https://doi.org/10.29321/MAJ.10.A03665

Effect of Legume Component on the Relationship between Quality and Quantity of *Sorghum* Forage

by

H. G. SINGH[1] and A. K. SOGANI[2]

Introduction: Introduction of cowpea as a companion crop has often been recommended to improve the quality of *sorghum* forage (Mann and Barnes, 1953; Henderson and Davis, 1955; Garg, 1961; Tawaka *et al.*, 1962; Kalinina, 1962 and Shpakora, 1962). Although quality of forage as a result of companion cropping with legume may increase but quantitative loss in forage production has often been observed because legumes are inefficient producers of dry matter as compared to *sorghum*. Ayyangar (1942) reported that yield of *sorghum* was reduced when sown mixed with pulses. Thompson (1958) and Dey *et al* (1958) also observed suppression in the growth of *sorghum* due to heavy intertwining effect of legumes. Since area under forage crops is limited because of its greater need for food production, it is necessary to work out the practices which may increase the quality of *sorghum* forage without causing any quantitative loss. This calls for improvement in forage evaluation than used hitherto. With these objectives in mind a field experiment comprising various agronomic practices was planned.

Materials and Methods: The treatments for the experiment consisted of five legume—non-legume proportions, two levels of nitrogen fertilization and two seed rates. The legume—non-legume proportions were (i) *sorghum* alone, (ii) *sorghum* and cowpea in the ratio of 3:1 in alternate lines, (iii) *sorghum* and cowpea in the ratio of 1:1 in alternate lines, (iv) *sorghum* and cowpea in the ratio of 1:3 in alternate lines and (v) cowpea alone. Fertilization with nitrogen was done at 0 and 60 kg. N/ha through ammonium sulphate. Seed rate treatments were (1) normal seed rate and (2) double seed rate. The experiment was conducted in split plot design with three replications. Computation of total digestible nutrients (TDN), starch equivalent (SE) and dry matter production per hectare and analysis of fodder for its TDN, SE, crude fibre and crude protein content were used as criteria for treatment evaluation.

Starch equivalent was computed by utilizing the values for crude fat, crude fibre, crude protein and nitrogen free extract of the fodder. Values for these, obtained by actual chemical analysis, were converted into digestible values and then into starch equivalent by multiplying with appropriate

[1] and [2] Department of Agronomy, College of Agriculture, Udaipur.

Received on 2—9—1967.

conversion factors. Conversion factors for digestibility of crude protein, nitrogen free extract, crude fibre and ether extract used were 0·75, 0·90, 0·50 and 0·90 respectively. The values 0·94, 1·91 and 1·00 were used as starch equivalents for digestible crude protein, digestible fat and digestible fibre plus nitrogen free extract. TDN was calculated as per formula given below:

TDN = Digestible protein + digestible fibre + digestible N. free extract + (digestible fat 2·25)

Data on these aspects were statistically analysed and variations due to the effect of crop mixture only were found significant.

Results: Data in Table 1 show that growing of *jowar* with cowpea in the ratio of 3 : 1 increased the production of total digestible nutrients, starch equivalent and dry matter production as compared to growing of *jowar* alone, cowpea alone and growing of *jowar* plus cowpea in any other proportion.

TABLE 1. *Effect of legume — non-legume on the production of feed units (q / hh)*

Treatment	TDN	SE	Dry matter
jowar alone	112·93	77·94	152·10
¾ *jowar* + ¼ cowpea	122·45	89·51	161·35
½ *jowar* + ½ cowpea	111·35	81·59	146·37
¼ *jowar* + ¾ cowpea	88·97	66·16	116·05
Cowpea alone	34·32	26·75	43·56
S. Em. ±	3·51	3·16	5·27
L. S. D. at 5%	10·50	8·91	15·05

TDN: Growing *jowar* with cowpea in the ratio of 3 : 1 resulted in the production of maximum TDN. Compared to growing of *jowar* alone, *jowar* + cowpea in 1 : 1 and 1 : 3 ratios and cowpea alone increased TDN production by 8·45, 37·63 and 256·78 per cent respectively. The increases in the proportion of legume to *jowar* brought about significant reduction in the production of total digestible nutrients. Cowpea alone produced only 1/3 total digestible nutrients.

Starch Equivalent (SE): Starch equivalent, a measure of fat producing ability of the fodder was also affected significantly by the proportion of legume—non-legume fraction of the fodder. Here too growing of *jowar* with cowpea in the ratio of 3 : 1 produced significantly more SE than any other crop mixture. The relative efficiency of 3 : 1, 1 : 1, *jowar* alone, 1 : 3 and

cowpea alone crop mixtures ranged in the order named. Thus growing of *jowar* + cowpea in the ratio of 3 : 1 associated with 63·25, 23·35, 11·57 and 7·92 quintals increased starch equivalent production per hectare over cowpea alone, ¼ *jowar* + ¾ cowpea, *jowar* alone and ½ *jowar* + ½ cowpea respectively.

