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SHRUBS AND TREE FODDERS OR FARM ANIMALS

PROCEEDINGS OF A WORKSHOP IN DENPASAR, INDONESIA, 24 - 29 JULY 1989
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Shrubs and tree fodders for farm animals

Proceedings of a workshop in Denpasar, Indonesia, 24–29 July 1989

Editor: C. Devendra
Devendra, C.
IDRC. Regional Office for Southeast and East Asia, Singapore


UDC: 636.085
ISBN: 0-88936-556-3

Technical editor: W.M. Carman

A microfiche edition is available.

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Abstract

This publication presents the results of an international meeting held in Denpasar, Bali, Indonesia, 24–29 July 1989, that focused on the use of shrubs and tree fodders by farm animals. Through 26 papers, the workshop addressed feed-resource availability, use by ruminants and nonruminants, processing methodology, economics, and development issues. These aspects and the current knowledge on shrubs and tree fodders were further highlighted by country case studies detailing prevailing situations and policy matters. A special session was held to discuss the successful development and results achieved in the three-strata forage system in Indonesia. The workshop concluded with important working group discussions on the priorities for further research and development, and on the potential for the wider use of shrubs and tree fodders in the developing world.

Résumé

Cette publication présente les résultats d’une rencontre internationale tenue à Denpasar, Bali, Indonésie, du 24 au 29 juillet 1989 et qui a porté sur l’utilisation des arbustes et fourrages végétaux par les animaux d’élevage. Les 26 communications qui y ont été présentées traitaient de la disponibilité des ressources alimentaires pour les animaux, de leur utilisation par les ruminants et les non-ruminants, des méthodes de transformation, des aspects économiques et des questions du développement. Ces sujets et les connaissances actuelles sur les arbustes et les fourrages végétaux ont ensuite été étudiés plus à fond dans le cadre d’études de cas de divers pays exposant les circonstances particulières de chacun et les questions liées aux politiques. Une séance spéciale a porté sur la mise en place et les résultats des systèmes de production de fourrages végétaux en trois strates en Indonésie. L’atelier s’est terminé par d’importantes discussions des groupes de travail sur les priorités de recherche et de développement pour l’avenir et sur les possibilités d’utilisation élargie des arbustes et des fourrages végétaux dans les pays en développement.

Resumen

Esta publicación presenta los resultados de una reunión internacional celebrada en Denpasar, Bali, Indonesia, del 24 al 29 de julio de 1989, y la cual centró su atención en la utilización de forrajes elaborados a partir de arbustos y árboles para alimentar a animales de granjas. En 26 trabajos presentados al seminario, los participantes abordaron temas tales como la disponibilidad de recursos alimentarios y la utilización de los mismos por rumiantes y no rumiantes, metodologías de procesamiento y cuestiones de economía y desarrollo. Estos aspectos y el conocimiento que se tiene actualmente sobre los forrajes de arbustos y árboles se vieron subrayados aún más por estudios de casos por países en los que se detallaron situaciones existentes y cuestiones de políticas. Se celebró una sesión especial para discutir el desarrollo y resultados exitosos alcanzados en Indonesia con el sistema de forraje de tres niveles. El taller concluyó con importantes discusiones de los grupos de trabajo sobre las prioridades existentes en el campo de la investigación y el desarrollo y sobre el potencial que encierra la amplia utilización de arbustos y árboles en el mundo en desarrollo.
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Opportunities for processing and using shrubs and tree fodders

M.R. Reddy

College of Veterinary Science, Andhra Pradesh Agricultural University, Rajendranagar, Hyderabad 500 030, India

Abstract — The development of appropriate processing methods for the intensive use of fallen dry tree leaves is discussed in view of the available biomass and chronic feed deficit situation in India. Grinding increases the bulk density of fallen tree leaves 30 times. Improved bulk density and easy flow characteristics of the ground leaves simplify and make processing more economic. Studies on grinding leaves and on steam pelleting of feeds containing fallen tree leaves have given promising results. The formulation and processing of complete feeds in mash or pelleted form, using fallen tree leaves as a roughage source, was successfully tested with sheep. Because knowledge on the use of fallen tree leaves is limited, intensive, long-term nutritional studies with on-farm testing and evaluation, the development of simple mechanical devices for the collection of leaves from forests, the fabrication of small steam-pelleting units, and the establishment of suitable grinding mills are important priorities.

