American jointvetch improves summer range for white-tailed deer

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Abstract

Livestock production is limited on upland forested sites in the Southeast by the low quality of native range. Supplemental feeding in the form of improved pastures has dramatic effects on herd production and individual animal performance. Similar relationships probably exist for wild herbivores; and food plots with highly palatable, high quality forages might improve animal performance for wild as well as domestic herbivores. Sixteen American jointvetch *(Aeschynomene americana)* plots ($\bar{x} \pm$ SE = 0.21 ± 0.02 ha) were established in pastures adjacent to mixed pine (*Pinus* spp.)—hardwood habitat on a 980-ha tract in southeast Louisiana to estimate the influence of summer-fall food plots on diets of free-ranging white-tailed deer *(Odocoileus virginianus)*. American jointvetch accounted for 32.4% of the dry matter in deer diets and occurred in 90.7% of fecal pellet groups. Individual deer consumed about 0.45 kg (ovendry weight) of American jointvetch per day over 2 growing seasons. For all sampling periods, crude protein, phosphorus, in vitro digestible dry matter, and calcium levels were higher ($P \leq 0.006$) in supplemented diets compared to native diets. Calcium:phosphorus ratios in supplemented diets were lower ($P \leq 0.0001$) (improved) compared to ratios in native diets. Dietary crude protein, phosphorus, in vitro digestible dry matter, and calcium were positively associated ($P \leq 0.0001$) with proportions of American jointvetch in deer diets. Warm-season food plots should be considered as viable options for intensive deer management programs in parts of the southeastern United States.

Key Words: ***Aeschynomen americana*, American jointvetch, Louisiana, microhistological analysis, nutrition, *Odocoileus virginianus*, supplemental feeding, white-tailed deer.**

The white-tailed deer is the most popular and economically valuable game species in the United States. Changing land-use practices leading to decreased habitat availability (Newsom 1984:376) and increasing demand for hunting (Dudderar 1981) indicate that intensive management may be needed to maintain healthy, productive deer populations. Artificially increasing carrying capacities may be justified to satisfy future demands for sport hunting.

Nutrient levels in native forages on southern upland range are often insufficient for maximum deer growth and reproduction during summer and fall (Lay 1957, Short 1969, Blair et al. 1977, Sowell et al. 1985, Thill et al. 1987). Crude protein (CP) and phosphorus (P) deficiencies limit individual deer growth and population size in parts of the southeastern United States (Lay 1969, Short 1969, Thill and Morris 1983, Thill et al. 1987).

Although food supplies are least abundant during winter, late summer may be a critical period in the South due to heat, low forage quality, and reduced forage intake (Goodrum and Reid 1962, Hafez 1967, Ockenfels and Bissonette 1982, Blair et al. 1984). The need for high quality forage during summer is compounded by high metabolic costs of growth and reproduction. Gestation (which can extend into October) (Roberson and Dennet 1967), lactation, and subsequent recovery for breeding create a need for high-quality forage (Verme 1963, 1967; Short 1969). Bucks need high-quality forage for antler development (Gore 1984, Jacobson 1984). Fawn survival and growth are affected by the ability of does to produce milk and the quality of forage as fawns are weaned (Verme 1963, Murphy and Coates 1966, Meyer et al. 1984).

Reasons for supplemental feeding include diet supplementation on poor-quality range, increased diet variety, improved survival of stocked game, protection of agricultural crops, improved harvest rates, and improved relations between landowners, game managers, and sportsmen (Halls and Stransky 1968). Ozoga and Verme (1982) found that captive deer supplemented year-round with a pelleted ration increased growth rates, antler development, and productivity.

American jointvetch is a warm-season tropical legume (Moore and Hilman 1969) that is highly palatable to deer and produces large quantities of high-quality forage (Moore 1978, Keegan and Johnson 1987). Weight gains and antler development of captive yearling bucks grazing American jointvetch improved compared with bucks fed simulated native diets (S.R. Schultz, La. State Univ., unpub. data). However, effects of warm-season food plantings on free-ranging deer are not known.

We selected American jointvetch as a model forage to determine impacts of warm-season food plots on free-ranging deer in upland, mixed pine-hardwood habitat and to estimate nutritional improvements that may occur in diets containing supplemental forage.