Dry matter: While differences in dry matter production due to adoption of different proportions of legume to non-legume were quite large, there was no significant difference in forage production due to growing of *jowar* alone and *jowar* and cowpea in the ratio of 3 : 1 and 1 : 1. Growing of cowpea alone or *jowar* + cowpea in the ratio of 1 : 3 was unsuitable for dry matter production. Quantitative increases in fodder production due to adoption of *jowar* cowpea mixture in the ratio of 3 : 1 over *jowar* alone, *jowar* cowpea in the ratio of 1 : 1, 1 : 3 and 3 : 1 were 9, 15, 45 and 118 quintals per hectare respectively.

TABLE 2. *Effect of legume — non-legume component on the quality of forage (per cent)*

Treatment	TDN	SE	Crude protein	Crude fibre
Jowar alone	74·21	51·31	6·48	38·69
¾ *jowar* + ¼ cowpea	75·87	55·45	8·11	34·17
½ *jowar* + ½ cowpea	76·05	55·72	8·63	33·94
¼ *jowar* + ¾ cowpea	76·59	56·90	9·41	32·99
Cowpea alone	78·78	61·34	16·16	27·66
S. Em. ±	0·33	0·72	0·44	0·66
L. S. D. at 5%	0·94	2·05	1·25	1·88

From the stand point of TDN content in the fodder the treatments could be arranged in three groups. Cowpea alone producing approximately two per cent more TDN than *jowar* and cowpea in any proportion and producing 45 per cent more TDN when *jowar* alone was grown. Thus cowpea alone and cowpea *jowor* mixtures gave significantly greater TDN than *jowar* alone.

The order of effectiveness of the treatments in the SE content of the fodder remained as in TDN. Growing cowpea as companion crop with *jowar* significantly increased its SE content over growing of *jowar* alone and the increases were approximately five per cent. Cowpea alone, however, gave the highest SE content in the fodder.

Growing *jowar* with cowpea in any proportion was found to be associated with increased crude protein content as compared to that of *jowar* fodder and increased proportion of legume to non-legume tended to increase crude protein content. Fodder from *jowar* alone, $\frac{1}{2}$ *jowar* + $\frac{1}{2}$ cowpea, $\frac{3}{4}$ *jowar* + $\frac{1}{4}$ cowpea and $\frac{1}{4}$ *jowar* + $\frac{3}{4}$ cowpea contained 39·87, 23·52, 22·70 and 19·20 per cent increased crude fibre content as compared to fodder from cowpea alone.

It may thus be summed up that *jowar* fodder analysed the least TDN, SE and crude protein but more crude fibre. Fodder from *jowar* + cowpea in the ratio of 3 : 1 had very high content of TDN, SE and crude protein with moderate content of crude fibre and increasing proportion of legume in the fodder tended to increase TDN, SE and crude protein but reduce crude fibre content.

Discussion: Growing *jowar* and cowpea in the ratio of 3 : 1 increased TDN and SE significantly per hectare in comparison with *jowar* or cowpea or their mixture in any proportion. Significant increase in production of TDN and SE due to growing of *jowar* and cowpea in 3 : 1 ratio appears to have been brought about by significant increase in dry matter production and/or better composition of fodder (Tables 1 and 2) with this treatment. When *jowar* and cowpea were grown in this ratio they grew to mutual advantage of each other and cowpea being legume tended to improve the quality of fodder without reducing the yield of dry matter. When grown in this proportion the advantage of high yield potential of *jowar* was fully exploited and the disadvantage of poor quality of *jowar* was offset by cowpea which is rich in TDN and crude protein. It was further observed that growing *jowar* alone was associated with slightly reduced dry matter production and poor quality. It is no wonder that these two things together brought down the TDN and SE production due to growing *jowar* alone. While every increase, on the other hand, in the proportion of legume to non-legume in fodder tended to improve its quality, associated weight loss was so much that even a major gain in quality was far more offset due to reduced dry matter production.

That TDN and SE production were function of greater dry matter production, which means proportionately more crude fibre, is supported by the existence of a significant positive correlation between crude fibre content of fodder and TDN and SE. Correlation coefficients of 0·850 and 0·805 were observed between TDN and crude fibre and SE and crude fibre respectively. When a regression equation was fitted to highlight the function of crude fibre in the production of TDN and SE (Fig. 1 a—b) it was seen that the equation assumed the following values:

$$\hat{Y} = 94{\cdot}00 + 7{\cdot}68\ (X - 33{\cdot}49)$$

$$\hat{Y} = 68{\cdot}39 + 5{\cdot}06\ (X - 33{\cdot}49)$$

for the effect of crude fibre per cent on TDN and SE respectively. These equations show that an unit increase of 33·49 per cent in crude fibre increased TDN and SE by 7·68 and 5·06 quintals per hectare respectively.