Resume — L’auteur discute de la mise au point de bonnes méthodes de transformation, aux fins d’usage intensif, des feuilles d’arbre mortes à la lumière de la biomasse disponible et de la situation déficitaire chronique des fourrages en Inde. Le broyage accroît trente fois la densité de la masse des feuilles mortes. Une meilleure densité et des caractéristiques qui faciliteraient leur passage dans les machines simplifieraient leur transformation et la rendraient plus économique. Les études sur le broyage des feuilles et sur la granulation à la vapeur de fourrages contenant des feuilles mortes ont donné des résultats encourageants. La formulation et la transformation de fourrages complets sous forme de pâte ou de granules, dans lesquels les feuilles mortes fournissent le fourrage grossier, ont été testées avec succès pour le mouton. Parce les connaissances sur l’emploi des feuilles mortes sont restreintes, il s’impose en priorité de réaliser des études nutritionnelles intensives et de longue durée accompagnées d’essais et d’évaluations en ferme, de mettre au point des machines simples de collecte des feuilles dans les forêts, de fabriquer de petites presses à granuler à la vapeur et d’aménager les moulins à broyer indiqués.

Resumen — Se estuda la preparación de métodos de procesamiento adecuados para usar intensivamente las hojas secas caídas de los árboles, en vista del déficit crónico en materia alimenticia y biomasa disponible en la India. La molienda incrementa 30 veces la densidad aparente de las hojas caídas de árboles. El aumento de densidad aparente y la facilidad de extracción de las hojas del suelo, simplifican y economizan el procesamiento. Se han obtenido resultados promisorios de los estudios efectuados con hojas molidas y forrajes que contienen hojas caídas de árboles comprimidas al vapor. La formulación y el procesamiento de pienso comprimidos o
prensados, usando hojas caídas de árboles como fuente de forraje grosero, dio excelentes resultados en las ovejas. Debido a la limitada información que se tiene respecto al uso de hojas caídas de árboles, debe darse preferencia a estudios sobre alimentación intensiva de animales, a largo plazo, con verificación y evaluación práctica (en la granja), así como la creación de dispositivos mecánicos simples para recolectar hojas de bosques, la fabricación de equipos pequeños de compresión al vapor, y la instalación de molinos de muelas apropiados.

Introduction

India accounts for about 15% of the world's livestock population. The projected green and dry fodder requirements for the year 2000 are \(1 \times 10^8\) and \(9.49 \times 10^6\) t, respectively (Punjab Singh 1988). Currently, the feed and fodder resources of India can meet only 46.6% of the requirement of the livestock population of over 400 million. Of the country’s cropped area, \(6.9 \times 10^5\) ha (4.4%) is under fodder crops and there is hardly any scope for expansion of fodder cultivation because of pressure on agricultural land for food and cash crops. The forest grazing resources are also dwindling at a rate of about \(1.5 \times 10^6\) ha/year. The solution, therefore, lies in maximizing the use of nonconventional feed resources such as shrub and tree fodders, and fibrous agricultural residues.

The use of shrubs and tree fodders in India has been discussed in detail by Raghavan (this volume). There is also about \(43 \times 10^6\) t of fallen forest tree leaves that, if processed, could be used by the animals. Every year, during autumn, huge quantities of tree leaves become available. Punj (1983) has also reported that there is \(300-350 \times 10^6\) t/year of unused dry, fallen, forest leaves and forest grass from \(67.4 \times 10^6\) ha of forest. In addition to fallen tree leaves, enormous quantities of tree leaves are available because of the felling of the trees from the forests and from the Farm Forestry area. The planting of trees by the farmers alternate to crop farming has recently increased significantly in India.

Fallen dry leaves from forests and various tree plantations represent a potentially important source of livestock feed, if appropriate processing technology is developed and adopted. This paper focuses on these aspects.

