INTERCROPPING OF LEGUMES IN FODDER SORGHUM - A REVIEW

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ABSTRACT

Sorghum as a fodder crop needs improvement in quality. Sorghum cut at 50% flowering are generally with 8% protein only. Augmentation of protein could be attempted by cultivation of forage sorghum intercropped with leguminous fodder crops. A more balanced nutritive feed can be obtained by mixing fodder sorghum and leguminous crops. Sorghum based intercropping system increases LER, nitrogen balance and monetary returns. Literatures on leguminous intercropping in fodder sorghum are reviewed in this article.

India possesses an enormous livestock population of 489 million heads (Hazra and Misri, 1995) with the annual forage production of 691 million tonnes as against the requirement of 1824 million tonnes. Area under forage crops in India is only 4.6% of total cultivated land. In India, on a very limited area cereals and legumes are grown solely for forage production. In this context, intercropping has been recognized as a potential system of forage production for subsistence farming situations, which helps in providing balanced diet by accommodating cereals and legumes. Suitable intercropping of protein rich leguminous crops with sweet sorghum would improve the forage quality and subsequently the productivity of animals. Leguminous crops are most useful both as a forage species and their beneficial effects on the growth of associated cereals. Intercropping of cereals and legume is a profitable composition in terms of supply of good quantity and quality fodder production. Sorghum as a fodder crop needs improvement in quality. All the varieties of sorghum cut at 50% flowering are generally with 8% protein only. Increasing of protein could be attempted by cultivation of forage sorghum with leguminous fodder crops. Suitable incorporation of protein rich leguminous crops with sorghum would improve the feed quality and subsequently the potential of animals.

Fodder yield

Green fodder yield of sorghum and intercrops declined greatly under intercropped situations than sole crops. Competition for light and nutrients may be probable reason for such decrease in yield (IGFRI, 1995). Significantly more total digestible nutrients and starch equivalent yields were obtained in sorghum + cowpea intercropping in 3:1 ratio as compared to 1:1 and 2:1 ratio (Singh and Sogani, 1968). Sequential intercropping of pearl millet followed by cowpea in long duration fodder sorghum gave a better yield than sole crop of sorghum (Andrews, 1972). Maximum green forage and dry matter yield were recorded under sorghum + cowpea intercropping (4:1) which was at par with sorghum + cowpea in ratios of 3:1 and 2:1 (Taneja et al., 1983). Intercropping of fodder cowpea in fodder sorghum in 3:1 ratio recorded maximum green and dry fodder yield (AICRPFC, 1989). Better crop growth and dry matter production in intercropping system of different legumes with fodder sorghum was mainly due to better crowding coefficient, aggressivity and other conditions (Chaudhary, 1979).

Intercrop on sorghum

Increased intercrop competition from 1:1 to 1:2 ratio of fodder cowpea and fodder
sorghum, plant height, green fodder yield and
dry fodder yield reduced owing to increased
population pressure of the legume in the
system (Gumaste, 1990). In contrast,
intercropping of fodder cowpea with fodder
sorghum in 1:1 to 3:1 ratio increased the plant
height, green fodder yield and dry fodder yield
due to spatial arrangements by harnessing
increased solar radiation (Paris et al., 1993).
Intercropping of fodder cowpea in fodder
sorghum increased the number of tillers, green
fodder and dry fodder yield of sorghum
(Ibrahim, 1994).

Sweet sorghum + field bean
intercropping system at 2:1 row proportion
produced significantly higher mixed green
forage (59.5 t/ha), dry matter (11.35 t/ha)
and crude protein (812 kg/ha), crude fibre
(3820 kg/ha), either extract (259 kg/ha) and
total ash (804 kg/ha) followed by sorghum +
cowpea intercropping system at 2:1 row
proportion and sweet sorghum + horsegram
(2:1) ratio (Thippeswamy and Alagundagi,
2001). The lowest yield of base crop sweet
sorghum might be due to only 50 % of its plant
population in 1:1 row ratio and higher
suppressing effect by horse gram by vigourous
and viny growth (Sukanya and Govindasamy,
1985; Rout et al., 1990; Anonymous, 1992).
Higher green forage and dry matter yields with
the intercropping of sorghum + cowpea may
be attributed to complementary effect of
cowpea which supplemented nitrogen to
sorghum and better utilization of environmental
resources (Mishra et al., 1997). Sorghum +
cowpea intercropping gave significantly more
green fodder (113.7 q/ha), dry matter yield
(27.2 q/ha) and sorghum equivalent yield (26.8
q/ha) than sorghum + pigeon pea and
sorghum + Cenchrus setigerus intercropping
systems (AICRPFC, 1982) (Table 1).