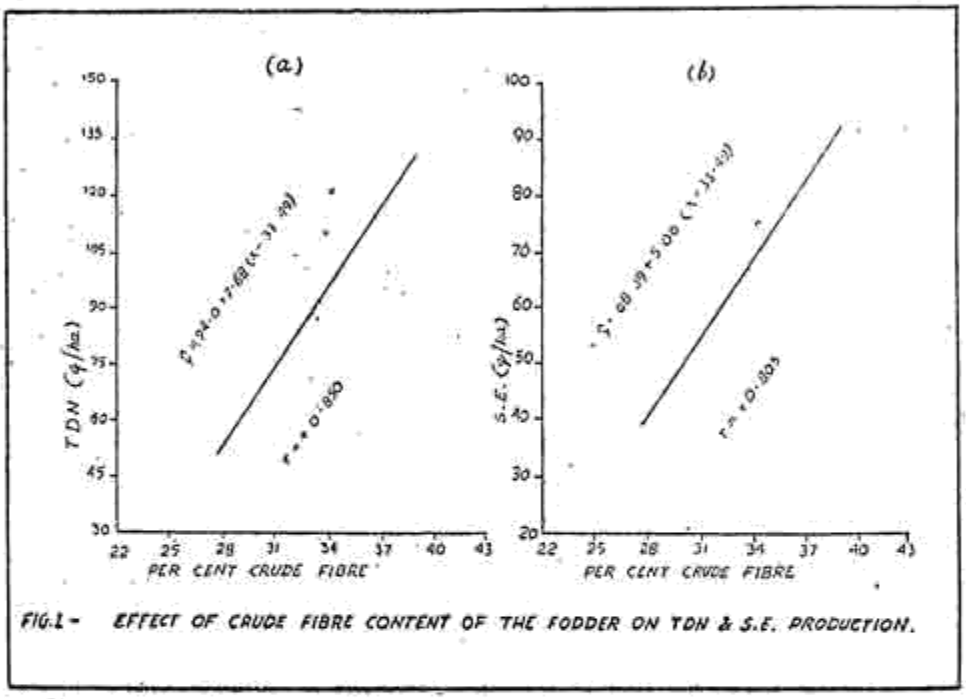

FIG. 1 - EFFECT OF CRUDE FIBRE CONTENT OF THE FODDER ON TDN & S.E. PRODUCTION.

That increased protein content as a result of increased proportion of legume in forage was not associated with increased production of TDN, SE or dry matter can be verified from the existence of a negative correlation between crude protein content on one hand and TDN and SE on the other. The correlation coefficients were 0·957 and 0·937 respectively. The corresponding regression equations in Fig. 2 (a–b) show that an unit increase of 9·75 per cent in crude protein content decreased TDN by 9·11 q/ha and SE by 6·21 q/ha.

That TDN and SE production per hectare were function of crude fibre content has been amply demonstrated and that dry matter is the function of crude fibre can be shown by the existence of a significant positive correlation of 0·866 between crude fibre and dry matter production. The regression equation in Fig. 3 (a–b) shows that an increase of 33·49 per cent in crude fibre increased dry matter production by 10·56 quintals per hectare. As against this an unit increase in crude protein content by 9·75 per cent increased dry matter production by 12·37 quintals per hectare. Reduced dry matter production due to increased proportion of legume to non-legume was also reported by Tomar and Singh (1963).