Study Area

The study was conducted on Blairstown Plantation, about 5 km south of Clinton, East Feliciana Parish, Louisiana. The study area consisted of about 190 ha of open, native-grass pasture dispersed among 790 ha of forest. Cattle were continuously grazed on most pastures throughout summer at about 1 animal unit per ha. Pasture management for cattle consisted of summer mowing for weed control and occasional prescribed burning in late winter. Based on annual line transect surveys (Hayne 1949), fall deer populations were about 1 deer/6.6 ha and 1 deer/5.5 ha in 1985 and 1986, respectively.

Soils are in the Providence and Lexington series of the Loessial Hills association. These soils are moderately well to well-drained, acid, silt loams occurring on gentle to moderately sloping uplands (SCS Soil Survey of Idlewild Experiment Station, Clinton, Louisiana 1970). Natural fertility of these soils is low with respect to crop and pasture production. Soil tests performed at the Louisiana Agr. Exp. Sta. Soil Testing Laboratory, Baton Rouge, indicated low levels of exchangeable phosphorus (P) (7.4 ppm), extractable potassium (K) (34.7 ppm), and calcium (Ca) (609 ppm), and soil pH (4.5–5.9). Forested areas were typical of mixed pine-hardwood upland forests in southeast Louisiana. Keegan (1988) reported common vegetative cover that occurred on the study area.

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Methods

Food Plot Establishment

Johnson et al. (1987) established 14 plots on the study area for cool-season forage research in 1983 and we established another plot in May 1985. Plots occurred in pastures at forest edges; American jointvetch was presumably available to most, if not all, deer on the study area. Plot size ranged from 0.08 to 0.34 ha ($\bar{x}$ = 0.21, $S\bar{x}$ = 0.02). Plots were fenced with 3-strand barbed wire to exclude cattle but not deer, or located in areas where cattle did not range.

We planted 15 plots (3.0 ha) to American jointvetch (11.2 kg/ha) in early June 1985. A well-disked seedbed was broadcast with inoculated seed and harrowed lightly to insure seed-soil contact. Annual fertilization rates were about 225 kg/ha of 8-24-24, and dolomitic limestone was applied at a rate of 2,240 kg/ha in spring 1986 (Peevy 1972). Cattle destroyed 1 plot in 1985 so it was deleted from analyses, leaving about 2.8 ha.

Optimum grazing potential for American jointvetch occurs when plants are grazed to about 36 cm (Hodges et al. 1982) and removal equals about 50% of the standing crop (Moore and Hilman 1969). According to these criteria, several plots were underutilized in 1985. Therefore, 8 plots were removed from the American jointvetch management system in 1986. We estimated that production from 8 plots would be sufficient for herd supplementation. In May 1986, we disked 7 of the original 15 plots to improve germination from natural reseeding and reduce grass competition. A new plot was established to maintain distribution over the study area.

Broadleafs and grasses were reduced with applications of 2,4-D (2.3 L/ha) and flauzifop butyl (1.1 kg/ha), respectively, where particular weed problems were judged to be critical with regard to American jointvetch survival.

Food Plot Production and Deer Use

We randomly placed a deer exclosure (about 1.2 m^2) in the center of each plot in late June. A standard clipping frame (0.94 m^2) was used to define sampling areas inside and outside each exclosure. We sampled during the last week of each month from July through November 1985 and from June through October 1986. Exclosures were randomly relocated after each sampling period. We did not sample in November 1986 due to American jointvetch senescence.

Plants were clipped with hand shears about 1 cm above the soil, oven-dried at 100° C for 25 hours, and weighed to the nearest 0.1 g. Differences between paired samples were used to estimate average forage removal by deer during the previous month. We calculated season-long production by adding the amount of standing forage clipped to ground level inside an exclosure during the last month to amounts of forage removed by deer during all previous months.

Fecal Collection and Analyses

We collected 30 fresh fecal pellet groups (≥5 individual pellets) each month during each period that food plots were sampled. Pellet groups were collected at random throughout forested areas to estimate proportions of the deer population using food plots. Pellets were assumed to be fresh if they had not completely dried following defecation.