Processing methods

About \(18.8 \times 10^6\) t of fallen teak leaves (Tectona grandis; ICAR 1985), \(0.5 \times 10^6\) t of fallen mango leaves (Mangifera indica; College of Veterinary Science 1983), and about \(23.8 \times 10^6\) t of fallen mixed dry tree leaves (College of Veterinary Science 1981) are produced every year. Currently, the fallen tree leaves are not used and mostly either burn in forest fire accidents during summer or decay naturally. The Indian Department of Forestry prohibits the lopping of forest trees such as teak, sal, mahua, etc.; however, they have no objection to the removal of fallen leaves. Fallen leaves are not consumed by the animals as they are dry and unpalatable. These materials are nutritionally inferior to even low-grade crop residues (Table 1), and the animals cannot use them unless they are suitably processed. Considering the huge availability of this biomass and the serious shortage of feedstuffs in India, there is an urgent need to develop appropriate processing technologies.
### Table 1. Chemical composition of fallen dry leaves (% dry matter basis)

<table>
<thead>
<tr>
<th>Botanical name (common name)</th>
<th>CP</th>
<th>EE</th>
<th>CF</th>
<th>NFE</th>
<th>Total ash</th>
<th>Ca</th>
<th>P</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Tectona grandis</em> (teak)</td>
<td>4.9</td>
<td>3.1</td>
<td>20.3</td>
<td>51.5</td>
<td>20.2</td>
<td>2.4</td>
<td>0.1</td>
<td>V.A. Reddy and M.R. Reddy (1984)</td>
</tr>
<tr>
<td><em>Mangifera indica</em> (mango)</td>
<td>4.0</td>
<td>2.8</td>
<td>25.7</td>
<td>43.2</td>
<td>24.3</td>
<td>2.4</td>
<td>0.5</td>
<td>Reddy et al. (1984)</td>
</tr>
<tr>
<td><em>Eucalyptus</em> spp. (eucalyptus)</td>
<td>3.4</td>
<td>2.9</td>
<td>29.9</td>
<td>47.8</td>
<td>16.1</td>
<td>—</td>
<td>—</td>
<td>Garudoji and Reddy (1986)</td>
</tr>
<tr>
<td>Mixed leaves from forest</td>
<td>10.1</td>
<td>4.7</td>
<td>25.3</td>
<td>48.5</td>
<td>11.4</td>
<td>2.6</td>
<td>0.6</td>
<td>Reddy et al. (1984)</td>
</tr>
<tr>
<td><em>Madhuca indica</em> (mahua)</td>
<td>10.0</td>
<td>2.3</td>
<td>20.5</td>
<td>56.8</td>
<td>10.5</td>
<td>—</td>
<td>—</td>
<td>Punj (1983)</td>
</tr>
<tr>
<td><em>Bengalensis glomerales</em> (Banyan)</td>
<td>5.2</td>
<td>3.3</td>
<td>20.1</td>
<td>45.6</td>
<td>24.9</td>
<td>2.0</td>
<td>0.2</td>
<td>Swamy (1988)</td>
</tr>
</tbody>
</table>

Note: CP, crude protein; EE, ether extract; CF, crude fibre; NFE, nitrogen-free extract.

* Diospyros meclonoxylon (beedi), 21%; *Ficus bengalensis* and *F. glomerales* (ficus), 43%; *Butea frondosa* (moduga), 11%; *Azadirachta indica* (neem), 1%; miscellaneous, 24%.
Processing methods like grinding in hammer mills or steam pelleting can be used with fallen dry tree leaves. These leaves are lighter than crop residues; their bulk density is 11 kg/m$^3$, compared with 60–80 kg/m$^3$ for chopped cereal straws. After grinding, the bulk density of the leaves increases more than 30 times. The bulk density of ground tree leaves is 370 kg/m$^3$, compared with 100–150 kg/m$^3$ for cereal straws. This clearly indicates that light tree leaves can be economically transported, after grinding, from where they are available to where they are needed. Hammer mill production performance increased markedly when fallen tree leaves were ground (500 kg/h), compared with cereal straws like sorghum straw (200 kg/h). Thus, size reduction of fallen dry tree leaves is easy compared with fibrous crop residues. The fibre of the fallen tree leaves is more brittle and less resistant than the cereal straws and, hence, the performance of the hammer mill increases markedly, while reducing the cost of grinding. The ground tree leaves may be incorporated in various feed formulae and commercial feed compounds at appropriate levels (G.V.N. Reddy and M.R. Reddy 1984, 1986). Fallen tree leaves cannot, however, form the sole source of feed: they have a poor palatability and a low nutritional value (Reddy et al. 1984).

