Relative Forage Preference by Cottontails for Ryegrass, Wheat and Subterranean Clover[1]

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Abstract: On 2 sites in southeastern Louisiana, eastern cottontail (*Sylvilagus floridanus*) food preference was compared among ryegrass (*Lolium multiflorum*), winter wheat (*Triticum aestivum*), and subterranean clover (*Trifolium subterraneum*). Native forages comprised most of the winter diet. Fecal pellets contained more ryegrass than subterranean clover most months from December through May. Cottontails used little wheat, but this was probably due to poor production of this forage. Cottontail diet selection was not associated with total digestible nutrients, crude protein, phosphorus, calcium. We suspect that the greater use of ryegrass compared to clover was due to differences in cover provided by these forages.

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The eastern cottontail is one of the most hunted game animals in North America (Chapman and Feldhamer 1982:111). The annual harvest of about 2.2 million cottontails in Louisiana ranks second only to squirrels (*Sciurus carolinensis* and *S. niger*) (La. Dep. Wildl. and Fish. 1982).

The most common recommendation for improving cottontail habitat is to establish cover (Hickie 1940:75, Madson 1959:31–32, Sims 1960, Graves 1970). Although cottontails select a diverse array of foods during most of the year (Trip-

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pensee 1938, Dusi 1949, Hastings 1954), the number of plant species available to cottontails during winter may be limited (Trippensee 1938). Therefore, the supply of winter forage may be important.

Ryegrass, wheat, and oats (*Avena sativa*) are commonly used in food plots in the South to attract white-tailed deer (*Odocoileus virginianus*) and turkey (*Meleagris gallopavo*) to high quality supplements during the winter when native plants are dead and/or nutritionally deficient (Davis 1983: 1, Webb, 1965). Food plots may benefit other wildlife including cottontails. The major deterrent to planting these forages for wildlife is the annual cost of cultivation, seed and fertilizer. On upland sites, cool season grasses generally require relatively large applications of fertilizer to stimulate growth and improve nutritional quality of the forage (Huffman and Boucher 1982: 51). In addition, top-dressing with nitrogen during late winter is usually needed to maintain quality forage, but following the hunting seasons game managers often do not top-dress food plots because of cost and lack of interest after the hunting season. Furthermore, cool season grasses mature in spring and concentrations of total digestible nutrients (TDN), crude protein, phosphorus, and calcium decline (Maynard and Loosli 1962). Heavy grazing or mowing plus additional nitrogen fertilizer is needed to maintain young growth that is high in protein.

Webb (1965) concluded that crimson clover (*Trifolium incarnatum*) and 2 varieties of white clover (*T. repens*), ladino and white dutch, were consumed more by white-tailed deer and turkey than 5 agronomic grasses. In addition, he found that the clovers produced more dry forage and were more economical to maintain than forage grasses. Although clovers produce high quality forage without application of nitrogen fertilizer, application of phosphorus and potasium may be necessary (Peevy 1972). Hendrickson (1938) and Croft (1961: 30) concluded that ryegrass was consumed more by cottontails than red clover (*T. pratense*) or white dutch clover on the basis of number of fecal pellets found in each forage type. However, because no attempt was made to quantify the diet of cottontails, this conclusion may have been erroneous.

Subterranean clover has advantages over other winter clovers because it can produce amounts of seed adequate for reseeding even after being heavily grazed during flowering (Green 1979). Additionally, subterranean clover will tolerate more acid soils than most other agronomic species (Green 1979) and can be managed to volunteer after the establishment year (Knight 1978). Annual costs following the initial establishment year can be as much as $235/ha cheaper than costs for ryegrass (Davis et al. 1982).

Currently, interest is great in subterranean clover as a grazing resource for cattle in the southeastern United States (Davis and Johnson 1984). Because it can be managed at a lower cost than the cool season grasses and reseeds efficiently even if heavily grazed during its flowering stage, subterranean clover appears to be an economical alternative to planting cool season grasses for wildlife. Additionally, it can be grown under managed pine stands (Davis 1983: 17). Therefore, subterranean clover food plots can be established in areas where cool season grasses cannot be grown. Regardless, use of subterranean clover in wildlife food plots is contingent upon it being attractive to wildlife. The primary purpose of this study was to compare cottontail use of subterranean clover, wheat of ryegrass.

