An Economic View to Forage and Fodder Production in Eastern India

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An Economic View to Forage and Fodder Production in Eastern India

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The mixed crop–livestock systems of India are underpinned by the crop residues which contribute on an average 40–60% of the total dry matter intake per livestock unit. There is however considerable regional variation in the dominant type of crop residue: rice and wheat straws in irrigated regions compared to coarse cereal straws and hay from leguminous crops in the drier, semi-arid regions. This paper synthesizes a series of recent studies on the role and importance of crop residues and farmers' perceptions of fodder quantity and quality in coarse cereal and groundnut based feeding systems. Crop improvement programs for sorghum, pearl millet and groundnut have traditionally focused on grain/pod yield improvement, pest and water stress tolerance. Only relatively recently have dual-purpose (grain and fodder) plant types been developed. While the nutritive value of fodder from dual-purpose crops can be determined through in vivo and in vitro analysis, such experimental procedures cannot necessarily capture the often-subjective quality attributes that farmers (and their animals) value. Results indicate that farmers perceive a range of quality traits, some of which could be screened for relatively easily, whereas others may be more difficult to assess. These findings highlight the importance of farmer participatory evaluation of fodder traits in the development of improved dual-purpose varieties. However the impact of these varieties on poor farm households will be contingent on the complementary improvement in the effectiveness of seed systems.

Livestock are vital to subsistence farming and sustainable livelihood in most developing countries. Of India's population of one billion people, more than 70 percent live in the rural areas. India also has more than 30 percent of the world's bovine population. This has resulted in not only egalitarian ownership of cattle, but also in an almost inseparable cultural and symbiotic relationship between rural families and their farm animals, particularly large ruminants.

Livestock rearing plays a significant role in the economy of the Indian people. Crop residues and pastures /grasslands are the major feed resource for this activity. Climatic, topography, physiographic factors, altitude and related aspects have influenced the distribution of various crop and grass species, which determine the fodder/forages production both qualitatively and

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quantitatively (Whyte, 1968). Though livestock rearing is an important occupation of farmers in the area, the forage cultivation has remained almost neglected. Grazing in the forest areas and sub-alpine and alpine pastures is the mainstay for the animals. Fodder trees and shrubs also contribute significantly. The natural resources have been exploited for centuries in an unplanned manner leading to degradation all along. Reckless cutting of trees, indiscriminate use of grazing areas and absence of rehabilitation programmes has lead to denudation of hill slopes, which has resulted in critically low biomass availability and adverse effects on livestock production. Consequently the livestock productivity is very low.

The Benefits of Including Forages in Crop Rotation[4]

Why Should we Consider Forages?

Forages can be a simple answer to soil erosion and decline in organic matter and fertility, a problem caused by modern cultivation and fallowing practices on much of the farmland the world over. Forages can also help you reduce nitrogen fertilizer costs and the energy costs associated with applying nutrients. Many farmers are using forages for positive results on any land, but particularly, on marginal crop land. The numerous benefits in any situation include:

- increased soil fertility when legumes are used;
- increased soil quality;
- better water filtration and internal drainage;
- less disease in subsequent cereal crops;
- reduced weed populations;
- increased yields in subsequent crops;
- better economics in subsequent crops;
- Greater and deeper carbon sequestering for greenhouse gas reduction.

Forages require fewer cash inputs than most grain crops, and although you will need special harvesting equipment, there are now many more options for harvesting forage crops than in the past. These include sharing equipment with other producers or utilizing custom harvesters.

[4] Source- http://www.gov.mb.ca/agriculture//crops//forages/bjb00s43.html

Increased Soil Fertility

Legume forages such as alfalfa are usually inoculated with rhizobia bacteria at the time of seeding in order to force the development of tiny nodules on the plant root hairs. These nodules capture nitrogen (N) from the atmosphere and make it available for plant growth and development, a process called nitrogen fixation. Because inoculated legumes are very efficient at nitrogen fixation, they are able to return their stored nitrogen to the soil through root decay for subsequent grain crops to utilize. Research has shown that nitrogen produced as a result of rhizobia is the most cost-efficient way to supply the N needs of a legume crop, and to provide additional N benefits to the soil. If a legume/grass forage crop is fertilized commercially with N rather than being inoculated, a portion of the commercial fertilizer may be lost to volatilization or leaching and will not be available to the plant.

