

The

# RHINOCEROS BROWSE SURVEY



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# **RHINOCEROS BROWSE SURVEY**

## **INTRODUCTION**

### Reasons for conducting the survey

Chester Zoo uses quite a lot of browse which comes from the Zoo's own land or is donated to us. Some tree species are common locally and so used more often which means also that these are becoming well trimmed after years of use. Others species are available but have not been used as we are not too sure what effect they would have on the rhinoceros. Because of this it was decided to do this survey to find out which species are regarded as 'safe' by other collections and which are regarded as poisonous.

### How it was conducted

A single-sided questionnaire was put together explaining, the reasons for conducting this survey. On the questionnaire the collections were asked to list all the plants that they have tried, if they were still used, fed fresh or dry, was it always eaten, or some left, any side effects suffered, if so what? If the collections have had more than one species of rhinoceros then they were asked to fill a questionnaire in for each species to see if there is any variation in their choice of browse. Photocopies of the questionnaire were handed out at the Rhinoceros Workshop held at Whipsnade Zoo on 15<sup>th</sup> July, 1998. Also, where possible, information was collected from zoos who used to keep the rhinoceros and those that have closed.

### Response

After a great deal of chasing up all the questionnaires were returned or details given over the telephone.

### Results

The results of the survey are summarised in the Appendices to this project.

## **COLLECTIONS TAKING PART IN THE SURVEY**

**BLACKPOOL MUNICIPAL ZOOLOGICAL GARDENS**

**BLAIR DRUMMOND SAFARI & LEISURE PARK**

**BRISTOL ZOO ( *THE BRISTOL, CLIFTON & WEST OF ENGLAND ZOOLOGICAL SOCIETY* )**

**CHESTER ZOO ( *THE NORTH OF ENGLAND ZOOLOGICAL SOCIETY* )**

**COLCHESTER ZOO**

**COTSWOLDS WILDLIFE PARK**

**DUBLIN ZOO ( *THE ROYAL ZOOLOGICAL SOCIETY OF IRELAND* )**

**EDINBURGH ZOO ( *THE ROYAL ZOOLOGICAL SOCIETY OF SCOTLAND* )**

**KNOWSLEY SAFARI PARK**

**LAMBTON LION PARK**

**LONDON ZOO ( *ZOOLOGICAL SOCIETY OF LONDON* )**

**LONGLEAT**

**MARWELL ZOOLOGICAL PARK ( *MARWELL PRESERVATION TRUST LTD* )**

**PAIGNTON ZOOLOGICAL & BOTANICAL GARDENS ( *THE WHITLEY WILDLIFE CONSERVATION TRUST* )**

**PORT LYMPNE ZOO PARK**

**WEST MIDLAND SAFARI & LEISURE PARK**

**WHIPPSNADE WILDLIFE PARK ( *ZOOLOGICAL SOCIETY OF LONDON* )**

**WOBURN SAFARI PARK**

## THE DIGESTIVE SYSTEM OF THE HORSE

The horse and rhinoceros have very similar digestive systems. There is not much information on the digestive system of the rhinoceros so a description of the horse's is the closest to it.

The highly specialised large intestine has developed to allow this herbivore to thrive on a high-fibre diet. The stomach and small intestine which are designed to digest soluble nutrients and function to diminish the time fibre spends in these segments before delivering it rapidly to the large intestine.

### Saliva

Contains ptyalin to digest starches and mucus for lubrication.

### Stomach

Secretes hydrochloric acid and pepsinogen which participate in the digestion of proteins. Also secretes mucus and bicarbonate which help protect the lining against digestion by acid and pepsin. The gastric pH decreases (ie becomes more acid) with a decreased food intake. Buffers released from food during digestion can raise the pH (ie becomes less acid) during times of food intake. Severe ulceration of the stomach lining can develop rapidly (in less than 7 days) in horses deprived of feed or not eating.

### Pancreatic Secretion

Secretes bicarbonate to neutralise the acid in the first part of the small intestine. Enzymes for digesting carbohydrates, fat and protein. Resting secretion is 10-12 litres/100 kg body weight/day.

### Biliary Secretion by the Liver

Provides a source of bile salts for fat digestion and absorption. The horse has no gall bladder so it secretes bile continuously into the intestine. The fat soluble vitamins A, D and E are usually stored in the body but vitamin K is not. Therefore, if bile secretion ceases, a deficiency of vitamin K develops and this leads to a deficient formation of blood clotting factors.

### Small Intestine

Secretes mucus and extracellular fluid which is rapidly re-absorbed so the overall effect is net absorption.

Nutrient absorption (carbohydrates, proteins and fats) and surface digestion occur in the jejunum and ileum but not in the colon. Almost all volatile fatty acid absorption takes place in the colon.

### Function of the Caecum and Colon

The large intestine of the horse is a complex, voluminous structure with a greater capacity relative to the entire gastrointestinal tract than the large intestine of ruminants, pigs, dogs and man.

The weight of the contents of the large intestine of the horse accounts for 13.1% of the the weight of the whole animal.

### Microbial Digestion in the Large Intestine

(Digestion by millions of bacteria and protozoa in the large intestine)

There are marked similarities between microbial digestion in the rumen and in the equine large intestine. The conditions present in the large intestine which enable this type of digestion are:- the availability of substrate, prolonged retention time, anaerobic (no oxygen) and the ability to maintain the optimum level of acidity despite the fact that the acid and products of bacterial fermentation are continually being added.

The polysaccharides of plant fibre provide the substrate for microbial digestion in the large intestine resulting in the production of short chain fatty acids.

The small intestine is the primary site of digestion and absorption of soluble nutrients in the diet.

If any excess soluble carbohydrates reaches the colon from the small intestine the bacteria in the colon can convert it to short chain fatty acids and lactate which the horse can use as a source of energy.

Short chain fatty acid production in the horse's caecum alone accounts for approximately 30% of the animal's basal energy requirement.

The overall transit time through the gastrointestinal tract of the horse ranges from 48-96 hours, depending on the physical form of the diet. The prolonged retention of solid particles in the horse's large colon is related to the need for microbial digestion.

Microbial digestion produces large quantities of acid that must be continuously neutralised.

Storage and absorption of tremendous volumes of water is one the most important functions of the equine large intestine, and short chain fatty acids appear to play a major role in this process. Large volumes of water rich in sodium and bicarbonate are exchanged across the colonic mucosa in cyclic periods resulting from a cyclic pattern of microbial digestion

Over 95% of sodium bicarbonate and water in the large intestine is reabsorbed daily.

The caecum appears to play an important role in water conservation in the horse.