Intercropping of fodder sorghum
(pusachari) + fodder cowpea (EC 4216) and
harvested on 60 DAS, recorded higher green
fodder yield (39.5 t/ha and 38.8 t/ha in two
years) than sole fodder sorghum (37.2 and
36.2 t/ha). Sorghum + cowpea intercropping
produced significantly more green fodder
(115.9 q/ha) and dry matter yields (27.96 q/
ha) of fodder crops than sorghum + grass strips
of Cenchrus setigerus at 4:1 m apart (51.65
and 13.45 q/ha of green and dry matter yields
respectively) under dryland conditions (Arya
et al., 1999). Intercropping of sorghum/
pigeonpea with fodder crops yielded
significantly more fodder than sole crops,
without affecting yield of main crops (Niranjan
et al., 1998). Significantly higher fodder yield
was obtained with combined use of organic
and inorganic N compared to inorganic
fertilizers alone in sorghum + cowpea under
rainfed conditions (Arya and Niranjan, 1994).

Quality of fodder
Sorghum with cowpea mixed fodder
cropping produced higher metabolizable
energy (Kalra and Khokhar, 1979). Sorghum
intercropped with cowpea (3:1) produced
highest crude protein yield when compared to
sorghum with cowpea 1:1, 2:1 and 4:1 ratios
(AICRPFC, 1982). Sole cowpea and fieldbean
recorded significantly lower crude protein and
crude fibre yields. However, all the sole legumes
(cowpea, field bean and horse gram) recorded
significantly lower yields of either extract and
total ash compared to sole sorghum and other
intercropping systems (Verma et al., 1997).
Sorghum + cowpea mixture gave higher
protein yield than other mixture and pure
sorghum (Singh et al., 1971; Rao et al., 1976).

Maximum crude protein yield was
obtained in sole sorghum than sorghum +
cowpea intercropping system (Khanna et al.,
1996) (Table 1).

Maximum crude protein yield was
registered with sorghum + cowpea (3:1)
intercropping system when compared to
sorghum + cowpea 1:1, 2:1 and 4:1 system
(AICRPFC, 1982). Fodder sorghum intercropped
Table 1. Productivity of sorghum based intercropping system

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Sorghum</th>
<th>Green fodder yield (q/ha)</th>
<th>Dry matter yield (q/ha)</th>
<th>Sorghum equivalent yield (q/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sorghum + cowpea</td>
<td>6.0</td>
<td>52.5</td>
<td>113.7</td>
<td>27.2</td>
</tr>
<tr>
<td>Sorghum + pigeon pea</td>
<td>7.2</td>
<td>57.4</td>
<td>1.76*</td>
<td>-</td>
</tr>
<tr>
<td>Sorghum + Cenchrus setigerus</td>
<td>6.7</td>
<td>54.5</td>
<td>52.0</td>
<td>13.6</td>
</tr>
<tr>
<td>CD (5%)</td>
<td>0.3</td>
<td>3.27</td>
<td>3.51</td>
<td>1.06</td>
</tr>
</tbody>
</table>

( Arya et al., 2000)

Grain yield of pigeon pea.

Table 2. Cowpea intercropping in fodder sorghum

<table>
<thead>
<tr>
<th>Cropping pattern</th>
<th>Green fodder (q/ha)</th>
<th>Crude protein yield (q/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I cut</td>
<td>II cut</td>
</tr>
<tr>
<td>Sole sorghum</td>
<td>378</td>
<td>56.0</td>
</tr>
<tr>
<td>Sorghum + cowpea (2:2)</td>
<td>257</td>
<td>32.6</td>
</tr>
<tr>
<td>Sorghum + cowpea (3:3)</td>
<td>255</td>
<td>31.7</td>
</tr>
<tr>
<td>CD (5%)</td>
<td>6.9</td>
<td>1.9</td>
</tr>
</tbody>
</table>

(Khanna et al., 1996).

with legumes like cowpea and soybean produced high quality forage indicated by high crude protein content (12.8%) as compared to sorghum crop alone (7.10%) (Sood and Sharma, 1992). Addition of legumes at 25, 50 and 75% level improved the in vitro dry matter digestibility and significantly reduced the neutral detergent fibre content (Rekib et al., 1987). Sorghum intercropped with cowpea was comparatively better in feed qualities, viz., crude protein, crude fat, crude fibre and mineral mixture when compared to sorghum + guar and sorghum + moth bean system.