Steam pelleting is an important processing method that can be economically applied for processing feeds containing fallen dry tree leaves. The pelleting process improves the acceptability and use of low-quality roughages (Hale and Theurer 1972), controls dustiness, and prevents segregation of ground particles. Pelleting also improves the density (Reddy 1986) and keeping quality of feedstuffs. The increase in bulk density as a result of pelleting mash feeds ranged from 52 to 137%, depending on the level and type of crop residues used in the ration (Reddy 1986). The advantages of pelleting are more pronounced in fibrous roughages than in concentrate feeds (Hale and Theurer 1972).

Because of the high density of the ground mash, the fallen tree leaf powder is free flowing in the processing machinery, especially in conveying systems, allowing easy and economic processing. Ground crop residues, however, do not flow easily because of low density and flat particle shape. This adversely affects the production performance of the processing machines and increases the cost of processing (Reddy 1988).

High levels of fallen dry tree leaves (up to 70%) can be used in the formulation and processing of pelleted complete diets. These feeds were successfully fed to sheep without any adverse effects (G.V.N. Reddy and M.R. Reddy 1984). Preliminary investigations (G.V.N. Reddy and M.R. Reddy 1984, 1986) have revealed that economic rations for small ruminants could be processed into pelleted form using fallen tree leaves as the sole source of roughage.

It has been reported that the fibre of fallen dry tree leaves is less resistant and easy to grind and pellet, resulting in more feed production per hour and reduced processing cost (Reddy 1988). The rate of pelleted feed production ranged from 300 kg/h (68% dry mixed grass ration) to 857 kg/h (70% fallen teak leaves ration) for a pellet mill with a capacity of 1 000 kg/h for a conventional concentrate mixture (Reddy 1988). Physical characteristics like bulk density, particle size, particle shape, molasses absorbability, grinding performance, pelletability, etc., of fallen tree leaves are more favourable for economic processing compared with crop residues (Table 2). Thus, grinding and steam pelleting of fallen dry tree leaves is an easy and economical processing method, and can be used to manufacture low-cost livestock feeds.
Table 2. Physical characteristics of fallen tree leaves and crop residues.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Fallen dry leaves (mango)</th>
<th>Sorgham straw</th>
<th>Corn straw</th>
<th>Corn cobs</th>
<th>Peanut hulls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulk density (kg/m³)</td>
<td>11</td>
<td>82a</td>
<td>59a</td>
<td>148</td>
<td>104</td>
</tr>
<tr>
<td>Bulk density (ground material) (kg/m³)b</td>
<td>370</td>
<td>133</td>
<td>103</td>
<td>322</td>
<td>185</td>
</tr>
<tr>
<td>Hammer mill performance (kg/h)b</td>
<td>500</td>
<td>200</td>
<td>150</td>
<td>150</td>
<td>300</td>
</tr>
<tr>
<td>Particle size (µm)b</td>
<td>343</td>
<td>584</td>
<td>659</td>
<td>1148</td>
<td>851</td>
</tr>
<tr>
<td>Modulus of fineness°b</td>
<td>2.94</td>
<td>3.37</td>
<td>3.66</td>
<td>4.97</td>
<td>4.22</td>
</tr>
<tr>
<td>Molasses absorbability (%)b</td>
<td>52</td>
<td>40</td>
<td>52</td>
<td>28</td>
<td>30</td>
</tr>
<tr>
<td>Pellatabilityb</td>
<td>Medium</td>
<td>Very low</td>
<td>Very low</td>
<td>Very low</td>
<td>Medium</td>
</tr>
</tbody>
</table>

a Chopped.
b Material ground in a hammer mill (40 horsepower) through an 8-mm sieve.
c Proportion of coarse, medium, and fine particles in a ground sample.
Use of processed tree leaves

Fallen mixed tree leaves in the forest were ground in a hammer mill using a 5-mm sieve and the ground mash was the sole feed given to adult Nellore sheep (Reddy et al. 1984). The animals consumed an average of 2.44 kg dry matter/100 kg body weight (58.2 g/unit metabolic body weight) and lost weight at a rate of 100 g/day during the experiment. The nutritive value of the fallen forest mixed leaves (Ficus spp., Butea frondosa [moduga], Azadirachta indica [neem], etc.) was 2.3% digestible crude protein (DCP) and 26.7% total digestible nutrients (TDN). The animals were on negative nitrogen, calcium, and phosphorus balances, indicating that the fallen tree leaves cannot form the sole feed.