Digestive secretions are estimated at 30 litres/100kg body weight per day for parotid, gastric, biliary, pancreatic and small intestinal secretions and 7 litres/100kg body weight /day for the large intestine.

To conserve normal gastrointestinal water balance the total net absorption from the intestine is about 98% of the combined intake of water and secretions, an amount equivalent to the animal's extracellular fluid space.

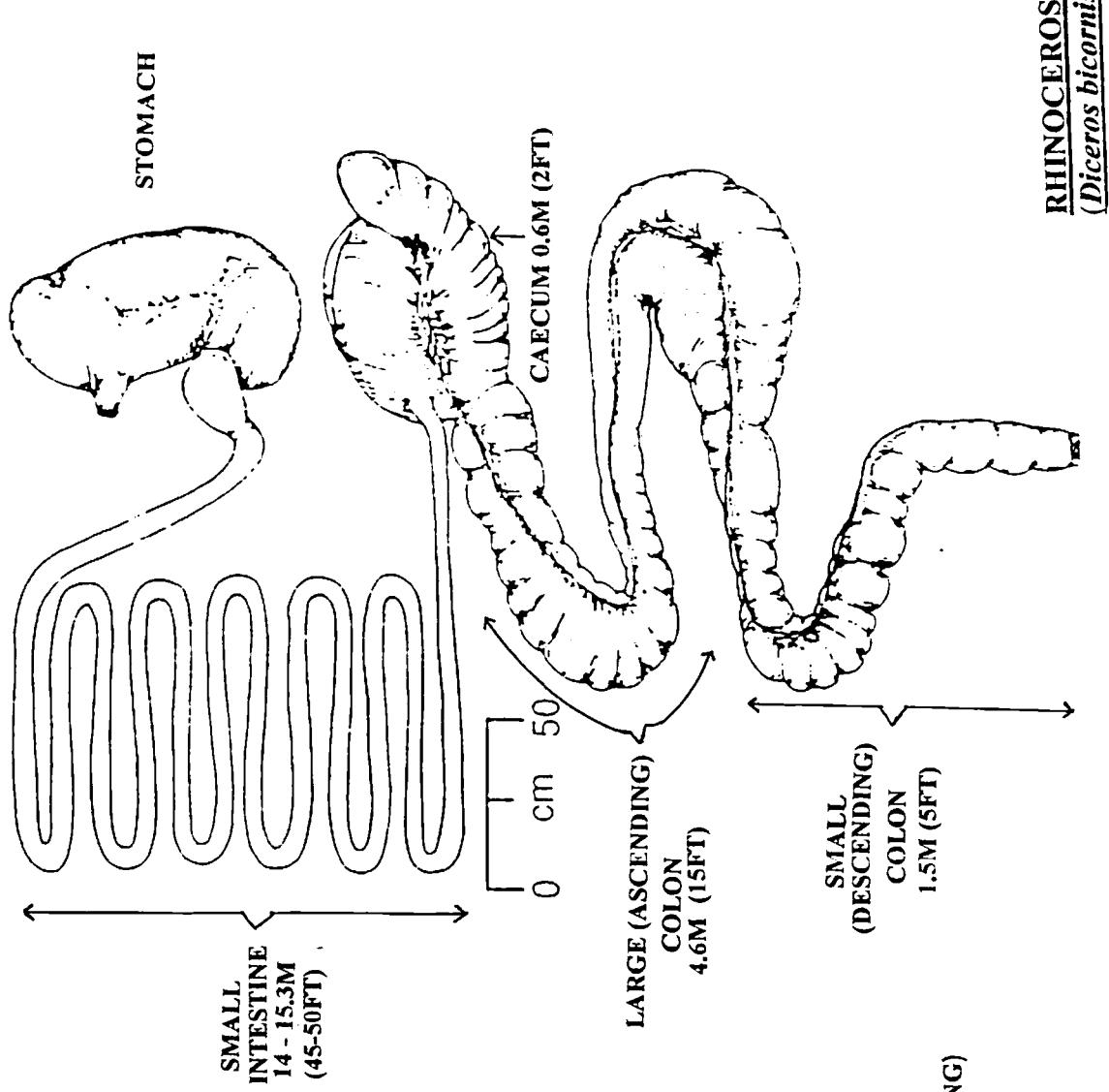
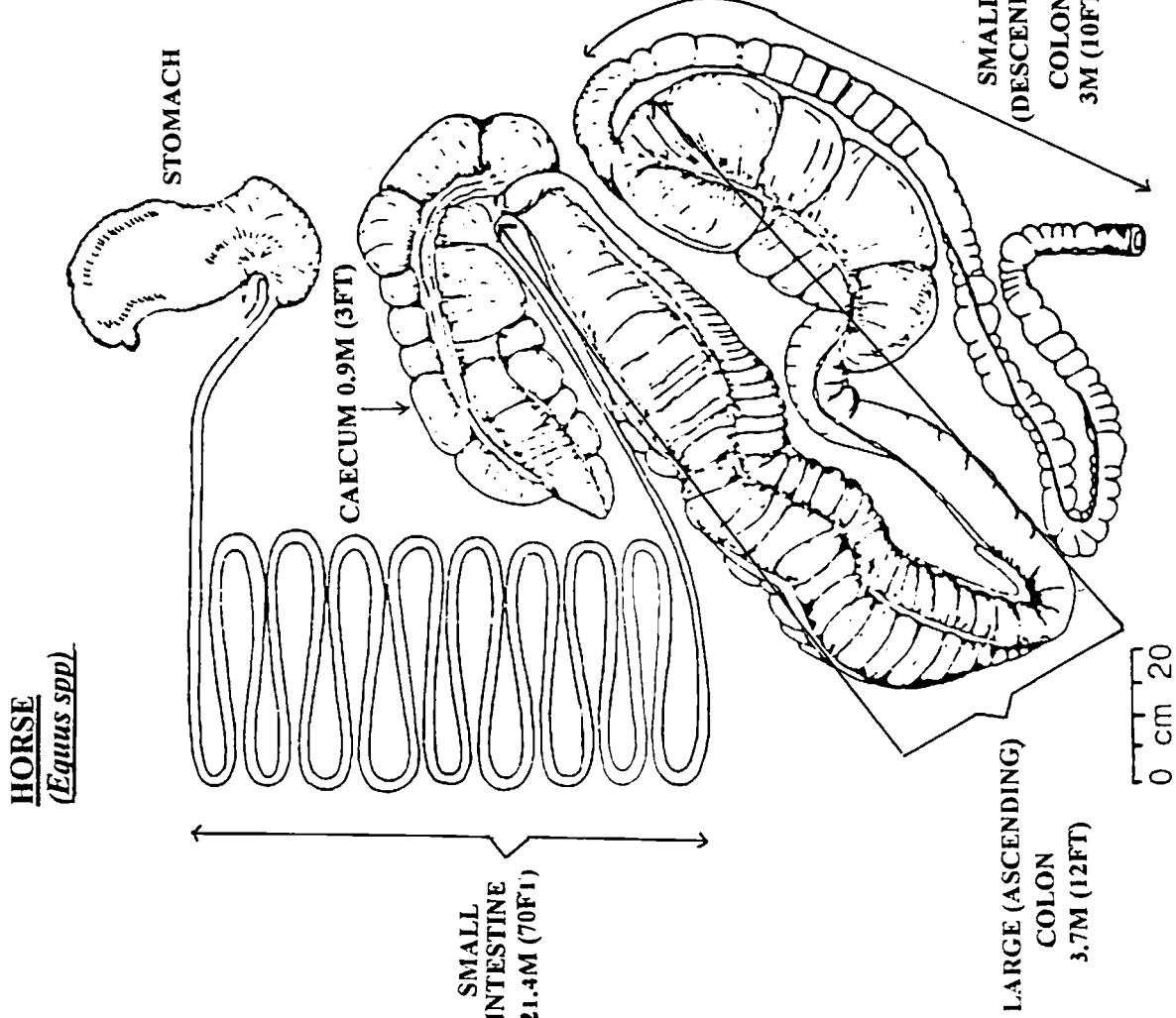
Failure to recover this fluid can lead to diarrhoea while recovery of too much can lead to impaction colic.