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Methods

Idlewild Research Station, located 5 km south of Clinton, Louisiana, and Lee Memorial Forest, located about 16 km west of Bogalusa, Louisiana, were study areas. At both locations studies were conducted on upland pine sites where soils are highly leached and infertile (Lay 1956). Soils from both locations are below levels recommended for production of forage crops in extractable phosphorus (5–9 ppm) and exchangeable potassium (40–86 ppm) (Peevy 1972). Both areas are primarily forested with loblolly-shortleaf pine (*Pinus taeda, P. echinata*) -mixed hardwood forest.

Fifteen plots ranging in size from 0.05 to 0.1 ha were established in openings within or adjacent to pine stands on Idlewild Research Station (N = 8) and Lee Memorial Forest (N = 7). Wheat, subclover, and ryegrass were planted on ⅓ of each plot during late October 1982. Each forage was broadcast seeded, covered by light disking, and fertilized according to recommendations established by the Louisiana Cooperative Extension Service (Curtis 1982). Ryegrass and wheat portions of food plots were fertilized with 67 kg/ha of each P_2O_5 and K_2O, and 112 kg/ha of nitrogen. Half of the nitrogen was applied at planting, the other half was applied by top-dressing during the first week of December. Subterranean clover portions of food plots were fertilized at planting with 67 kg/ha of P_2O_5 and K_2O.

Three samples (0.3 × 0.3 m) of each of the 3 forages from each plot were collected monthly (Dec 1982–Apr 1983) to estimate forage production. Samples were placed in paper bags, oven dried at 100° C for 48 hours, and weighed. Three 10-g samples of each forage were also collected each month and analyzed for crude protein, total digestible nutrients (TDN), percent phosphorus, and percent calcium at the Agricultural Center's laboratories.

We attempted to collect all fecal pellets once each month from each forage and these were combined as a single sample for that forage type for each plot. Botanical composition of cottontail diets was determined by microhistological analyses (Johnson and Pearson 1981).

Composite samples were ground in a Wiley mill through a 40-mesh screen. The samples were then placed in a water and household bleach solution (1:1) for 3–5 minutes and rinsed. Five slides were made from each sample and discernible plant fragments in 20 (100×) fields were identified for each slide. However, only the presence or absence of each forage in each microscope field was recorded. The procedure for quantifying fecal pellet composition was similar to that reported by Sparks and Malechek (1968). The technique has been tested and found accurate by a number of authors (Sparks and Malechek 1968, Vavra and Holechek 1980).

For each composite sample, percent frequency of occurrence for each forage (F) was used to estimate the average number of plant fragments per field (d). This estimate was obtained from the relationship between frequency and density which is

$$F = 1 - e^{-d}$$

where e is the base of natural logarithm (Johnson 1982). Relative fragment densities were calculated for each of the 3 forage categories.

Feeding trials were performed from March 1983 to April 1983 to determine the relationship between proportions of forages ingested and estimates of proportions in fecal pellets. Three captive rabbits were each fed 5 different mixtures of the 3 forages; each forage made up from 25% to 75% of any mixture. Fecal pellets were collected after complete ingestion of a 2-day diet of each mixture and analyzed microscopically according to the procedure described above.

To determine whether the proportion of pellets collected from each forage type was associated with consumption of each forage, a test for linear trends in proportions was used (Snedecor and Cochran 1973:246). Specific comparisons were made between the proportions of fecal pellets found on each forage versus proportions of each forage in fecal pellets, and proportions of fecal pellets on each forage versus forage production. Student's *t*-tests were used to compare mean proportions of forage in fecal pellets and mean numbers of fecal pellets deposited between forages. Data were averaged among the 15 food plots for each month. Statistical significance was accepted at the 0.05 probability level for type 1 error. Data reported herein are means and standard errors. Scientific nomenclature of plants is from Radford et al. (1968), except for *Trifolium subterraneum* which is from Hitchcock and Conquist (1973).

Results and Discussion

Feeding Trials

None of the estimated proportions of forages in fecal pellets were significantly different from proportions of forages in feed mixtures (Table 1). These results support the contention that differential digestibility does not significantly bias diet estimates obtained from analyses of fecal pellets. Similar results in feeding trials with goats and cattle were obtained by Hansen et al. (1973) and Johnson and Pearson (1981), respectively. Based on their findings and on our results, we are confident that analyses of cottontail fecal pellets collected from the field accurately estimated relative amounts of different forages used by cottontails.