We used microhistological analysis (Johnson et al. 1983) to determine botanical composition of fecal pellet groups. Pellets in an individual group were oven-dried, ground in a Wiley mill (1.0-mm mesh screen), soaked in a 50:50 household bleach-water solution for 15 minutes to remove plant pigments, rinsed over a 120-mesh sieve, and placed in a blender for 45 seconds at high speed to disperse clumped plant fragments. We mounted about 0.1 g of each sample on each of 5 slides for examination at 125-power magnification and examined 20 fields per slide for a total of 100 fields per pellet group.

Relative particle densities were calculated for each taxa and used as estimators of relative dry weight of each forage ingested (Sparks and Malechek 1968, Johnson 1982). We averaged relative particle densities among all samples within a month (n = 30) for monthly estimates and among all samples within a year (n = 150) for season estimates. We realize that microhistological analyses do not provide perfect estimators of herbivore diets. However, it is the only nondestructive method available and is useful because material representing large numbers of different meals from many animals can be collected. Mushrooms and mast can be adequately identified and quantified (Johnson et al. 1983). We choose to ignore mushrooms because mycelia and spores were rarely observed in the samples and the extra effort needed to quantify mushrooms was not justified based on our microscopic observations. Furthermore, our primary objective was to estimate whether deer use of American jointvetch was large or small rather than to precisely estimate its exact contribution to the diets.

Forage Quality

Samples of probable native-forage taxa used by deer (Matthews and Glasgow 1981, Thill 1983) and American jointvetch were collected randomly from the study area at the end of each month. We collected the most recent plant growth to simulate deer feeding behavior (Short 1967, Thill and Morris 1983). Forage taxa were collected separately and oven-dried at 100° C for 24 hours. Four 15-g samples of each taxa were ground in a Wiley mill (1.0-mm mesh screen) and analyzed for CP, in vitro digestible dry matter (IVDDM), P, and Ca at the Forage Analysis Laboratory of the Southeast Research Station following methods of the Association of Official Analytical Chemists (1970). Determinations of IVDDM used bovine rumen fluid (Nelson et al. 1972) to provide reliable approximations of IVDDM by deer rumen fluid (Robbins et al. 1975, Palmer et al. 1976).

We estimated nutrient concentrations for plant taxa that occurred in fecal pellets but were not collected for analyses from Causey (1964), Short et al. (1975), Ensminger and Olentine (1978), Everitt and Gonzalez (1981), Pearson et al. (1982), DeLany (1985), and Hoveland et al. (1986). We applied average nutritive values of forage groups (forb or browse) from similar habitat (Pearson et al. 1982) when values for any taxon were not reported in the literature. Although these estimates may have varied from nutrient levels actually available on our study area, differences would not significantly affect our data because estimates from the literature were used for less than 5% of the diet composition.

Dietary CP, IVDDM, P, and Ca in deer diets were estimated monthly by multiplying percentage dry weight of each forage in a fecal sample by the corresponding nutrient concentration and summing values among forage taxa in each fecal sample. We averaged among all fecal samples for each month (n = 30) and season (n = 150) to estimate mean nutrient levels obtained by deer. We estimated nutrient concentrations in diets composed solely of native forages (native diets) similarly, under the assumption that availability of American jointvetch did not affect relative amounts of individual native forages consumed by deer.

Statistical Analyses

We used paired t-tests (Steel and Torrie 1980:102) to determine whether nutrient concentrations varied significantly between diet types (native versus supplemented) within sampling periods. We used the general linear models procedure (GLM) of SAS (1985:433-506) to determine if dietary nutrient concentrations varied significantly with proportions of American jointvetch in deer diets within years. Data are reported as means and standard errors. We accepted significance at the 0.10 level of probability of Type I error.

Results and Discussion

Food Plot Production and Deer Use

The proportion of fecal pellet groups containing American jointvetch averaged 90.7% over both years (Table 1). Results are similar to those for deer use of cool-season food plots on the same study area (Johnson et al. 1987).

Table 1. Percentage of deer fecal pellet groups (n = 30/month) containing American jointvetch, and proportion of botanical fragments in fecal pellets made up by American jointvetch (% dry weight), Blairstown Plantation, East Feliciana Parish, Louisiana, June through November, 1985 and 1986.