Episodic feeding (ie fed twice a day) can cause a 15% decrease in plasma volume at each feeding compared with horses fed continuously caused by abrupt loss of fluid into the bowel during production of normal digestive tract sections.

#### Acknowledgement

I am especially grateful to G.B. Edwards, Professor of Equine Studies, The University of Liverpool, Leahurst for this description of the horses digestive system.

**THE DIGESTIVE TRACTS OF THE HORSE AND RHINOCEROS**



## SOME CASES OF INTEREST RELATING TO THE FEEDING OF BROWSE

In 1967 the black rhinoceros, Roger of Chester Zoo was suffering from a mysterious illness, which was thought life threatening.

He had swollen lesions in his mouth, which were constantly bleeding. They appeared to be causing some irritation as he was always rubbing his mouth down the corners of the wall, leaving blood and flesh everywhere. Members of the public would say it looked like an abattoir! Roger's face, limbs and testicles were grossly swollen so much that he had difficulty walking.

Quite a few vets and experts were called in to give their views and hopefully come up with some answers, but all were baffled. At that time Ian Player (the brother of the renowned golf player Gary Player and the author of the book '*The White Rhino Saga*') was in U.K and visiting the Zoo.

Ian Player was in charge of the Umfolozi Game Reserve in South Africa. He took one look at Roger and asked if he was getting any browse. When he was told that he was not Ian said that browse, in particular oak (*Quercus spp*), was essential because of the iodine content.

Roger had been suffering from this condition for a number of weeks and it appeared to be getting worse. However, when Ian Player's advice was acted upon and Roger got some oak his condition improved after a few days. Within a week he was completely cured.

As far as George Mottershead was concerned the iodine in the oak had saved the rhino's life.

Ever since then all the rhinos have been getting browse throughout the summer, which is obtained from the oak trees surrounding the Zoo.

In the late 1970's or early 1980's the black rhino Mama Kidago at Whipsnade caused a haemolytic anaemia scare. She had discoloured urine and was off colour. The vet was convinced it was haemolytic anaemia. She did make a full recovery, it was however after the recent feeding of willow branches so they may have been implicated. They were not happy to feed any of the willow (*Salix spp*) species as it was thought cause stomach upsets, Saliciolosis, due to the aspirin contents in trees.

One collection that used the False Acacia (*Robina pseudacacia*) now avoids it being fed to the rhinoceros. This is because the fruit and bark are stated as being poisonous to the Giraffe (*Zoo Federation Guidelines to the Management of the Giraffe*)

One collection now avoids the use of oak if other species of browse are available. This is because it is thought to be toxic if ingested in large quantities. It can cause nephrosis manifested by polyuria, ventral edema, abdominal pain and constipation followed by the passage of faeces containing mucus and blood in other species.

## OBSERVATIONS OF THE RESULTS

Appendix 1 gives the number of groups using the browse species and, in brackets the number of collections using it. This is to show how widespread the use of certain species is. For example a collection that has kept three species of rhinoceros would count as three. It makes allowance for the fact different species of rhinoceros did not have the same taste in their preference for browse.

1. There are 30 species of plant listed as having been eaten by the rhinoceros, 23 of these are used by two or more collections. This list allows the possibility of most collections safely extending the species of browse fed.
2. Oak (*Quercus spp*) is the most widely used browse species, having been used by 9 collections and 14 groups within these. All four species of rhinoceros have eaten oak. One collection noted that holm oak (*Quercus ilex*) turned the urine orange, yellow or red.
3. Willow (*Salix spp*) follows behind the oak in its popularity of use. It is also used by 9 collections, but 13 groups within these. One collection also noted that willow turned the urine orange, red or yellow.
4. Bramble (*Robus spp*) and alder (*Alnus glutinosa*) are the least used by one collection and the Sumatran rhinoceros (*Didermocerus sumatrensis*)
5. The two species of grass, in the list, are eaten by the rhinoceros of their own choice, as they grow in their paddocks.
6. The black rhinoceros (*Diceros bicornis*) has the largest range of species fed to it, (25 of the 30 species listed.) See Appendix 3 for this list.
7. The Indian rhinoceros (*Rhinoceros unicornis*) follows the black rhinoceros (*Diceros bicornis*) in the range of browse offered to it. They have been offered 22 of 30 species listed. See Appendix 4 for this list.
8. The Sumatran rhinoceros (*Didermocerus sumatrensis*) is offered the smallest range of browse, although this is only by one collection. See Appendix 6.
9. The white rhinoceros (*Ceratherium simnum*) are offered the same total in the range as that of the Sumatran rhinoceros (*Didermocerus sumatrensis*). It has been offered browse by 5 of 15 collections taking part in the survey. It should however be noted that two of these five collections are mixed exhibits so browse in not being fed out just for the rhinoceros. See Appendix 5 for this list.
10. The black rhinoceros (*Diceros bicornis*) and the white rhinoceros (*Ceratherium simnum*) share the same choice in the most frequently fed browse. These are the oak (*Quercus spp*) and willow (*Salix spp*). With the Indian rhinoceros (*Rhinoceros unicornis*) there are three species that are equal in popularity used by them. They are the ash (*Fraxinus excelsior*), sycamore (*Acer pseudopantanus*) and the willow (*Salix spp*). However the sycamore and ash are not always eaten.