Forage Utilization

Based on forages identified in cottontail fecal pellets, ryegrass was consumed more than subterranean clover or wheat for all months except January, and consumption of wheat was significantly lower than consumption of ryegrass and subterranean clover for all months (Table 2).

Table 1. Estimated ($\bar{x}$ ± SE) dry weight proportions of ryegrass, subclover, and wheat in cottontail fecal pellets compared to known dry weight proportions of each forage in the diet. No other food was included in the diets for these feeding trials.

Forage Proportion in Diet Mixture %	Microhistological Estimates of Forage Proportions in Fecal Pellets		
	Ryegrass	Subclover	Wheat
25	24.10 ± 2.09	24.37 ± 1.65	25.20 ± 1.06
33	32.23 ± 1.30	30.97 ± 2.07	33.13 ± 4.67
50	48.07 ± 0.79	49.17 ± 1.99	51.80 ± 2.01
66	69.03 ± 2.07	69.27 ± 3.39	67.77 ± 1.30
75	75.63 ± 1.65	74.80 ± 1.06	77.96 ± 3.47

Table 2. Mean (± SE) monthly proportion of each forage in cottontail fecal pellets at Lee Memorial Forest and Idlewild Research Station.

Month	N[a]	Ryegrass	Subclover	Wheat	Native
Dec	12	45.1 ± 5.9	11.3 ± 2.5	0.7 ± 0.3	43.0 ± 5.6
Jan	20	8.7 ± 1.4	12.2 ± 1.3	1.7 ± 1.0	77.4 ± 1.7
Feb	15	18.4 ± 4.3	13.4 ± 2.8	0.9 ± 0.4	67.3 ± 5.0
Mar	7	18.4 ± 4.0	7.7 ± 2.8	2.2 ± 1.0	71.7 ± 3.5
Apr	12	30.8 ± 5.8	14.3 ± 4.7	1.1 ± 0.5	53.9 ± 3.6
May	13	15.4 ± 2.7	11.6 ± 1.5	1.7 ± 0.7	71.4 ± 3.7

[a] *N* is the number of pellet composites collected each month from a possible total of 45 composites (15 plots × 3 portions of each plot).

Table 3. Mean (± SE) production (oven-dried weight) of ryegrass, subclover, and wheat and mean number of fecal pellets collection from plots of each forage.

Month	Biomass (kg/ha)			Pellets/Plot		
	Ryegrass	Subclover	Wheat	Ryegrass	Subclover	Wheat
Dec	552 ± 142	321 ± 41	154 ± 37	58.3 ± 17.1	26.6 ± 3.4	32.0 ± 10.3
Jan	542 ± 98	345 ± 67	112 ± 28	74.0 ± 22.6	31.3 ± 5.0	22.4 ± 2.1
Feb	636 ± 148	457 ± 45	170 ± 45	76.6 ± 22.9	44.0 ± 8.7	35.2 ± 7.6
Mar	1162 ± 268	922 ± 255	473 ± 281	49.8 ± 5.4	53.0 ± 3.0	36.5 ± 14.5
Apr	2164 ± 311	1407 ± 353	293 ± 68	76.5 ± 18.7	41.6 ± 8.2	58.0 ± 58.0
May				39.3 ± 9.9	37.3 ± 10.8	42.5 ± 20.5

Production of ryegrass and subterranean clover peaked in April with 2164 ± 311 and 1407 ± 353 kg/ha, respectively (Table 3). Production of wheat peaked in March at 471 ± 281 kg/ha.

For all months the number of pellets from ryegrass plots (62 ± 7) was significantly greater than the average number from subterranean clover or wheat plots. The average number of pellets from subterranean clover (39 ± 4) was not significantly different from the average number of pellets from wheat (38 ± 5). For all months average proportions of ryegrass, subclover, and wheat in fecal pellets were significantly different, (22.8 ± 5.8%, 11.8 ± 2.6%, and 1.4 ± 0.6%, respectively). Pellets collected from wheat plots contained low amounts of wheat compared to relative numbers of pellets deposited.

