data)

Species	Survival % of planted seedlings				
	Gajurichhap	Gauthale	Tawari	Ange	Chankubesi
Ipil Ipil *Leucaena diversifolia*	84.8	71.7	50.4	45.8	45.1
Bhatamase *Flemengia Congesta*	45	49	67.0	67.0	-
Kimbu *Morus alba*	56.2	77.3	82.4	64	54.8
Badahar *Artocarpus lakoocha*	73.7	78.1	-	50.0	56.2
Gauzuma *Gauzuma ulmilofia*	-	94. 0	-	-	-

But, the recent analysis done by NRI for the data taken at June 2000, one year after plantation, the survival percentage ranged from 23 to 88 percent (table 4).

Table. 4. Survival percentage of planted seedlings at June 2000, one year after plantation

	Species types. Survival in %.				
Villages	Ipil	Kimbu	Badahar	Bhatmase	Tanki
Gajuri-Chhap	79	53	71	36	
Gauthale	86	45	88	23	
Tawari					
Ange	33	64	50	57	
Chankubesi	31	41	53		45

The best survival rates overall for Ipil *(L. diversifolia*) and Badahar (*Artocarpus lakoocha*) are found in Gajuri Chhap and Gauthale. Whilst, Bhatmase (*Flemingia congesta*) and Kimbu (*Morus alba*) had the highest survival in Ange.

Crop growth and analysis:

The crop growth data has been analyzed by using Genstat and a Split Plot Anova Design. An ANOVA comparing average real growth (June mean growth – March mean growth) of tree species across four villages shows that only *Ipil* has a significant difference ($p<0.05$). There was no data available from Tawari. *Flemengia* was planted across three villages; Gajuri Chhap, Gauthale and Ange (Table 5). *Tanki* and *Guazuma* had too few degrees of freedom to consider. It was found that there is no significant different in the height increment over the different locations for either specific time. Further multiple ANOVA comparing growth within households in each village; over time and within households overtime, showed only that there is a significant difference ($p<0.05$) over time.

The analysis of variance is shown in Table 5.

ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
IPIL Between Groups	16333.463	3	5444.488	4.028	.016
Within Groups	41902.676	31	1351.699		
Total	58236.139	34			
KIMBU Between Groups	6090.330	3	2030.110	2.736	.060
Within Groups	23741.118	32	741.910		
Total	29831.448	35			
BADA Between Groups	515.288	3	171.763	1.352	.276
Within Groups	3821.503	30	127.083		
Total	4327.791	33			

Table. 6.

FLEMENGIA CONGESTA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	648.060	2	324.030	2.774	.091
Within Groups	1985.933	17	116.820		
Total	2633.993	19			

Multiple Comparisons

LSD

Dependent Variable	(I) VILL	(J) VILL	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
KIMBU	1.00	2.00	19.8020	12.1812	.114	-5.0103	44.6143
		4.00	5.3927	12.9201	.679	-20.9247	31.7102
		5.00	-16.7848	12.9201	.203	-43.1022	9.5327
	2.00	1.00	-19.8020	12.1812	.114	-44.6143	5.0103
		4.00	-14.4092	12.9201	.273	-40.7267	11.9082
		5.00	-36.5867*	12.9201	.008	-62.9042	-10.2693
	4.00	1.00	-5.3927	12.9201	.679	-31.7102	20.9247
		2.00	14.4092	12.9201	.273	-11.9082	40.7267
		5.00	-22.1775	13.6190	.113	-49.9185	5.5635
	5.00	1.00	16.7848	12.9201	.203	-9.5327	43.1022
		2.00	36.5867*	12.9201	.008	10.2693	62.9042
		4.00	22.1775	13.6190	.113	-5.5635	49.9185
IPIL	1.00	2.00	39.4580*	16.4420	.023	5.9243	72.9917
		4.00	56.1767*	18.1182	.004	19.2244	93.1291
		5.00	12.7747	17.4394	.469	-22.7931	48.3426
	2.00	1.00	-39.4580*	16.4420	.023	-72.9917	-5.9243
		4.00	16.7187	18.1182	.363	-20.2336	53.6711
		5.00	-26.6833	17.4394	.136	-62.2511	8.8846
	4.00	1.00	-56.1767*	18.1182	.004	-93.1291	-19.2244
		2.00	-16.7187	18.1182	.363	-53.6711	20.2336
		5.00	-43.4020*	19.0279	.030	-82.2097	-4.5942
	5.00	1.00	-12.7747	17.4394	.469	-48.3426	22.7931
		2.00	26.6833	17.4394	.136	-8.8846	62.2511
		4.00	43.4020*	19.0279	.030	4.5942	82.2097
BADA	1.00	2.00	2.8513	5.1796	.586	-7.7269	13.4296
		4.00	-1.1410	5.6811	.842	-12.7434	10.4614
		5.00	-7.7017	5.4778	.170	-18.8887	3.4854
	2.00	1.00	-2.8513	5.1796	.586	-13.4296	7.7269
		4.00	-3.9923	5.5555	.478	-15.3380	7.3535
		5.00	-10.5530	5.3473	.058	-21.4737	.3677
	4.00	1.00	1.1410	5.6811	.842	-10.4614	12.7434
		2.00	3.9923	5.5555	.478	-7.3535	15.3380
		5.00	-6.5607	5.8344	.270	-18.4761	5.3547
	5.00	1.00	7.7017	5.4778	.170	-3.4854	18.8887
		2.00	10.5530	5.3473	.058	-.3677	21.4737
		4.00	6.5607	5.8344	.270	-5.3547	18.4761