**APPENDIX 1**  
**BROWSE LISTED IN ORDER OF POPULARITY OF USE**

<b>SPECIES</b>		<b>Number of users</b>	<b>Species using it</b>	<b>Notes</b>
OAK	<i>Quercus spp</i>	14 (9)	W,B,I,S	F/D 5 NAE
WILLOW	<i>Salix spp</i>	13 (9)	W,B,I,S	F/D 4 NAE
BEECH	<i>Fagus sylvatica</i>	11 (8)	W,B,I	F/D 4 NAE
SYCAMORE	<i>Acer pseudoplatanus</i>	11 (6)	W,B,I,S	F/D 4 NAE
ASH	<i>Fraxinus excelsior</i>	8 (5)	W,B,I,S	1 N/E
MAPLE	<i>Acer spp</i>	8 (5)	W,B,I,S	2 NAE 1 N/E
APPLE	<i>Malus domestica</i>	7 (4)	B,I,S	
HAWTHORN	<i>Crataegus monogyna</i>	7 (4)	B,I,S	F/D 2 NAE
BIRCH	<i>Betula spp</i>	6 (4)	W,B,I,S	F/D 2 NAE
CHERRY	<i>Prunus avium</i>	6 (4)	B,I	F/D 2 NAE
SWEET CHESTNUT	<i>Castanea sativa</i>	6 (3)	B,I,S	F/D
POPLAR	<i>Populus spp</i>	4 (3)	W,B,I	1 N/E
HORSE CHESTNUT	<i>Aesculus hippocastanum</i>	4 (3)	W,B,I	F/D 2 NAE
HAZEL	<i>Corylus avellana</i>	4 (3)	W,B, S	
PEAR	<i>Pyrus communis</i>	3 (2)	B,I	F/D
PLUM	<i>Prunus avium</i>	3 (2)	B,I	F/D
CRAB APPLE	<i>Malus sylvestris</i>	3 (2)	B	F/D 2 NAE
LIME	<i>Malus x vulgaris</i>	3 (2)	B	2 NAE 1 N/E
ROWAN	<i>Sorbus aucuparia</i>	3 (2)	B,I	2 NAE 1 N/E
MAIZE	<i>Zea mays</i>	3 (2)	B,I,S	
PLANE	<i>Platanus spp</i>	3 (1)	W,B,I	F/D 1 NAE
FALSE ACASIA	<i>Robinia pseudoacacia</i>	2 (1)	B,I	
BLACKTHORN	<i>Prunus spinosa</i>	2 (1)	B, S	
COMMON HORNBEAM	<i>Carpinus betulus</i>	2 (2)	I,S	F/D
KALE	<i>Brassica oleracea</i>	2 (1)	B,I	
ELM	<i>Ulmus spp</i>	2 (2)	B,I	F/D
PAMPAS GRASS	<i>Spp</i>	2 (2)	W	
ALDER	<i>Alnus glutinosa</i>	1 (1)	W	
BRAMBLE	<i>Rubus spp</i>	1 (1)	S	
SEDGE GRASS	<i>Carex spp</i>	1 (1)	W	

**KEY:** F/D = Fed fresh or dry. NAE = Not always eaten. N/E = Never eaten.

W = White rhinoceros. B = Black rhinoceros. I = Indian rhinoceros.

S = Sumatran rhinoceros

This table gives the number of groups using the browse species and, in brackets the number of collections using it. This is to show how widespread the use of certain species is. For example a collection which has had three species of rhinoceros, and all have eaten oak, would count as three. It makes the allowance for the fact that the different species of rhinoceros did not have the same taste in their preference for browse.

**APPENDIX 2**  
**BROWSE IN ORDER OF POPULARITY OF USE**

<u>EXPANSION ON SPECIES</u>		<u>NUMBER OF USERS</u>
<b>OAK</b>		
HOLM OAK	<i>Quercus ilex</i>	9
PEDUNCULATE OAK	<i>Quercus cerris</i>	4
TURKEY OAK	<i>Quercus robur</i>	2
SESSILE OAK	<i>Quercus petraea</i>	2
UNSPECIFIED	<i>Quercus spp</i>	8

<u>WILLOW</u>		
WEEPING WILLOW	<i>Salix babylonica</i>	4
GOAT WILLOW	<i>Salix caprea</i>	1
UNSPECIFIED		12

<u>BIRCH</u>		
SILVER BIRCH	<i>Betula pendula</i>	5
UNSPECIFIED	<i>Betula spp</i>	1

<u>ELM</u>		
SCOTS or SCOTCH ELM or WYCH ELM	<i>Ulmus glabra</i>	1
UNSPECIFIED	<i>Ulmus spp</i>	1

<u>PLANE</u>		
LONDON PLANE	<i>Platanus x hybrida</i> or <i>Platanus acerifolia</i>	1
UNSPECIFIED	<i>Platanus spp</i>	2

<u>MAPLE</u>		
FIELD MAPLE	<i>Acer campestre</i>	1
UNSPECIFIED	<i>Acer spp</i>	6

**APPENDIX 3**  
**THE POPULARITY OF BROWSE BY THE SPECIES**  
**THE BLACK RHINOCEROS (*Diceros bicornis*)**

All 6 of the collections who have kept the black rhinoceros, and taken part in the survey, have fed browse regularly. Two other collections, who have kept the black rhinoceros, unfortunately have no record of their diet.