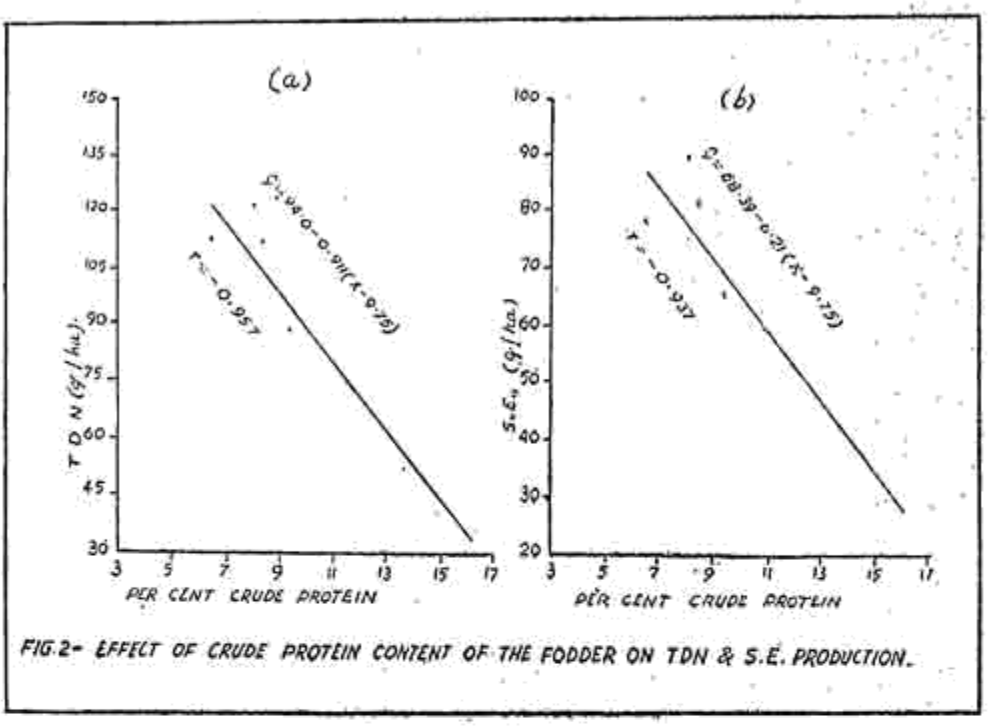

FIG. 2- EFFECT OF CRUDE PROTEIN CONTENT OF THE FODDER ON TDN & S.E. PRODUCTION.

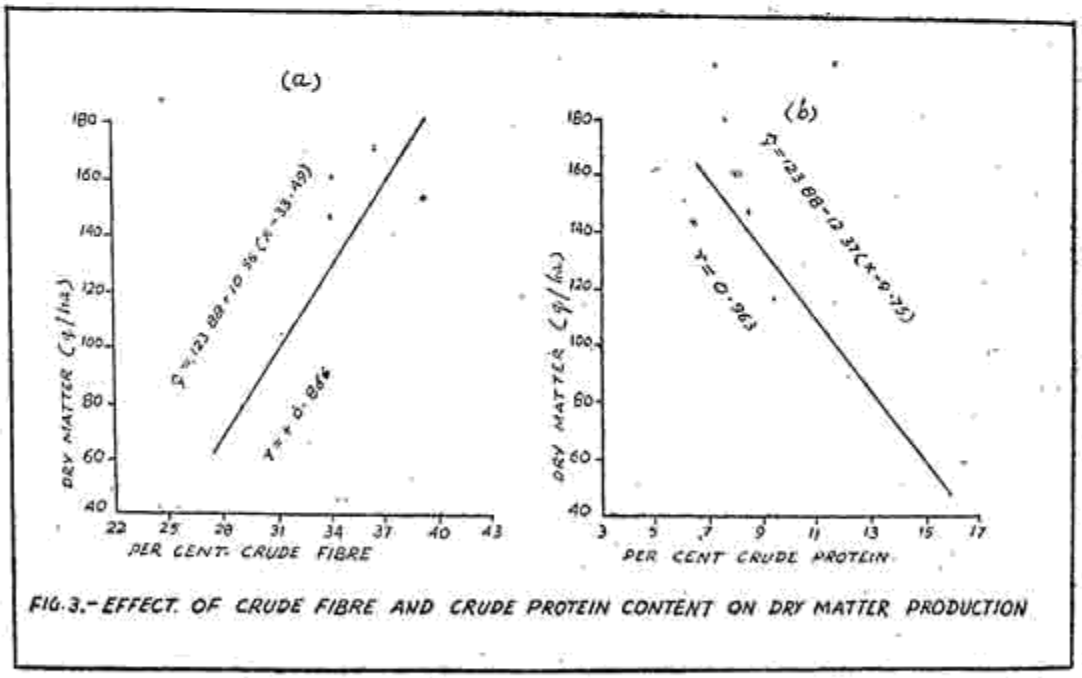

FIG. 3.- EFFECT OF CRUDE FIBRE AND CRUDE PROTEIN CONTENT ON DRY MATTER PRODUCTION

Per cent TDN and SE, on the other hand, were negatively correlated with crude fibre and positively with crude protein. Crude protein and crude fibre were also negatively correlated. Rajorhia *et al.* (1959) obtained a low TDN and SE percentage with high fibre and low protein content. Similarly Gupta *et al* (1967) reported as low as 51·85 per cent TDN in Napier grass when its crude fibre was 43·57 per cent only.

Summary: Growing *jowar* and cowpea in 3:1 ratio increased significantly TDN production and starch equivalent per hectare as compared to growing *jowar*, cowpea, *jowar* cowpea in 1:1 ratio or in 1:3 ratio. Crude protein and crude fibre content of fodder had a significant relationship with TDN and starch equivalent. Increased crude protein content in fodder although increased TDN percentage reduced crude fibre content and consequently dry matter and TDN or SE per hectare.

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