	1985		1986	
Month	Frequency (%)	Proportion of fragments in fecal pellets (%)	Frequency (%)	Proportion of fragments in fecal pellets (%)
Jun			86.7	18.0 ± 3.2
Jul	83.3	29.4 ± 3.4	90.0	29.8 ± 3.4
Aug	96.7	42.9 ± 4.1	90.0	28.3 ± 3.3
Sep	83.3	34.2 ± 5.0	100.0	49.3 ± 4.3
Oct	86.7	39.2 ± 5.7	100.0	37.3 ± 3.7
Nov	90.0	15.7 ± 3.2		
Season	88.0	32.3 ± 2.1	93.3	32.5 ± 1.8

Average monthly yields of American jointvetch (ovendry weight) were similar between 1985 (2,239 ± 553 kg/ha) and 1986 (2,273 ± 252 kg/ha) (Table 2). However, average monthly deer use almost doubled from 1985 (578 ^{3} 199 kg/ha) to 1986 (1,129 ^{3} 221 kg/ha). Increased use per plot in 1986 may have been caused by decreased available hectarage. Deer apparently concentrated their foraging efforts on fewer plots.

Table 2. Ovendry production and deer use (kg/ha) of American jointvetch on Blairstown Plantation, East Feliciana Parish, Louisiana, 1985 (n = 14 plots) and 1986 (n = 8 plots).

	1985		1986	
Month	Production	Use	Production	Use
Jul	412 ± 111	248 ± 78	1698 ± 440	1107 ± 320
Aug	2386 ± 278	1347 ± 195	2845 ± 271	1742 ± 187
Sep	1598 ± 353	526 ± 226	2503 ± 401	964 ± 197
Oct	3657 ± 416	463 ± 141	2047 ± 307	704 ± 193
Nov	3143 ± 387	305 ± 122		
Season[a]	5727 ± 350	2889 ± 429	5860 ± 709	4517 ± 625

[a]Total production equals production of last month plus the amount of forage consumed by deer in previous months.

American jointvetch accounted for about 32% of summer-fall deer diets each year. Peak dietary occurrence of American jointvetch coincided with peak use of standing forage in 1985, but not in 1986. The discrepancy between apparent use and dietary occurrence may have been caused by changes in deer feeding behavior. During hot weather, deer may reduce total forage intake (Hafez 1967, Ockenfels and Bissonette 1982) while concentrating foraging efforts on food plots (Byford 1970). Diets would contain relatively high proportions of American jointvetch even though apparent forage use was relatively low. Changes in availability and palatability of native foods probably altered deer feeding behavior as well.

Total biomass of American jointvetch consumed by the deer population was about 8,200 kg dry forage in 1985 and 7,800 kg in 1986 (ovendry weight), respectively. The deer population was about 120 and 144 animals in 1985 and 1986, respectively. Based on these estimates, daily consumption of American jointvetch averaged about 0.45 kg/animal (ovendry weight) in 1985 and (July through November) and about 0.44 kg/animal in 1986 (June through October). These data support the previous decision to reduce the number of food plots from 14 in 1985 to 8 in 1986.

Our estimate of American jointvetch use derived from clip-plot analyses (0.45 kg/deer/day) is about 32% of the estimated 1.4 kg daily dry forage intake of deer (Fowler et al. 1968). This value is similar to our estimates from microhistological analyses, supporting our contention that estimates of supplemental forage use are reasonable.

Diet Composition and Forage Quality

We identified 51 plant taxa during microhistological analyses of fecal pellets. Fourteen taxa that occurred in <5% of all pellet groups were classified as miscellaneous forb or miscellaneous browse. Final estimates of diet composition included 37 taxa and 3 miscellaneous categories (Table 3). Diets contained more American jointvetch than any other taxon and introduced species made up more than 50% of season-long deer diets. Other introduced species in diets were Japanese honeysuckle *(Lonicera japonica)*, privet *(Ligustrum sinense)*, corn *(Zea mays)*, soybean *(Glycine max)*, and subterranean clover *(Trifolium subterraneum)*.

Table 3. Botanical composition (% dry weight) of summer-fall deer diets, Blairstown Plantation, East Feliciana Parish, Louisiana, 1985 and 1986, estimated by microhistological analysis of fecal pellets.