SPECIES		NUMBER OF USERS	NOTES
HOLM OAK	<i>Quercus ilex</i>	5	2 NAE, F/D. Turns urine yellow, orange or red.
WILLOW	<i>Salix spp</i>	5	1 NAE, F/D. Turns urine yellow, orange or red.
APPLE	<i>Malus domestica</i>	4	F/D. Turns urine pink.
BEECH	<i>Fagus sylvatica</i>	4	2 NAE
CHERRY	<i>Prunus avium</i>	4	1 NAE, F/D. Turns urine pink.
HAWTHORN	<i>Crataegus monogyna</i>	4	1 NAE, F/D.
OAK	<i>Quercus spp</i>	4	1 NAE, F/D.
SYCAMORE	<i>Acer pseudoplatanus</i>	4	2 NAE, F/D. Turns urine orange, yellow or red.
ASH	<i>Fraxinus excelsior</i>	3	1 N/E, F/D
MAPLE	<i>Acer spp</i>	3	1 N/E
SWEET CHESTNUT	<i>Castanea sativa</i>	3	1 NAE, F/D. Turns urine brown.
CRAB APPLE	<i>Malus sylvestris</i>	2	1 NAE, F/D. Turns urine pink.
LIME	<i>Tilia x vulgaris</i>	2	1 NAE, 1 N/E.
PEAR	<i>Pyrus communis</i>	2	F/D. Turns urine pink.
PLUM	<i>Prunus avium</i>	2	F/D. Turns urine pink.
POPLAR	<i>Populus spp</i>	2	1 N/E.
ROWAN	<i>Sorbus aucuparia</i>	2	1 N/E.
SILVER BIRCH	<i>Betula pendula</i>	2	2 NAE.
WEEPING WILLOW	<i>Salix babylonica</i>	2	
BIRCH	<i>Betula spp</i>	1	F/D
BLACKTHORN	<i>Prunus spinosa</i>	1	
ELM	<i>Ulmus spp</i>	1	
FALSE ACASIA	<i>Robinia pseudoacacia</i>	1	
HAZEL	<i>Corylus avellana</i>	1	
HORSE CHESTNUT	<i>Aesculus hippocatanum</i>	1	F/D. Turns urine red, orange or yellow.
KALE	<i>Brassica oleracea</i>	1	
MAIZE	<i>Zea mays</i>	1	
PEDUNCULATE OAK	<i>Quercus robur</i>	1	
PLANE	<i>Platanus spp</i>	1	NAE, F/D. Turns urine red, orange or yellow.
SESSILE OAK	<i>Quercus petraea</i>	1	
TURKEY OAK	<i>Quercus cerris</i>	1	

KEY: NAE = Not always eaten. N/E = Never eaten. F/D = Fed fresh or dry.

**APPENDIX 4**  
**THE POPULARITY OF BROWSE BY SPECIES**  
**THE INDIAN RHINOCEROS (*Rhinoceros unicornis*)**

Three of the collections taking part in the survey have kept the Indian rhinoceros. All three fed browse regularly. The species they ate are;

<u>SPECIES</u>		<u>Number of users</u>	<u>Notes</u>
ASH	<i>Fraxinus excelsior</i>	3	F/D
SYCAMORE	<i>Acer pseudoplantus</i>	3	1 NAE F/D
WILLOW	<i>Salix spp</i>	3	1 NAE
APPLE	<i>Malus domestica</i>	2	
BEECH	<i>Fagus sylvatica</i>	2	F/D
HAWTHORN	<i>Crataegus monogyna</i>	2	1 NAE
HOLM OAK	<i>Quercus ilex</i>	2	1 NAE
MAPLE	<i>Acer spp</i>	2	
PEDUNCULATE OAK	<i>Quercus robur</i>	2	F/D
SWEET CHESTNUT	<i>Castanea sativa</i>	2	Turns urine brown
CHERRY	<i>Prunus avium</i>	1	1 NAE
COMMON HORNBEAM	<i>Carpinus betulus</i>	1	F/D
CRAB APPLE	<i>Malus sylvestris</i>	1	1 NAE
FALSE ACASIA	<i>Robinia pseudocacia</i>	1	
HORSE CHESTNUT	<i>Aesculus hippocastanum</i>	1	F/D
KALE	<i>Brassica oleracea</i>	1	
LIME	<i>Tilia x vulgaris</i>	1	1 NAE
LONDON PLANE	<i>Platanus x hybrida</i>	1	
MAIZE	<i>Zea mays</i>	1	
OAK	<i>Quercus spp</i>	1	F/D
PEAR	<i>Pyrus communis</i>	1	
PLUM	<i>Prunus avium</i>	1	
POPLAR	<i>Populus spp</i>	1	
ROWAN	<i>Sorbus aucuparia</i>	1	
SESSILE OAK	<i>Quercus petraea</i>	1	
SILVER BIRCH	<i>Betula pendula</i>	1	1 NAE
SCOT'S ELM	<i>Ulmus glabra</i>	1	F/D
TURKEY OAK	<i>Quercus cerris</i>	1	
WEEPING WILLOW	<i>Salix babylonica</i>	1	

**KEY:** NAE=Not always eaten. F/D = Fed fresh or dry.

**APPENDIX 5**  
**THE POPULARITY OF BROWSE BY SPECIES**

**THE WHITE RHINOCEROS (*Ceratotherium simun*)**

Of the 15 collections taking part in this survey 8 have offered browse to their white rhinoceros. Of the 12 collections who still keep white rhinoceros, and took part in the survey, only 5 feed browse on a regular basis (two are however mixed exhibits.)

<u>SPECIES</u>		<u>NUMBER OF USERS</u>	<u>NOTES</u>
OAK	<i>Quercus spp</i>	4	1 NAE
WILLOW	<i>Salix spp</i>	4	
BEECH	<i>Fagus sylvatica</i>	3	1 NAE
SYCAMORE	<i>Acer pseudoplantonus</i>	3	1 NAE
HAZEL	<i>Corylus avellana</i>	2	
HOLM OAK	<i>Quercus ilex</i>	2	1 N/E
PAMPAS GRASS	<i>Spp</i>	2	
ALDER	<i>Alnus glutinosa</i>	1	
ASH	<i>Fraxinus excelsior</i>	1	
GOAT WILLOW	<i>Salix caprea</i>	1	1 NAE
HORSE CHESTNUT	<i>Aesculus hippocastanum</i>	1	1 NAE
MAPLE	<i>Acer spp</i>	1	1 NAE
PEDUNCULATE OAK	<i>Quercus robur</i>	1	1 NAE
LONDON PLANE	<i>Platanus x hybrida</i>	1	
POPLAR	<i>Populus spp</i>	1	
SEDGE GRASS	<i>Carex spp</i>	1	
SILVER BIRCH	<i>Betula pedula</i>	1	
WEEPING WILLOW	<i>Salix babylonica</i>	1	1NAE

KEY: NAE = Not always eaten. N/E =Never eaten

**NOTES**

As mentioned 2 of the 5 collections still feeding browse to their white rhinoceros are mixed exhibits; One of these collections keeps their white rhinoceros with eland, camel and Ankole cattle. Sycamore, pedunculate oak and common beech are put into the mixed exhibit. It has been found that the rhinoceros eat the remaining twigs after the other animals have stripped them.

The other collection feeds oak, sycamore, silver birch and alder to their Mixed Reserve species which the rhinos will eat.

One collection who have 1.2 white rhinoceros has found that the male and one of the females like to eat pampas grass, which can be found on top of the ha-ha. It is only eaten in August. All three of them like to eat the sedge grass found in their enclosure, but only when grazing is sparse.

Another collection does not feed their rhinoceros browse, but they will eat pampas grass periodically.

Fresh browse is not used by one collection which uses bark on the floor of the house. The white rhinoceros will chew on this wood, which is made of dead oak and chestnut trees.