There was no significant association between proportions of pellets found in each forage and proportions of forages identified in cottontail fecal pellets (R = 0.53). Proportions of each forage in fecal pellets were significantly associated with biomass produced by each forage (R = 0.76), and the number of pellets found on each forage (R = 0.79). However, relative use among forages did not always follow the same trend as use for pellet deposition. For example, the proportion of subterranean clover in January was greater than the proportion of ryegrass but there were significantly more pellets deposited on ryegrass. Furthermore, production and consumption of wheat were significantly lower than production and consumption of ryegrass each month, but fecal deposition on ryegrass was significantly greater than on wheat for only 2 of 6 months and greater on wheat during May. Although the trend for consumption of ryegrass to be associated with fecal deposition was obvious, variation among food plots was too large to permit meaningful comparisons on a monthly basis and no such trend occurred for the comparison of subterranean clover versus wheat.

Relative fecal deposition should not be considered as a reliable indicator of relative preference among forages. Other factors such as cover value and preference relative to type of native vegetation are probably more associated with fecal pellet deposition.

Nutrition

Subterranean clover averaged significantly higher in crude protein (19%) than ryegrass (12%) or wheat (13%) (Table 4). Crude protein levels were highest during early growth stages of the grasses (Dec–Feb) and gradually decreased toward the end of the growing season. Conversely, subterranean clover contained highest crude protein levels during the latter part of the growing season (Feb–Apr). Nutrient levels of crude protein recommended for maintenance, growth and lactation of domestic rabbits are 12%, 15–16% and 17%, respectively (Arrington and Kelley 1976: 113). Crude protein concentrations in ryegrass and wheat were above the recommended concentrations for growth in December, but were below that needed for maintenance from January through April. Crude protein concentrations in subterranean clover exceeded the level recommended for growth throughout the study period, and the level recommended for lactation from February through April.

TDN in ryegrass and wheat peaked earlier and at a lower level than that in subterranean clover. Nutrient levels of TDN recommended for maintenance, growth and lactation of domestic rabbits are 55%, 60%–65%, and 70%, respectively (Arrington and Kelley 1976: 113). Levels of TDN in all 3 forages exceeded that needed for maintenance in December, were adequate for growth from January through April, and were adequate for lactation from February through April.

Table 4. Mean (± SE) monthly concentrations of TDN, crude protein, calcium and phosphorus in ryegrass, subclover and wheat.

Month	Forage	TDN (%)	Crude Protein (%)	Calcium (%)	Phosphorus (%)
Dec	Subclover	56.8 ± 3.2	16.0 ± 1.6	0.56 ± 1.10	0.18 ± 0.01
	Ryegrass	63.9 ± 1.9	19.6 ± 2.1	0.25 ± 0.04	0.33 ± 0.01
	Wheat	70.7 ± 1.9	22.7 ± 2.6	0.29 ± 0.04	0.36 ± 0.03
Jan	Subclover	57.7 ± 3.5	16.7 ± 1.7	0.77 ± 0.30	0.18 ± 0.02
	Ryegrass	65.5 ± 2.8	10.9 ± 1.3	0.30 ± 0.03	0.23 ± 0.02
	Wheat	57.7 ± 6.6	11.4 ± 0.7	0.38 ± 0.16	0.18 ± 0.02
Feb	Subclover	68.1 ± 2.1	22.3 ± 1.5	0.91 ± 0.13	0.25 ± 0.02
	Ryegrass	72.4 ± 0.9	8.6 ± 1.2	0.37 ± 0.04	0.26 ± 0.03
	Wheat	70.9 ± 0.7	9.8 ± 1.6	0.19 ± 0.02	0.23 ± 0.03
Mar	Subclover	73.7 ± 0.6	23.7 ± 0.7	0.66 ± 0.16	0.23 ± 0.02
	Ryegrass	72.4 ± 0.9	8.6 ± 1.2	0.37 ± 0.04	0.21 ± 0.03
	Wheat	70.9 ± 0.7	9.8 ± 1.6	0.19 ± 0.02	0.23 ± 0.03
Apr	Subclover	72.8 ± 0.5	21.3 ± 1.3	1.11 ± 0.11	0.23 ± 0.02
	Ryegrass	68.6 ± 1.1	8.9 ± 0.9	0.27 ± 0.02	0.24 ± 0.02
	Wheat	68.0 ± 1.7	9.4 ± 1.5	0.33 ± 0.18	0.20 ± 0.03