Forage taxa[a]	1985	1986
American jointvetch	32.3 ± 2.07	32.5 ± 1.81
Japanese honeysuckle	10.4 ± 0.82	14.5 ± 0.87
Rattan-vine *(Berchemia scandens)*	6.7 ± 0.48	2.7 ± 0.35
Yellow jessamine *(Gelsemium sempervirens)*	5.3 ± 0.31	4.8 ± 0.30
Unknown	5.1 ± 0.25	5.4 ± 0.23
Oak leaves (*Quercus* spp.)	3.9 ± 0.50	4.2 ± 0.40
Privet	3.6 ± 0.23	3.3 ± 0.26
Miscellaneous browse	3.5 ± 0.45	2.5 ± 0.32
Corn (kernels)	3.5 ± 0.56	1.2 ± 0.39
Partridgeberry *(Mitchella repens)*	3.4 ± 0.27	2.9 ± 0.28
Oak mast	3.3 ± 0.46	2.8 ± 0.59
Soybean	3.0 ± 0.76	0.4 ± 0.08
Grape (*Vitis* spp.)	2.2 ± 0.26	2.9 ± 0.28
Blackberry (*Rubus* spp.)	1.6 ± 0.20	2.1 ± 0.25
Subterranean clover	1.4 ± 0.28	0.5 ± 0.19
Grass (Poaceae)	1.3 ± 0.23	2.9 ± 0.34
Greenbrier (*Smilax* spp.)	1.2 ± 0.19	0.4 ± 0.09
Flowering spurge *(Euphorbia corollata)*	1.1 ± 0.13	1.0 ± 0.12
Wood sorrel *(Oxalis stricta)*	0.1 ± 0.03	2.3 ± 0.35
Sida *(Sida rhombifolia)*	0.4 ± 0.14	1.9 ± 0.29
Black medic *(Medicago lupulina)*	0.2 ± 0.05	1.1 ± 0.21

[a]Other taxa identified in trace amounts (<1.0%) were beggar lice (*Desmodium* spp.), bracken *(Pteridium aquilinum)*, chocolate-weed *(Melochia corchorifolia)*, cross vine *(Anisostichus capreolata)*, dogwood (*Cornus* spp.), elderberry *(Sambucus canaden-* [illegible]

CP and P levels in forages were generally lower in 1985 than in 1986. American jointvetch contained more CP than any other plant taxa collected from the study area and contained more P, except in July 1985. American jointvetch was the most digestible plant collected in June and July 1985 and throughout 1986. Complete nutritional data are reported in Keegan (1988).

Deer Diet Quality

Monthly CP levels in summer-fall native diets in Blairstown ranged from 9.3% to 13.5% (Table 4) and generally fell within the range (9–11.5%) estimated by Thill et al. (1987) for similar habitat in central Louisiana. For all sampling periods, supplemented diets contained significantly higher concentrations of CP compared to estimated native diets ($P \leq 0.0001$). Assuming that use of American

Table 4. Estimated levels of dietary crude protein (% ovendry weight) in native and supplemented deer diets on Blairstown Plantation, East Feliciana Parish, Louisiana, 1985 and 1986.

	1985		1986	
Month	Native	Supplemented	Native	Supplemented
Jun			13.5 ± 0.18	16.0 ± 0.45
Jul	10.9 ± 0.24	15.6 ± 0.49	11.7 ± 0.11	16.7 ± 0.55
Aug	9.8 ± 0.18	15.2 ± 0.48	12.3 ± 0.10	17.2 ± 0.56
Sep	9.9 ± 0.28	17.4 ± 1.00	13.2 ± 0.19	21.1 ± 0.69
Oct	9.7 ± 0.14	17.9 ± 1.15	9.8 ± 0.18	16.5 ± 0.63
Nov	9.3 ± 0.20	12.5 ± 0.60		
Season	9.9 ± 0.07	15.7 ± 0.38	12.1 ± 0.13	17.5 ± 0.30