To improve the feeding quality of the dry tree leaves, ground teak leaves were added at 0, 25, 50, and 100% as the roughage source, replacing conventional roughage. Dry, mixed grass and four complete diets were formulated and processed into pelleted form. The four pelleted feeds containing various levels of fallen teak leaves were fed to Nellore rams to assess palatability, nutrient digestibility, and use. The results of this study (Table 3) indicated that the voluntary dry matter intake (DMI) increased as the level of ground teak leaves in the feed increased. However, the digestibility of dry matter and crude fibre significantly ($P < 0.01$) decreased with increased teak levels. DCP and TDN reduced from 8.4 to 7.2% and from 55.8 to 50.8%, respectively, when mixed grass was completely replaced with teak leaves as the sole source (70% of the complete feed) of roughage. However, there was

Table 3. Value of fallen dry teak leaves in four complete pelleted feeds for sheep.

<table>
<thead>
<tr>
<th>% composition</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry mixed grass</td>
<td>70.0</td>
<td>52.5</td>
<td>35.0</td>
<td>—</td>
</tr>
<tr>
<td>Fallen dry teak leaves</td>
<td>—</td>
<td>17.5</td>
<td>35.0</td>
<td>70.0</td>
</tr>
<tr>
<td>Peanut meal</td>
<td>9.5</td>
<td>9.5</td>
<td>9.5</td>
<td>9.5</td>
</tr>
<tr>
<td>Tapioca chips</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Cage layer droppings (dried)</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Molasses</td>
<td>8.5</td>
<td>8.5</td>
<td>8.5</td>
<td>8.5</td>
</tr>
<tr>
<td>Mineral mixture</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Urea</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Common salt Rovimix*</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Nutritive value

| DMI/100 kg body weight (kg) | 3.7 | 4.0 | 4.2 | 4.6 |
| DMI/kg$^{0.75}$ (g) | 85.9 | 93.3 | 97.1 | 106.7 |
| DCP intake/kg$^{0.75}$ (g) | 8.6 | 7.5 | 8.8 | 8.6 |
| ME intake/kg$^{0.75}$ (kJ) | 723.8 | 790.8 | 774.0 | 820.1 |
| TVFA (mequiv./L) | 102.3 | — | — | 96.5 |
| DCP (%) | 8.4 | 7.4 | 7.4 | 7.2 |
| TDN (%) | 55.8 | 55.7 | 52.7 | 50.8 |

* Rovimix: A and D$_3$ vitamin supplement with 40 000 IU/g vitamin A and 5 000 IU/g vitamin D$_3$ was added at 10 g/100 kg of feed.

** DMI, dry matter intake; DCP, digestible crude protein; ME, metabolizable energy; TVFA, total volatile fatty acids; TDN, total digestible nutrients.
little variation in the nutritive quality of the feed when 25–50% mixed grass was replaced with ground fallen teak leaves. The addition of teak leaves to the complete feed did not affect nitrogen, calcium, and phosphorus balances. The cost of processing the complete feeds decreased significantly as the level of teak leaves increased.

Mango leaves were successfully used as a roughage source in complete feeds of sheep (G.V.N. Reddy and M.R. Reddy 1984). The fallen dry mango leaves were ground in a hammer mill using a 5-mm sieve. The ground leaves were added at 30 and 60%, replacing dry mixed grass as the roughage source and were processed into mash and pelleted forms. These four complete feeds (Table 4) were tested on 24 Nellore rams. DMI was more ($P < 0.01$) with the pelleted feed than with the corresponding mash. Including fallen dry mango leaves as the roughage source did not affect DMI. DCP was higher ($P < 0.01$) with the pelleted feeds. Pelleting also improved in both feeds containing mango leaves. However, TDN decreased as the level of mango leaves increased from 30 to 60%; this may be due to the high tannin content of mango leaves. Fallen mango tree leaves contain 9.35% tannin; steam pelleting of the mash feed markedly reduced this tannin content. This study indicates that fallen dry mango leaves could be safely used in complete feeds at a level of 30% without any adverse effects. However, pelleting complete mash feeds may further improve nutrient use.