APPENDIX 6  
THE POPULARITY OF BROWSE BY  
SPECIES

**THE SUMATRAN RHINOCEROS**

*(Didermocerus sumatrensis)*

Only one collection in the British Isles has kept the Sumatran rhinoceros in the last few years.

The species eaten are;

<b>APPLE</b>	<i>Malus domestica</i>
<b>ASH</b>	<i>Fraxinus excelsior</i>
<b>BLACKTHORN</b>	<i>Prunus spinosa</i>
<b>BRAMBLE</b>	<i>Robus spp</i>
<b>FIELD MAPLE</b>	<i>Acer campestre</i>
<b>HAWTHORN</b>	<i>Crataegus monogyna</i>
<b>HOLM OAK</b>	<i>Quercus ilex</i>
<b>HORNBEAM</b>	<i>Carpinus betulas</i>
<b>MAIZE</b>	<i>Zea mays</i>
<b>OAK</b>	<i>Quercus spp</i>
<b>SILVER BIRCH</b>	<i>Betula pendula</i>
<b>SWEET CHESTNUT</b>	<i>Castanea sativa</i>
<b>SYCAMORE</b>	<i>Acer pseudoplantanus</i>
<b>WILLOW</b>	<i>Salix spp</i>

## APPENDIX 7 BROWSE SUBSTITUTES

Browse is not always available so a substitute is used to replace it.

The different substitutes used by the collections taking part in the survey are;

<b>RHINO SUPPLEMENT</b>	<b>MAZURI ZOO FOODS,</b> Special Food Services, Witham, Essex. CM8 3AD.
<b>BROWSER BREEDER</b>	<b>MAZURI ZOO FOODS,</b> Special Food Services, Witham, Essex. CM8 3AD.
<b>RHINO DIET</b>	<b>MAZURI ZOO FOODS,</b> Special Food Services, Witham, Essex. CM8 3AD.
<b>ACASIA PELLETS</b>	<b>BOSKOS GAME PELLETS,</b> Wes Enterprises (Pty) Ltd, Posbus 340, Thabazimbi, 0380. South Africa.
<b>What some collections regard as a substitute others regard as browse these include;</b>	
<b>GRASS</b>	
<b>MAIZE (<i>Zea mays</i>)</b>	
<b>KALE (<i>Brassica oleracea</i>)</b>	

**PLANTS KNOWN TO BE POISONOUS TO THE HORSE**
**APPENDIX 8**

<u>SPECIES</u>	<u>DEGREE OF TOXICITY</u>	<u>PROBABLE SERIOUS OR FATAL DOSAGE</u> (fresh wt)	<u>POISON INVOLVED</u>	<u>POISON PARTS OF THE PLANT</u>	<u>WHETHER IT IS POISONOUS IN DRY FORM</u>	<u>CLINICAL SYMPTOMS AND BEFORE DEATH IF FATAL</u>
AVOCADO ( <i>Persa americana</i> )				Flowers the main source of toxin when in bloom & the leaves		Causes heart disease. Death a few days
ACONITE, WINTER ( <i>Eranthis hyemalis</i> )			Bryonin & other glycosides	All parts		Restless & attacked by colic. Walks with an unsteady gait, paralysis in hind limbs. Death follows later.
ACRID, BUTTER-CUP ( <i>Ranunculus</i> <i>Acris</i> )	Very toxic	Large dosage	Protoanemonin		Harmless When dry	Inflammation & narcosis
BUTTERCUP ( <i>R. spp</i> )	Very slight	Very large	Protoanemonin	All parts	Harmless when dry	Inflammation & narcosis
BULBOUS BUTTERCUP ( <i>R. bulbis</i> )	Very toxic	Large dosage			Harmless when dry	Inflammation & narcosis
BUTTERCUP, CREEPING ( <i>R. repens</i> )	Very slight	Large dosage	Protoanemonin		Harmless when dry	Inflammation & narcosis
BUTTERCUP, CELERY – LEAVED ( <i>R. scleratus</i> )	Very slight	Large dosage	Protoanemonin		Harmless when dry	
BRACKEN ( <i>Pteridium aquilinum</i> )	Very toxic cumulative	Large dosage	Thiaminase & possibly other toxins	All parts	Toxic	
BRYONY, BLACK ( <i>Tamus communis</i> )	Very poison-ous	2.25 KG (2lb)	Glycosides	Roots & fruit dangerous, Foliage harmless		Vomiting & paralysis
BRYONY, WHITE ( <i>Bryonia dioica</i> )	Very poisonous	2.25 KG (2lb)	Bryonin & Other glycosides	Foliage Rarely eaten, roots Very toxic		Inflammation & convulsions
BOXWOOD ( <i>Buxus sempervirens</i> )	Very toxic	1 KG (2lb)	Buxine (alkloids)	All parts	Toxic	Purgung, Congestion Of the lungs
CASTOR OIL PLANT ( <i>Fantasia japonica</i> )	Very toxic	Small 0.1g/kg of Body weight	Toxalbumin	Seeds & recin		Severe diarrhoea weakness, feeble pulse, breathing difficulties & swollen joints
CHERRY LAUREL ( <i>Prunus laurocerasus</i> )	Slight to very poisonous	Varies	Cyanogen-ic glycosides	Leaves	Harmless	Difficulty Breathing, Convulsions Death sudden.
CHARLOCK ( <i>Sinapis arvensis</i> )	Very toxic	Small	Mustard oils	Seeds	Toxic	Acute gastroenteritis
CORNCOCKLE ( <i>Agrostemma lithago</i> )		0.25KG (0.5lb)	Saponin	Seeds	Toxic	Diarrhoea, wasting
COWBANE OR WATER HEMLOCK ( <i>Cnium maculatum</i> )	Very toxic	0.5KG (1lb)	Castotoxin	All parts, Roots main source	Toxic	Delirium, Convulsions Death 1 hour
DARNEL ( <i>Loilium temulentum</i> )		0.5 – 1KG (1 – 2lb)	Temuline (alkaloid)	Seeds	Toxic	Giddiness, stupefaction
DOGS MERCURY ( <i>Mercurialis perennis</i> )	Very toxic	Small	Alkaloids		Harmless	Irritation & narcosis
FOOLS PARSLEY ( <i>Aethusa cynapium</i> )	Very toxic	Small	Coniine		Harmless	