During December, phosphorus and calcium concentrations in ryegrass (0.33% and 29%, respectively) and wheat (0.36% and 0.28%, respectively) were significantly higher than concentrations in subterranean clover (0.18% and 0.56%, respectively). Phosphorus concentrations in the grasses were not significantly different from concentrations in subterranean clover during the remainder of the study period (Jan–Apr) and declined to 0.20% and 0.24% in April. Phosphorus concentrations in subterranean clover peaked at 0.25% in February. Phosphorus and calcium levels recommended for growth of domestic rabbits are 0.22% and 0.40%, respectively (Arrington and Kelley 1976: 113). Phosphorus concentrations in all 3 forages approached or exceeded the 0.22% level recommended for growth from February through April. Calcium concentrations in ryegrass and wheat are significantly lower than concentrations in subterranean clover for all months and remained fairly constant throughout the winter and spring at 0.29% for ryegrass and 0.28% for wheat. Calcium concentrations in subterranean clover peaked at 1.1% in April.

On the basis of these comparisons, subterranean clover was nutritionally superior to ryegrass and wheat, especially considering concentrations of crude protein and calcium in late winter and spring when a doe's requirements for lactation presumably could not be supported by ryegrass or wheat alone (Arrington and Kelley 1976: 113).

Regardless of differences in nutrient levels, none of the nutritional variables was significantly associated with proportions of any of the 3 forages in the diet for any month. These results are consistent with the findings of Richardson (1963: 51) and Sullivan (1966: 35), who performed nutritional analyses on a variety of native plants used in feeding trials with captive cottontails and swamp rabbits (*S. aquati-*

cus), respectively. Richardson (1963:51) compared crude protein, crude fat, crude fiber, crude nitrogen extract, ash, calcium, and phosphorus to amount of each forage eaten by cottontails and found no significant associations. Sullivan (1966:34) used a stepwise multiple regression procedure to identify relationships among crude protein, ether extract, crude fiber, nitrogen free extract, ash, calcium, and phosphorus versus consumption of plants by swamp rabbits. He found that consumption was significantly related only to percent ash, and concluded that swamp rabbits select plant foods on some basis other than the nutritional variables that were studied. Although palatability of different forages obviously affects level of preferences, palatability is a factor that is probably impossible to quantify and one that is not highly associated with nutrient concentrations (Radwan and Crouch 1974).

Beginning in March and through spring, we found smaller pellets in some of the subterranean clover plots, presumably from younger cottontails. This trend continued through spring. Basal metabolic rate is greater for small animals than for large animals (Brody 1945) and also greater in young animals than in mature animals (Kleiber 1961). Young animals require extra energy for growth (Maynard and Loosli 1962:387). As a result, energy requirements of young animals are greater than those of mature animals when measured relative to body size and capacity of the digestive tract. Bailey (1969) noted that young animals usually compensate for this by eating more frequently than mature animals and by selecting more digestible foods. He concluded that grasses that were approaching the end of their growing season could not be adequately digested by young cottontails. We found no relationship between winter diets of adult cottontails and nutritional quality of the forages. However, young cottontails may be more selective than adults because of higher nutritional requirements. Further research is needed to test this hypothesis.

Food Plot Management Alternatives

We know of no reports in the literature proving that food plots improve survival or reproduction of cottontails in the wild. Regardless, a common recommendation for cottontail management is to provide food plots (Madson 1959:30, Bailey 1969, Hastings 1954:74, Hickie 1940:77).

As alternative to pure ryegrass food plots is to provide a mixture of ryegrass and subterranean clover. Bailey (1969) stated that while a plant may be of little value to wild rabbits when fed in a single species diet, it may become important when eaten in combination with other foods. Because the amount of forage produced influenced cottontail use among forages, food plots containing a mixture of ryegrass and subterranean clover may be more desirable than monocultural plots. Ryegrass would provide more cover and higher nutrition for cottontails early in the growing season when subclover is usually low in production. Ryegrass would also provide concealing cover late in the growing season when it is decreasing in quality and subclover is highest in quality. Nitrogen fertilizer costs would be eliminated after the establishment year because of nitrogen-fixing capacity of the subterranean clover, and seeding costs would include only the annual cost of ryegrass seed (Davis et al. 1982).

Although most food plots are established to increase hunting success, improved forages may benefit wildlife on poor quality range. Providing the highest quality supplement for the longest period of time is most likely to provide desirable benefits. The use of a cool season legume, such as subterranean clover, can provide a high quality diet supplement for a longer period of time and at lower cost than intensive management of cool season grasses.

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