To overcome the tannin effect of fallen mango leaves, calcium oxide (CaO) or

<table>
<thead>
<tr>
<th>Table 4. Value of fallen dry mango leaves as the roughage source in pelleted and mash feeds for sheep.</th>
</tr>
</thead>
<tbody>
<tr>
<td>% composition</td>
</tr>
<tr>
<td>----------------</td>
</tr>
<tr>
<td>Fallen mango leaves (dried)</td>
</tr>
<tr>
<td>Dry mixed grass</td>
</tr>
<tr>
<td>Peanut meal</td>
</tr>
<tr>
<td>Cage layer droppings (dried)</td>
</tr>
<tr>
<td>Wheat bran</td>
</tr>
<tr>
<td>Molasses</td>
</tr>
<tr>
<td>Mineral mixture</td>
</tr>
<tr>
<td>Common salt</td>
</tr>
</tbody>
</table>

Nutritive value

<table>
<thead>
<tr>
<th>Nutritive value</th>
<th>Mash 1</th>
<th>Pellet 2</th>
<th>Mash 3</th>
<th>Pellet 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>DMI/100 kg body weight (kg)</td>
<td>3.3ab</td>
<td>3.9bc</td>
<td>3.0a</td>
<td>3.6b</td>
</tr>
<tr>
<td>DMI/kg$^{0.75}$ (g)</td>
<td>81.9g</td>
<td>95.6g</td>
<td>74.9e</td>
<td>87.6f</td>
</tr>
<tr>
<td>DCP intake/kg$^{0.75}$ (g)</td>
<td>4.7</td>
<td>6.0</td>
<td>4.5</td>
<td>5.6</td>
</tr>
<tr>
<td>ME intake/kg$^{0.75}$ (kJ)</td>
<td>464.4</td>
<td>506.3</td>
<td>389.1</td>
<td>418.4</td>
</tr>
<tr>
<td>Tannins (g%)</td>
<td>3.1</td>
<td>1.9</td>
<td>6.2</td>
<td>4.4</td>
</tr>
<tr>
<td>DCP (%)</td>
<td>5.7a</td>
<td>6.2c</td>
<td>5.9b</td>
<td>6.4c</td>
</tr>
<tr>
<td>TDN (%)</td>
<td>46.7c</td>
<td>50.7d</td>
<td>39.0a</td>
<td>42.1b</td>
</tr>
</tbody>
</table>

Note: Values in the same column followed by different letters differ significantly (a, b, c, d, $P < 0.01$; e, f, g, $P < 0.05$).

* Rovimix: A and D3 supplement with 40 000 IU/g vitamin A and 50 000 IU/g vitamin D3 was added at 10 g/100 kg of feed.

* DMI, dry matter intake; DCP, digestible crude protein; ME, metabolizable energy; TDN, total digestible nutrients.
urea were added to the feeds. Five complete feeds were formulated using dry mixed grass (control) and fallen dry mango leaves as the sole roughage source (50%), and the feeds were processed into mash form (Table 5). The effects of 0.5% CaO and 1% urea were evaluated in a metabolic study on 30 adult Nellore rams.

The feed containing CaO improved the use of mango leaves compared with the control. The study indicated that fallen mango leaves could be safely used as the sole source of roughage in complete feeds and that CaO, rather than urea, will improve the use of the leaves. Urea is a less effective nitrogen source when fallen mango leaves are used as roughage.

**Economic benefits**

The cost of processing complete feeds containing fallen tree leaves or dry mixed grass (Table 6) was calculated on a pilot-plant basis, considering both fixed charges (depreciation on building and machinery, interest on block investment, and maintenance) and direct charges (cost of power, labour, operators, etc.). The total cost of processing complete mash feeds containing dry fallen tree leaves as the sole source of roughage was 7.1 INR/q, compared with 8.0 INR/q for the feed containing dry mixed grass (1 q = 100 kg; in June 1989, 15.4 Indian rupees [INR] = 1 United States dollar). The processing cost of pelleted complete feeds containing tree leaves ranged from 8.6 to 16.0 INR/q with production rates of 6.1 to 8.6 q/h.
Table 6. Economic benefits of using fallen leaves.