jointvetch did not alter proportional use of native plants was the only way to index relative diet quality between supplemented and unsupplemented diets because native diets would not be identical among years or different areas. No control was possible for the experiment. We believe that the method was reasonable under the circumstances because we found no native plants used as diet staples that were as nutritious as American jointvetch. Our analysis suggests that use of any amount of American jointvetch would improve diet quality. The practical problem is determining if the improvement is biologically significant rather than only statistically significant. A compilation of research findings suggests that dietary CP should fall between 7% and 13% for maintenance, and dietary CP should exceed 13% to maximize deer growth and reproduction (Thill et al. 1987). Native diets provided maintenance levels of CP during all sampling periods, but exceeded 13% in only 2 months, June and September 1986; whereas dietary CP in supplemented diets fell below 13% in only 1 month, November 1985. Not only is this result statistically significant but it is probably biologically significant. In the previous study on Blairstown, Johnson et al. (1987) detected significant improvements in live weights of yearling bucks associated with an increase in dietary crude protein of about 20%. In the present study, our estimated dietary crude protein improved by 58.6% for summer-fall 1985 and by 44.6% for summer-fall 1986. We were not able to associate use of American jointvetch with live weights of deer on Blairstown because winter forage crops were also being used but live weights have continued to increase since the previous study. However, American jointvetch was added to Avondale (a portion of Blairstown with similar habitat used as a control area for the study reported by Johnson et al. 1987) in summer 1987 and winter plots have not been used. From 1982 through 1986, yearling bucks taken (N = 65) averaged 43.4 ± 1.3 kg and there were no differences among years. A sample (N = 12) in fall 1987 after using American jointvetch food plots averaged 47.7 ± 1.4 kg and these yearling bucks were significantly larger ($P \leq 0.05$). Although circumstantial, these data provide some evidence that performance of deer can improve due to use of improved forages during summer.

Monthly P concentrations in native diets from Blairstown ranged from 0.14% to 0.18% (Table 5), exceeding values presented by Thill et al. (1987) (0.10–0.13%) by a small margin both years. Phosphorus concentrations were higher in supplemented diets than in native diets every month both years ($P \leq 0.0001$). Previous estimates indicate that dietary P should fall between 0.20% and 0.40% (Ullrey et al. 1975, Verme and Ullrey 1972). Native diets never provided more than 0.18% P, suggesting that P levels were suboptimum throughout the summer-fall period. However, mean dietary P in supplemented diets fell below 0.20% in only 1 month, November 1985.

Table 5. Estimated levels of dietary phosphorous (% ovendry weight) in native and supplemented deer diets on Blairstown Plantation, East Feliciana Parish, Louisiana, 1985 and 1986.

	1985		1986	
Month	Native	Supplemented	Native	Supplemented
Jun			0.18 ± 0.005	0.21 ± 0.006
Jul	0.17 ± 0.006	0.20 ± 0.005	0.17 ± 0.003	0.23 ± 0.007
Aug	0.14 ± 0.005	0.20 ± 0.005	0.17 ± 0.004	0.22 ± 0.006
Sep	0.16 ± 0.005	0.22 ± 0.008	0.18 ± 0.004	0.27 ± 0.008
Oct	0.15 ± 0.006	0.21 ± 0.007	0.14 ± 0.005	0.23 ± 0.008
Nov	0.14 ± 0.004	0.17 ± 0.006		
Season	0.15 ± 0.002	0.20 ± 0.003	0.17 ± 0.002	0.23 ± 0.004

Monthly Ca levels in native diets from Blairstown ranged from 0.74% to 0.95% (Table 6) and were generally lower than values reported by Thill et al. (1987). Monthly Ca:P ratios in native diets from Blairstown ranged from 4.6:1 to 6.9:1 (Table 7), almost one-half the values estimated from central Louisiana (Thill et al. 1987). Ca concentrations were greater and Ca:P ratios were improved (lower) in supplemented diets, compared to native diets, for every month both years ($P \leq 0.001$). Native and supplemented diets contained more than the 0.30–0.50% Ca generally recommended for deer (Ullrey et al. 1973). Most plants in the Coastal Plain region contained high levels of Ca, probably exceeding the amounts required by deer. Excess Ca can disrupt P metabolism in deer through chemical complexing. Optimum Ca:P ratios for deer are not well defined, but ratios of 1:1 to 2:1 are recommended for domestic ruminants. Ca:P ratios in native diets on Blairstown fell within the "satisfactory" limit (7:1) reported by Ensminger and Olentine (1978:102), but ratios approached levels where animal performance might have been adversely affected. Ca:P ratios in supplemented diets were 16–18% lower than ratios in native diets.

Table 6. Estimated levels of dietary calcium (% ovendry weight) in native and supplemented deer diets on Blairstown Plantation, East Feliciana Parish, Louisiana, 1985 and 1986.