**PLANTS KNOWN TO BE POISONOUS TO THE HORSE** **APPENDIX 8 CONT**

<u>SPECIES</u>	<u>DEGREE OF TOXICITY</u>	<u>PROBABLE SERIOUS OR FATAL DOSAGE (fresh wt)</u>	<u>POISON INVOLVED</u>	<u>POISONOUS PARTS OF THE PLANT</u>	<u>WHETHER IT IS POISONOUS IN DRY FORM</u>	<u>CLINICAL SYMPTOMS AND TIME BEFORE DEATH IF FATAL</u>
FOXGLOVE ( <i>Digitalis purpurea</i> )	Very toxic	100g (0.25 lb)	Digitoxin & Other glycosides	Leaves, seeds & rosettes	Toxic	Contracted pupils & labored breathing.
GREATER CELANDINE ( <i>Cheidonium majus</i> )	Slight	Large	Alkaloids			Vomiting & purging
HARDRUSH ( <i>Janus inflexus</i> )	Very toxic	Small	?	All parts	?	?
HELLBORES ( <i>Hellbores spp</i> )	Very toxic		Hellborin & Other glycosides		Toxic	Narcosis & diarrhoea; death some weeks.
HEMLOCK ( <i>Conium maculatum</i> )	Very toxic	2.5 KG - 5KG (5-10 lb)	Coniine & Other glycosides	Flowers, fruits & leaves	Harmless	Narcosis & paralysis; death a few weeks.
HENBANE ( <i>Hyosyamus niger</i> )		Small	Hyosyamine & other alkaloids		Toxic	Narcosis, dilation of the pupils & Convulsions.
HORSE RADISH ( <i>Armoracia rusticana</i> )			Glycosides			
HORSETAIL ( <i>Equisetum palustre</i> )	Very toxic	Small	Thiaminase & possibly Other toxics		Toxic	Wasting, loss of muscular control
IRIS ( <i>Iris spp</i> )	Very toxic	Small	Iridin	All parts (rarely eaten fresh)	Toxic	Diarrhoea
LABERNUM ( <i>Laburnum anagyroides</i> )	Very toxic	0.5KG (1lb)	Cytisine (alkaloids)	All parts	Toxic	Excitement, convulsions, coma; death in a few hours.
LARKSPUR ( <i>Delphinium spp</i> )	Very toxic	0.5KG (1lb)	Alkaloids	Seeds & leaves		Depression & convulsions & paralysis; death in a few hours
LILY OF THE VALLEY LUPIN ( <i>Convallaria majalis</i> )	Very toxic	Small	Glycosides	All parts (seeds main source)		Chronic loss of appetite, weight, jaundice, cirrhosis of the liver, oedema of the head, ascites & then death.
MARSH MARIGOLD ( <i>Caltha palustris</i> )	Slight	Large	Protoanemonin		Harmless	Inflammation & narcosis
MEADOW SAFFRON ( <i>Colchicum maculatum</i> )	Very toxic	1.5 - 2.5KG (3-5lb)	Colchicine	All parts	Harmless	Vomiting, diarrhoea, stupefaction. Death a few hours.
MEZEREON ( <i>Daphne mezereum</i> )	Very toxic	Small	Glycosides			Purging, intestinal inflammation & narcosis.
MONKSHOOD ( <i>Aconitum napellus</i> )	Very toxic	0.5KG (1lb)	Aconitine (alkaloid)		Toxic	Depression & convulsions and paralysis; death a few hours
NIGHT SHADE, BLACK ( <i>Solanum nigrum</i> )	Slight	Large	Solanine (alkaloid)			Stupefaction & convulsions.
NIGHTSHADE, DEADLY ( <i>Atropa bella-donna</i> )	Very toxic	Varies with animal	Hyoscyamine & other alkaloids	All parts, berries & roots very toxic	Toxic	Narcosis, dilation of the pupils & convulsions.
NIGHTSHADE, WOODY ( <i>Solanum dulcamara</i> )	Slight	Large (?)	Solanine (alkaloid)	All parts	Toxic (?)	Giddiness, quickened heart beat, staggering gait, dilated pupils, greenish diarrhoea & raised temperature.
OAK ( <i>Quercus spp</i> )	Very slight	Very large	Tannins	Leaves & acorns		Constipation, blood in urine.
PIMPERNAL ( <i>Anagallis arvensis</i> )	Very slight	Large	Glycocides		Toxic	Irritation & narcosis

**PLANTS KNOWN TO BE POISONOUS TO THE HORSE** **APPENDIX 8 CONT**

<u>SPECIES</u>	<u>DEGREE OF TOXICITY</u>	<u>PROBABLE SERIOUS OR FATAL DOSAGE (fresh wt)</u>	<u>POISON INVOLVED</u>	<u>POISONOUS PARTS OF THE PLANT</u>	<u>WHETHER IT IS POISONOUS IN DRY FORM</u>	<u>CLINICAL SYMPTOMS AND TIME BEFORE DEATH IF FATAL</u>
POPPY ( <i>Popaver rhoeas</i> )	Slight	Large	Rhoeadine		Toxic	Excitement followed by coma
POTATO ( <i>Solanum tuberosum</i> )			Solanine (alkaloid)	Haulms & tops when Green & sprouting		Loss of appetite, prostration, interference in movement, weak pulse & a low or subnormal temperature.
PRIVET ( <i>Ligustrum vulgare</i> )	Slight	Large	Ligustrin (glycoside)	All parts		Vomiting, diarrhoea. Death sudden.
PURGE ( <i>Euphorbia spp</i> )	Slight	Large	Euphorbio-steriod		Toxic	Irritation & inflammation of the mouth.
RAGWORT ( <i>Senicio jacobaea</i> )	Very toxic & cumulative	1-5KG (2-10lb)	Jacobine & other alkaloids	All parts	Toxic	Straining, staggering, liver degeneration. Death up to 1 month.
RAGWORT, MARSH ( <i>Senecio aquaticus</i> )	Very toxic & cumulative	1-5KG (2-10lb)	Jacobine & Other alkaloids	All parts	Toxic	Straining, staggering, liver degeneration. Death up to 1 month.
RHODODENDRON ( <i>Rhododendron spp</i> )	Very toxic	Small	Andromedotoxin	All parts	Toxic	Vomiting, vertigo, death from failure of respiration.
SPEARWORT, GREATER	Very slight	Large	Protoanemonin		Harmless	Inflammation & narcosis.
SPEARWORT, LESSER	Very toxic	Large	Protoanemonin (?)		(?)	Inflammation & narcosis.
SPURGE LAUREL ( <i>Daphne laureola</i> )	Very toxic	Small	Cyangenetic glycoside		Toxic (?)	Purging, intestinal inflammation & narcosis.
ST JOHN'S WART ( <i>Hypericum perforatum</i> )						
THORN-APPLE ( <i>Datura stramonium</i> )	Very toxic	Small	Hyoscyamine, daturine & other alkaloids		Toxic	Narcosis, dilation of the pupils & convulsions.
WATER DROPWORT ( <i>Oenanthe fistulosa</i> )	Very toxic	0.5KG (1lb)	Oenathetoxin	All parts, particularly the roots.	Toxic	Narcosis & paralysis. Death one hour.
WILD ARUM ( <i>Arum maculatum</i> )	Slight		Acrid juice		harmless	Acute irritation.
WOOD ANEMONE ( <i>Anemone nemorosa</i> )		Large (?)	Photoanemonin		Harmless	Narcosis. Death sudden.
YEW ( <i>Taxus baccata</i> )	Very toxic	0.5-5KG (1-10lb)	Taxine (alkaloid)	All parts	Toxic	Irritation & narcosis. Death sudden.