*. The mean difference is significant at the .05 level.

site 1: Gajuri Chhap
site 2: Gauthale
Site 3: Ange
Site 5: Chankhubesi

Table. 7 Mean Growth rate of each fodder species in each village from 9 months to 12 months from planting

Site	Ipil	Kimbu	Badahar	Flemengia
1. Gajuri Chhap	78.1 **a**	32.53 (**ba)**	8.69	26.2
2. Gauthale	38.6 **b**	12.7 (**a)**	5.84	18.3
4. Ange	21.9 **b**	27.14 (**ba)**	9.8	12.48
5. Chankubesi	65.32 **a**	49.31 (**b)**	16.3	

Gajuri Chhap has the highest mean growth of all four villages. A closer look at the means for each household reveals that households 1, 7 and 10 have exceptionally high figures, between 95 and 160 cm. Chankubesi has the second highest growth. Ange and Gauthale share very similar results.

Discussion and Conclusion

Farmers have certain preferences regarding fodder trees. The criteria for preference vary according to the location, availability of fodder during the dry season and the quality of fodder. A total of six fodder trees were selected as popular at all sites by the participated farmers, of which three were indigenous and the other three exotic. These fodder trees were planted on farmer's fields as per the farm plan prepared by the research team as agreed by individual farmer. Tree and grass seedlings were made available to individual farmer as per their request.

Overall, *Guazuma ulimifolia*, an exotic fodder trees species, showed the highest survival rate (95%), although it was only planted at one site, Gauthale. The best survival rates overall for Ipil (*Leucaena diversifolia*) 86% and Badahar (*Artocarpus lakoocha*) 88% are found in Gauthale followed by Gajuri Chhap Ipil (79%) and Badahar (71%). Kimbu (*Morus alba) 64% and* Bhatmase (*Flemengia congesta*) 57 % had the highest survival in Ange. Survival was found highest for *Leucaena diversifolia* at Gauthale (86%), whilst only 31% survived at the Chankhubesi site. Similarly, the height of the seedlings varied according to location.

It has been found that there is no significant difference in the height of given species between locations. An ANOVA comparing growth of tree species across four villages shows that only *Leucaena diversifolia has* a a significant difference ($p<0.05$). For *Leucaena diversifolia* Gajuri Chhap has the highest mean growth of all four villages.

It has been found that the growth of Ipil in Gaujurichhap and Chankubesi is significantly different with the growth rate of Ipil in Gauthale and Ange. We can say that the mean growth rate of Kimbu is also very near to significantly different value. Consequently the growth of Kimbu in Gauthale appears significantly lower than the growth rate of Kimbu in the Chankubesi site. But, the growth rate of Badahar and Flemengia is not signifinantly different between villages.