	1985		1986	
Month	Native	Supplemented	Native	Supplemented
Jun			0.91 ± 0.02	0.93 ± 0.02
Jul	0.95 ± 0.02	1.00 ± 0.02	0.86 ± 0.01	0.95 ± 0.01
Aug	0.91 ± 0.02	1.04 ± 0.02	0.82 ± 0.01	0.95 ± 0.02
Sep	0.90 ± 0.02	1.00 ± 0.02	0.83 ± 0.02	1.00 ± 0.01
Oct	0.85 ± 0.02	1.01 ± 0.03	0.74 ± 0.03	0.94 ± 0.03
Nov	0.93 ± 0.02	0.99 ± 0.02		
Season	0.91 ± 0.01	1.01 ± 0.01	0.83 ± 0.01	0.95 ± 0.01

Table 7. Estimated calcium:phosphorous ratios in native and supplemented deer diets on Blairstown Plantation, East Feliciana Parish, Louisiana, 1985 and 1986.

	1985		1986	
Month	Native	Supplemented	Native	Supplemented
Jun			5.09 ± 0.17	4.47 ± 0.15
Jul	5.75 ± 0.18	5.11 ± 0.11	5.23 ± 0.08	4.30 ± 0.09
Aug	6.64 ± 0.24	5.17 ± 0.09	4.99 ± 0.13	4.24 ± 0.08
Sep	5.83 ± 0.17	4.81 ± 0.15	4.57 ± 0.15	3.76 ± 0.10
Oct	5.75 ± 0.25	4.85 ± 0.15	5.49 ± 0.23	4.16 ± 0.12
Nov	6.85 ± 0.21	6.11 ± 0.21		
Season	6.17 ± 0.10	5.21 ± 0.08	5.08 ± 0.07	4.18 ± 0.05

Digestibility of native diets from Blairstown ranged from 46.6% to 49.9% (Table 8) and was lower than warm-season values reported by Thill et al. (1987). Supplemented diets were more digestible than native diets every month both years ($P \leq 0.006$). These values were low relative to digestibility levels (65–70%) recommended for maximum lactation and growth in domestic livestock (Natl. Res. Counc. 1975, 1977, 1984). Although Ameri-

Table 8. Estimated levels of dietary in vitro digestible dry matter (% ovendry weight) in native and supplemented deer diets on Blairstown Plantation, East Feliciana Parish, Louisiana, 1985 and 1986.

	1985		1986	
Month	Native	Supplemented	Native	Supplemented
Jun			47.9 ± 0.74	51.1 ± 0.77
Jul	49.8 ± 0.70	56.2 ± 0.75	47.7 ± 0.49	52.0 ± 0.59
Aug	49.9 ± 0.61	56.0 ± 0.61	47.8 ± 0.48	52.7 ± 0.58
Sep	49.3 ± 0.58	51.3 ± 0.45	48.8 ± 0.69	56.9 ± 0.82
Oct	49.5 ± 0.78	52.1 ± 0.52	48.9 ± 0.66	55.7 ± 0.60
Nov	46.6 ± 0.76	47.5 ± 0.62		
Season	49.0 ± 0.32	52.6 ± 0.38	48.2 ± 0.28	53.7 ± 0.35

can jointvetch improved dietary digestibility, further improvements might be needed to promote maximum performance of free-ranging deer.

In general, native diets on Blairstown were probably suboptimal with respect to maximum deer growth and reproduction. This hypothesis is supported by Johnson et al. (1987), who reported significant improvements in weights of yearling bucks on the study area following winter range improvements. During the previous winter (1984–1985), native diets for the same study area (Johnson et al. 1987) contained about 25% higher levels of CP and were 25% more digestible than native diets in summer 1985. These comparisons support the contention that summer and fall may be limiting seasons for deer because physiological costs are higher during summer and fall, compared to winter, in the Southeast.

For 1985 and 1986, dietary CP, IVDDM, P, and Ca were positively associated with proportions of American jointvetch in deer diets ($P \leq 0.001$) and $n = 150$ for all correlations each year). Associations were strongest for CP ($r^2 = 0.97$ and 0.98, respectively) and P ($r^2 = 0.75$ and 0.85, respectively) because American jointvetch contained higher concentrations of these nutrients than other staple food items. Associations for dietary IVDDM ($r^2 = 0.67$ and 0.69, respectively) and Ca ($r^2 = 0.46$ and 0.53, respectively) were weaker because other forages contained similar and sometimes higher levels of these nutrients. Diets supplemented with American jointvetch provided deer with levels of CP, P, and IVDDM that should improve animal performance.