Soil fertility status

There was no significant difference in N and K uptake with legume intercropping and sole cropping of sorghum (Mohammad et al., 1996). Inclusion of legumes in intercropping system tended to improve organic carbon and available N and reduced the depletion of soil P and K (Mercy George and Rajendra Prasad, 1989). The organic carbon content increased with all the legumes involved in the system (Rana et al., 1995). Restoration of available N and K in the soil was more in the plot receiving FYM @ 12 t/ha in a sorghum + legume intercropping system (Arya and Niranjan, 1995).

Land equivalent ratio

Land equivalent ratio (LER) was 1.18 for sorghum + cowpea mixed stand with application of 60 kg N/ha (Tripathy et al., 1988). Intercropping of sorghum with cowpea in paired alternate rows (2:2) recorded higher LER (1.35) compared with other sole and intercropping system (Mishra et al., 1997). Intercropping system with fodder sorghum + groundnut 1:2 ratio appeared to be advantageous with higher LER and relative value total (Barik et al., 1998). Intercropping of fodder sorghum with cowpea paired alternate rows (2:2) recorded higher green fodder (42.3 t/ha), dry matter (8.17 t/ha), crude protein (9.26 q/ha), LER (1.35), net return (Rs. 6804/ha) and B:C ratio (2.77) compared to other sole and
Table 3. Intercropping of cowpea and horse gram in forage sorghum

<table>
<thead>
<tr>
<th>Intercropping systems</th>
<th>Fodder yield of sorghum (t/ha)</th>
<th>Total fodder yield (t/ha)</th>
<th>Dry matter yield (t/ha)</th>
<th>Crude protein yield (q/ha)</th>
<th>LER</th>
<th>Net return (Rs/ha)</th>
<th>B.C ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sole sorghum</td>
<td>29.8</td>
<td>29.8</td>
<td>6.84</td>
<td>4.31</td>
<td>-</td>
<td>4156</td>
<td>2.29</td>
</tr>
<tr>
<td>Sorghum + cowpea (1:1)</td>
<td>15.9</td>
<td>36.0</td>
<td>6.98</td>
<td>7.72</td>
<td>1.15</td>
<td>5664</td>
<td>2.70</td>
</tr>
<tr>
<td>Sorghum + cowpea (1:2)</td>
<td>13.1</td>
<td>37.5</td>
<td>7.20</td>
<td>8.64</td>
<td>1.18</td>
<td>5944</td>
<td>2.72</td>
</tr>
<tr>
<td>Sorghum + cowpea (2:2)</td>
<td>17.8</td>
<td>42.5</td>
<td>8.17</td>
<td>9.26</td>
<td>1.35</td>
<td>6804</td>
<td>2.77</td>
</tr>
<tr>
<td>Sorghum + horse gram (1:1)</td>
<td>20.4</td>
<td>27.1</td>
<td>5.58</td>
<td>4.53</td>
<td>1.11</td>
<td>3689</td>
<td>2.19</td>
</tr>
<tr>
<td>Sorghum + horsegram (1:2)</td>
<td>19.5</td>
<td>27.5</td>
<td>5.47</td>
<td>4.62</td>
<td>1.16</td>
<td>3780</td>
<td>2.21</td>
</tr>
<tr>
<td>Sorghum + horse gram (2:2)</td>
<td>22.1</td>
<td>28.3</td>
<td>5.96</td>
<td>4.67</td>
<td>1.13</td>
<td>3791</td>
<td>2.15</td>
</tr>
</tbody>
</table>

(Mishra et al., 1997).

Intercropping systems (Mishra et al., 1997) (Table 3).