It can be concluded that the overall trends of growth rate of species shows that the growth rate of Ipil is very good in Gajurichhap. Similarly Flemengia has also shown good growth in Gajurichhap. Kibmu and Badahar growth rate is good in Chankubesi. So among five sites, Gajurichhap and Chankhubesi performs very well for the growth of species like Ipil and Kimbu. Likewise, the

survival of Ipil is very well in Gajurichhap and Gauthale. The survival of Kimbu was also good in Gajurichhap and Ange. Bhatmase performs well in Ange and the survival rate of Badahar was also quite good in Gajurichhap and Gauthale.

It should be taken into account that the data covers only one year of growth and it would be premature to draw any conclusion on the performance of planted seedlings. Regular assessment of planted trees should continue at least 2 to 3 years before a firm conclusion can be made.

Annex-1 Brief description of fodder trees preferred by participating farmers

Badahar (*Artocarpus Lakoocha*)
It is a medium sized tree. It occurs naturally from the Terai to about 1600 m. It grows best on deep permeable soil with a good supply of moisture. It is one of the most valuable fodder trees in Nepal. Farmers prize it for its high nutrient value and good yield of leaves. It has a crude protein content of about 16 percent, and is relatively low in tannin. The tree can be lopped for fodder after it is about four years old. Estimation of fodder yields vary considerably from 36 to 270 kg of fresh matter per year for a mature tree; an average of 128 kg/tree/year (Vaidya and Gautam 1989).

Guazuma (*Guazuma ulmifolia*)
It is an exotic small to medium size tree. *Guazuma ulmifolia* is an evergreen except in areas with a long dry season. It grows up to 15m. in height. It thrives well in moist tropical climates with about 1000 to 2000 mm annual rainfall. Tolerates a wide range of soil types. Foliage is an excellent feed source for livestock especially in the dry season. It was introduced to Nepal in 1985. The tree coppices and pollards well. It yields 8.9 kg/tree/year (Amatya, 1992). Green leaves contain 95 percent total dry matter and 17 percent protein (Salazar and Qusda, 1987 quoted in Jackson, 1994). The leaves are highly palatable to livestock. The NDF, ADF and lignin percentages are 24.07, 19.86 and 10.71 respectively, The total nitrogen (%) and Total P(%) are 2.15 and 0.35 respectively (DFRS 2000, unpublished report)

Ipil Ipil (*Leucaena diversifolia*)
Leucaena is a tropical tree with a wide distribution. It is fast-growing with a low mimosine content. Under optimum growing conditions *Leucaena* stands have yielded extraordinary amounts of wood, indeed among the highest annual totals ever recorded. It also makes quality forage. Its additional uses include re-vegetation of hill slopes, provision of windbreaks and shade.
It grows on well drained, fertile soils and, if regularly mowed or clipped, produces large quantities of foliage. For ruminant animals it is palatable, digestible and nutritious. It is a promising candidate for increasing meat and milk production in some seasonal tropics (NAS, 1984) Annual yield of dry matter is between 12 and 20 tons per hectare. This is equivalent to the annual production of 800 to 4300 kg of protein per hectare (NAS. 1977).

Kimbu (*Morus alba*)
Kimbu (*Morus alba*) is a species native to China. It is a small deciduous tree, but can grow to fairly large dimensions on suitable sites. It thrives well on poor sites as well but for good growth the tree needs deep and well-aerated loamy soils. The tree coppices well, and can also be pollarded.
It is one of the fastest growing fodder trees and is an excellent source of feed for livestock. The crude protein content in the leaves ranges from 14 to 28 percent depending on locality (Pandey, 1982 and Singh 1982). A mature tree may produce 40-50 kg of tree leaves in a year.

Tanki (*Bauhinia purpurea*)
A moderate light demanding species found in all regions of Nepal, up to 1600 m. altitude. In the first few years the rate of growth is slow, especially at altitudes above 1200m. It is one of the most important native fodder trees. There are reports indicating increases in milk yield from feeding this

fodder to buffalo. The main season for utilization of fodder in most places is from November to February.
Old trees can be lopped twice yearly, first in February and March and second in April and May from the new flush. The average yield from mature trees is in the range of 21 to 111 kg. The crude protein content of its fodder is approximately 12.6 percent.

Bhatamase (*Flemingia congesta*)
Flemingia is a bushy legume species. It can be planted from the Terai to mid hills. It is very nutritious to livestock. It is a very suitable plant for hedgerow preparation and soil conservation. Fodder can be cut three times a year. It can be planted by direct sowing after the first monsoon rains.

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