## **THE SETTING UP OF A PLANTATION OR COPPICE**

With some collections it may be hard to get hold of a constant or reliable source of browse. If this is the case why not set up your own plantation or coppice so to produce this source of browse? It can also be used by other animals such as birds, primates and hoofstock.

**Site selection** is important when setting up a short rotation coppice or plantation;

- \*Soil should be at least 30cm deep. The pH must not be too high for willow or too low for poplar, about 6 is ideal.
- \*Land suited to mechanised planting and harvesting is preferable.
- \*Land needs protecting from animals such as deer and rabbits in the establishment phase.

### **Size of site**

The size of the area for the trial of the different hybrids should be 100 cuttings per plot, 10 rows with 10 in a row. An area of 2000m square is ample to set up the plantation with different hybrids and allow for replication.

### **Ground preparation**

- \*This should be carried out during autumn, to allow the winter frost to help break up the soil.
- \*Spray with *Glyphosate (Roundup)*, *Glufosinate (Challenge)*, *Amitrole (Weedazol TL)* or *Paraquat (Gramoxone 100)*
- \*Plough the land and then disc or harrow to break the soil to allow the 25cm cuttings to be planted a depth of 22cm (only 3-4cm should show above ground.)
- \*Prepare a fine tilth 4-5 days after planting.

### **What to plant**

There are several suitable clones of hybrids of willow and poplar. These are available for sale under the *Forest Reproductive Material Regulation*, which were initiated to assist plantings for biomass, and perform better than others in different soils and sites. Nurseries also stock a wider range of clones like *Dasyclados*, *Calodendron*, *Sericans*, *Matthews* or *Coles* and the late leafing *Kinugaugi*. Several different hybrids should be used to avoid the spread of disease and to see which perform best in the environment.

### **When to plant**

1<sup>st</sup> October to 31<sup>st</sup> March (or 30<sup>th</sup> April providing the cuttings have been kept in a cold store at -1 degrees centigrade, and to June if kept at -4 degrees centigrade.)

### **Planting**

Hand-plant or use a cabbage planter.

### **Planting densities**

Plant a distance of 0.9m between each plant and 0.75m between the rows and 1.5m between these for tractor access.

### Weed control

After planting let the ground settle around the cuttings for 4-5 days and then apply a residual herbicide to prevent weeds from germinating. *Simazine* is the basic herbicide used. Visit the site regularly keeping it weed-free until at least mid August of the first to second years.

### Harvesting for browse

\*Willows and poplars can be cut every year in the months of December, January, February and the first half of March.

\*They can be cut, as leafing-out-rods in March and April and fed to the animals. But the regrowth of the stool must not be cut again until January or February. It must not be cut later than February. It would be better if the rods were not cut at all the first winter and allowed to grow for a second season and cut in December, January, February, March as two-year-old rods for rhinos and elephants. This regime would not damage the stools.

\*Established stools, say three-year old, carrying two-year olds, or older rods can be cut in May, June or July, but the regrowth must not be cut the following winter. It must be allowed to grow on as two-year old rods throughout the next season and cut the following between December and March. Otherwise there could be a loss of vigour.

\*Leafy rods can be cut in October and November but the following seasons crop should not be cut until January or February. It would be better if it were allowed to grow on for a second season. The worst time to cut leafy shoots is August and September. Some try to resprout and do not harden-off in time for winter. Cutting in August imposes the most strain on the stool.

\*Established stools are more resistant to cutting out of season than young stools; two to three-year old crops more resistant than one-year old crops; and willows are more resistant than poplars.

### The Forest Reproductive Material Regulation

This Regulation was initiated to regulate the supply of material for biomass plantations because these attract a grant. The Forestry Commission wanted some control over what was planted. Mostly they now recommend the new *Salix viminalis* clones but other clones, as mentioned, are much more useful for browse but would never be on the FRMR.

Forestry Commission nurseries also stock a wider range of clones which are suitable for browse and not covered by the Forestry Reproductive Material Regulation. A list of these nurseries is available through the Forestry Commission, Research Station, Alice Holt Lodge, Wrecclesham, Farnham, Surrey. GU10 4LH.

**Manufactures of the products mentioned:**

**AMITROLE (Weedazol - TL)** - **Bayer PLC**, Crop Protection Business Group,  
Eastern Way, Bury St Edmunds, Suffolk. IP32 7AH.

**GLUFOSINATE (Challenge)** - **AgrEvo Crop protection Ltd**, East Winch Hall,  
East Winch, King's Lynn, Norfolk. PE32 1HN.

**GLYPHOSATE (Roundup)** - **Monsanto Plc.**, Thames Tower, Burley Way.  
Leicester. LE1 3TP.

**PARAQUAT**  
(*Gramoxone 100*) - **Zeneca Crop Protection**, Fernhurst, Haslemere,  
Surrey GU27 3JE.

**SIMAZINE** - **Ashlade Formulations Ltd**, Moorend House,  
Moorend Lane, Dewsbury,  
West Yorkshire. W13 4QQ.

- **Atlas Crop Protection Ltd**, PO Box 38, Low Moor,  
Bradford, West Yorkshire. BD12 0JZ.

- **Ciba Agricultural**, Whittlesford, Cambridge.  
CB2 4QT.

- **Mirfield Sales Services Ltd**, Moorend House,  
Moorend Lane, Dewsbury,  
West Yorkshire. W13 4QQ.

- **Unicrop**, Universal Crop Protection Ltd, Park House,  
Cookham, Maidenhead, Berks. SL6 9DS.

**Note**

All spraying operations should be carried out in accordance with current health and safety legislation and the operatives should be qualified in FEPA PA1 & PA6.

**Further reading**

***Home Grown Energy from Short Rotation Coppice.***

George McPherson.

ISBN 0-85236-289-7.

£14.95.

Available from Farming Press Books, Wharfedale Road, Ipswich. IP1 4LG.

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