Nitrogen economy

Nitrogen was one of the most important nutrients for increased production and quality of forage. In this case, the association of legumes with cereal fodder crops might be a practical approach to lower the nitrogen requirement (Singh et al., 1986). Some of the fodder legumes had better effect on the associated standing cereals than grain legumes because they were cut at flowering phase when the nitrogen fixation was more active. Naturally the release of nitrogen from ploughing off nodules was more from fodder legumes than grain legumes. Some legumes might have higher final nitrogen yield in mixture with cereals than their pure stands without much change in the yield of associated cereals. There was some amount of nitrogen transfer from legume to cereal when grown in association (Singh and Kaushik, 1987). Nitrogen fixation in soil by legumes was recorded under intercropping system (Taylor, 1980; Sharma et al., 1986). Available N status at harvest was higher in the sorghum + blackgram intercropping system. This might be probably due to fact that blackgram fixed nitrogen through root nodules and from leaf fall (Kandam et al., 1987). The 100 and 75% N application in sorghum + blackgram intercropping system showed increase in N status to the tune of 36.4 and 16.8 kg/ha due to association with blackgram. There was gain in nitrogen balance when legume was introduced in the cropping system (Ramshe and Patil, 1987; Singh et al., 1970). Apparent gain in nitrogen was noticed in sorghum + safflower, sorghum + greengram and sorghum + groundnut intercropping system (Zade et al., 1994).

Economics

Higher net profits were recorded mixed cropping system as compared with single crop of sorghum (Jain and Jain, 1986). Sorghum and cowpea intercropping system recorded higher monetary return than sole sorghum (Andrews, 1982). Soybean mixed with sorghum at 1:1 ratio registered higher net return than sole sorghum (Yadav, 1985). Sorghum intercropped with two rows of cowpea under paired row system of planting gave highest net return (Balasubramanian et al., 1989). Fodder cowpea intercropped with sorghum at 3:1 ratio recorded a net return of Rs. 6362/ha (AICRPFC, 1989).

Sorghum (SSG 5000 sown in 30 cm apart line) intercropped with cowpea (Russian Giant) registered significantly higher green fodder (452 q/ha), dry matter (110 q/ha), sorghum green fodder equivalent (577 q/ha) yields, net income (Rs. 12502/ha) and B.C ratio (2.06) than sorghum + cluster bean (Budel
Guar 2) intercropping and sole sorghum (Ram and Singh, 2001) (Table 4). The net return obtained from sorghum + pigeonpea intercropping system with 3:1 ratio was higher than 4:1 ratio (Lotome and Diabhade, 1990). Intercropping of sorghum with cowpea in paired alternate rows (2:2) gave 63 % more monetary return and 21% B:C ratio over sole crop sorghum (Mishra et al., 1997).

Intercropping of cowpea in multicut fodder sorghum varieties (CO 27, Harasona and MFSH-3) in 3:1 ratio registered maximum gross return, net return and B:C ratio than sole sorghum (Sankaranarayanan, 2000). Sorghum + groundnut intercropping system in 1:2 ratio gave the maximum return (Barik et al., 1998).

### REFERENCES


### Table 4. Intercropping of cowpea and cluster bean in forage sorghum

<table>
<thead>
<tr>
<th>Intercropping systems</th>
<th>Green fodder yield (q/ha)</th>
<th>Dry matter yield (q/ha)</th>
<th>Sorghum green fodder equivalent (q/ha)</th>
<th>Net return (Rs./ha)</th>
<th>B:C ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sole sorghum</td>
<td>382</td>
<td>96</td>
<td>382</td>
<td>6888</td>
<td>1.28</td>
</tr>
<tr>
<td>Sorghum + cowpea (1:1)</td>
<td>452</td>
<td>110</td>
<td>577</td>
<td>12502</td>
<td>2.06</td>
</tr>
<tr>
<td>Sorghum + clusterbean</td>
<td>406</td>
<td>100</td>
<td>456</td>
<td>8426</td>
<td>1.34</td>
</tr>
<tr>
<td>CD (5 %)</td>
<td>28</td>
<td>7</td>
<td>33</td>
<td>1072</td>
<td>0.15</td>
</tr>
</tbody>
</table>

(Ram and Singh, 2001).