<table>
<thead>
<tr>
<th>Roughage component of complete feed</th>
<th>Type of processing</th>
<th>Rate of feed production (g/h)(^a)</th>
<th>Processing cost (INR/q)(^b)</th>
<th>Total cost of the feed (INR/q)(^b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry mixed grass (70%)</td>
<td>Pellet</td>
<td>5.0</td>
<td>12.4</td>
<td>61.0</td>
</tr>
<tr>
<td>Dry mixed grass (52.5%) + teak leaves (17.5%)</td>
<td>Pellet</td>
<td>5.1</td>
<td>12.0</td>
<td>58.0</td>
</tr>
<tr>
<td>Dry mixed grass (35%) + teak leaves (35%)</td>
<td>Pellet</td>
<td>5.5</td>
<td>11.6</td>
<td>55.0</td>
</tr>
<tr>
<td>Teak leaves (70%)</td>
<td>Pellet</td>
<td>8.6</td>
<td>8.6</td>
<td>46.7</td>
</tr>
<tr>
<td>Mango leaves (30%) + dry mixed grass (30%)</td>
<td>Mash</td>
<td>—</td>
<td>8.0</td>
<td>61.5</td>
</tr>
<tr>
<td>Mango leaves (30%) + dry mixed grass (30%)</td>
<td>Pellet</td>
<td>6.1</td>
<td>16.4</td>
<td>69.9</td>
</tr>
<tr>
<td>Mango leaves (60%)</td>
<td>Mash</td>
<td>—</td>
<td>7.1</td>
<td>56.2</td>
</tr>
<tr>
<td>Mango leaves (60%)</td>
<td>Pellet</td>
<td>7.7</td>
<td>16.0</td>
<td>65.0</td>
</tr>
<tr>
<td>Mango leaves (50%)</td>
<td>Mash</td>
<td>7.5</td>
<td>7.2</td>
<td>59.5</td>
</tr>
<tr>
<td>Dry mixed grass (50%)</td>
<td>Mash</td>
<td>5.1</td>
<td>8.0</td>
<td>85.3</td>
</tr>
</tbody>
</table>

\(^a\) 1 q = 100 kg.  
\(^b\) In June 1989, 15.4 Indian rupees [INR] = 1 United States dollar. 1 q = 100 kg.

compared with 12.4 to 16.4 INR/q with production rates of 5.0 to 6.1 q/h for the feeds containing dry mixed grass. There was a marked increase in pellet mill performance and a considerable reduction in the processing cost with diets containing fallen tree leaves compared with diets containing dry mixed grass. These studies clearly indicate that fallen tree leaves can be economically ground and pelleted compared with fibrous roughages such as dry mixed grass.

The costs of the diets were calculated considering the existing market rates of the ingredients used in the formulae (Table 6). The total cost of the non-cereal-based diets (including processing cost) using fallen tree leaves ranged from 46.7 INR/q (70% fallen teak leaves) to 59.5 INR/q (50% fallen mango leaves), compared with 61.0–85.3 INR/q for the feed containing 50–70% dry mixed grass. Replacing dry mixed grass with fallen tree leaves resulted in a significantly reduced total cost of the feeds, without affecting nutritive quality and animal performance. These studies clearly demonstrated the economic benefits of processing and using fallen tree leaves in the diets of small ruminants. However, long-term studies on meat and milk production using optimum levels of fallen tree leaves, along with on-farm testing and evaluation, must still be performed.

### Constraints

Many constraints exist concerning processing.

- Inadequate data exist on the nutritional quality, levels that can be incorporated in the livestock feed, and pretreatments (physical and chemical) to improve nutritive quality.
- Practical leaf-collection methods from the forests must be developed.
• Problems of transportation and handling of these light materials must be solved.

• There is a lack of initiative and will from the government, cooperatives, and other related agencies to use these feed resources.

Strategy for action

Realizing the prevailing situation of livestock feed resources and with the primary objective of expanding the use of nonconventional feed resources such as fallen tree leaves, realistic development strategies are urgently required. The following steps must be undertaken.

• Simple and cheap mechanical devices must be developed to collect the fallen tree leaves from forests.

• Portable bailing units that can increase the density of the light tree leaves, allowing economic transportation, are needed.

• Suitable grinding machines and hammer mills must be established in the forest area.

• Steam pelleting units must be made locally.

• Long-range, intensive studies on the use of tree leaves for meat and milk production, including on-farm testing and economic evaluation, are needed.

References


Punj, M.L. 1983. Dry fallen forest leaves as livestock feed. In Proceedings of a National Seminar on Top Feed Resources, their Production, Utilization, and the Constraints,