Values for nutritional parameters that are reported as percentages are not absolutes by which one can determine diet quality. Such figures are generally used by convention, but actual assimilation of a particular nutrient is determined by forage intake rate and digestibility. This convention may account for some disparities in existing literature concerning nutrient requirements of white-tailed deer. Because microhistological techniques do not allow for estimation of dry matter intake, we did not estimate actual assimilation of dietary nutrients. Following the earlier study (Johnson et al. 1987), we continued to analyze crude protein content of fecal pellets of Avondale and Blairstown. Deer use of winter food plots increased fecal crude protein by about 13% (Johnson et al. 1987). During late-summer months deer fecal pellets on Avondale, an area without food plots prior to 1987, contained 15.6 ± 2.2% crude protein ($N = 79$) while those from Blairstown contained 21.9 ± 3%, which is a 40% increase. There were no differences in levels of fecal protein between Avondale and Blairstown during months when food plots were not present. Dietary and fecal protein are significantly associated in ruminants (Mould and Robbins 1981). However, the levels we observed are beyond levels where the direct linear association is usually high and much higher than values we found in fecal samples from winter months. These data suggest that use of American jointvetch significantly improved dry matter intake rates. We suspect that deer using American jointvetch were consuming more protein than could be assimilated. We suspect that our estimates of dietary quality are lower than what the supplemented deer actually obtained.

Costs

Ozoga and Verme (1982) calculated that supplementally feeding a captive deer herd with high-quality pelleted feed year-round cost about $83/deer/year from the feed alone. Based on pelleted feed costs and deer population estimates, costs of feeding deer on the study area from June through November would have been about $4,621 and $5,545 in 1985 and 1986, respectively.

Establishment cost for American jointvetch food plots on clear land, exclusive of fencing, was about $227/ha (seed, fertilizer, herbicide, and labor). Annual cost for regeneration of food plots was about $62/ha. Because total consumption of American jointvetch was similar between years, food plot acreage probably exceeded herd requirements in 1985. Assuming 8 plots (1.7 ha) were sufficient for herd supplementation, establishment and annual costs would have totaled $386 and $105, respectively. Therefore, food plots would have cost about $3.22/deer in 1985 (establishment year, 120 deer) and $0.73/deer/year thereafter (144 deer). Supplemental feeding costs will be better defined when optimum food plot acreage for a deer herd is known. Although costs may vary with location, food plots are an economical alternative to bagged feed for supplementing diets of free-ranging deer.

Management Implications and Conclusions

American jointvetch was used intensively by deer and supplemental forage provided by food plots was the most important component of summer-fall deer diets. Diet quality was significantly improved when deer supplemented their diets with American jointvetch and supplemented diets appeared to provide nutrient levels that would improve animal performance. Future research concerning summer-fall diet supplementation should focus on forage species that might further enhance deer diets at lower costs. Although American jointvetch is adapted only to the southeastern United States, its use provides a model for potential deer range improvements in many areas of North America where quality of native range is low.

Food planting programs have successfully focused hunter interest on habitat improvements in North Carolina (Betsill and Sharpe 1985). Our research with American jointvetch has drawn wide public interest in summer food plantings throughout the Southeast. We believe that hunter interest in American jointvetch has stimulated an increased awareness of many aspects of deer management and that sportsmen are spending more recreational time managing deer during closed seasons. We anticipate that the end result will be improvements in deer management by sportsmen who control private land.

For some lease holders, food plots are the only range improvement practice available because some landowners do not permit timely timber thinning or prescribed burning, or because prescribed burning is not possible or practical in some habitats. Under the assumption that forage quality is more limiting to deer than quantity in the South (Lay 1957), supplemental feeding may be the only practice that can be employed to effectively improve diet quality. Food plots are the most efficient method for attaining this goal.

Supplemental feeding in the form of food plots is not a panacea for current deer management problems, nor should it be considered a replacement for other range management practices. However, like stocker cattle grazing, improved pastures may be the most economical way to maximize growth rates of animals when range quality is poor. Summer-fall food plots improve range quality for free-ranging deer and should, therefore, be considered as viable options for intensive deer management programs in some parts of the southern United States.

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