- Average annual contribution of nitrogen by alfalfa is 45 lb/ac, but can be as high as 107 lb/ac during optimum growing conditions.
- Research trials show that soil N levels increased by a total of 130 lb/ac after 2 years of alfalfa, when two cuts were taken each year.
- A 5-year alfalfa stand can provide considerable nitrogen for 2 following crops, and nitrogen benefits can last for up to 7 years. In fact, a recent survey showed that cereal crops immediately following alfalfa require little added nitrogen and one-third of the average amount in the second year.
- Forages improve soil quality, a benefit that is especially important given that Manitoba soils have undergone serious degradation since the early part of the 20th century.

When a legume grass stand is terminated, there will be high amounts of nitrogen for subsequent crops at the beginning of the following season, but it will be lost if it is not used. On the other hand, studies show that in a no-till system when herbicide is used for crop termination, N becomes mineralized and is released more slowly at rates that can be better utilized by plants. This type of N release is metered out over the growing season and into the next, and can improve protein levels in spring wheat.

Improved Soil Quality

Forages improve soil quality, a benefit that is especially important given that Manitoba soils have undergone serious degradation since the early part of the 20th century.

More Organic Matter

The extensive root systems of perennial forages add significant amounts of soil organic matter. A 3-year perennial forage crop has been shown to return more than twice the soil organic matter as annual crops such as cereals or pulse crops. Soil organic matter is the energy which fuels decomposer organisms, which in turn affect soil structure, water-holding capacity, and resistance to both compaction and erosion.

Less Crusting

Soils higher in organic matter have fewer tendencies to crust, a problem when you are establishing many small-seeded crops and large-seeded pulses.

Better Water Infiltration and Drainage

Forage roots improve water infiltration, especially on clay soils. This results in improved soil drainage and water use by subsequent crops, and it can help producers get on the land earlier in spring when excess moisture is often an issue. Improved drainage is especially evident when alfalfa is terminated with herbicide, rather than tillage, because soil pores and tunnels remain intact.

Subsoil Advantages

Studies have shown that a perennial legume's drainage effect on subsoil lasts for at least 2 years after stand termination, particularly with alfalfa. On clay soil, because of this improved drainage, alfalfa-based rotations produce higher wheat yields than those of annual grain-based rotations.

Less Tillage in Subsequent Crops

Because of increased organic matter and better internal drainage, soil becomes more workable and requires less tillage.

Less Root Disease

Studies on cereal crops following 3-year forage hay stands have shown that there are reduced occurrences of common root rot. Perennial forage crops break disease cycles by removing host plants from the rotation for a longer term, thus reducing the level of pathogens in the soil.

Reduced Salinity

Soil salinity is caused when high water tables bring salts to the soil surface. Through deep roots that improve drainage, forages help to lower the water table level and thus reduce soil salinity.

Alfalfa's extremely deep roots can also lower salinity levels in the rooting zone of subsequent crops.

Less Erosion

Crop rotations that include forages provide more soil cover. Soil has higher levels of organic matter and a more stable structure to reduce the potential for wind and water erosion.

Anti-Leaching Effects

Perennial legume forages can extract nutrients such as N and phosphorus (P) from up to a 10-foot depth due to their deeper and more permanent root system as compared to annual crops. In particular, the deep taproot of alfalfa can utilize nitrogen that has leached past the rooting zone of annual crops – up to a depth of 3 feet the first year to 9 feet in year 4, according to recent research based on a four-year alfalfa stand.

Increased Yield and Quality in Following Grain Crops

Forages can produce increased yields in your subsequent grain crops, and improve quality, too. Following are the results of research illustrating this.

- 71 % of forage producers surveyed reported yield benefits in cereals after forage crops, with the greatest increases in higher rainfall areas of the black soil zones and lowest increases in the brown soil zones.
- No-till removal of alfalfa produced better yields in subsequent crops grown, especially in dry years.
- An 8-year study in the Red River Valley compared a 3-year-alfalfa/5-year-consecutive-wheat rotation with 8 years of straight wheat. The nitrogen benefits of the alfalfa-wheat rotation contributed an additional 18 bu/ac of wheat the first year and an additional 9 bu/ac per year when averaged over the 5 years
- In the same alfalfa/wheat versus wheat study, there was a 2% increase in wheat protein the first year after alfalfa, with increases ranging from 1/2 to 1% for up to 5 years after alfalfa termination.
- Another Manitoba study comparing various rotations using wheat, peas, and barley with wheat and alfalfa rotations showed predictably higher yields with alfalfa. However, including peas in a wheat-wheat rotation also produced excellent yield benefits. See chart at right (page 3) for details.

In long-term studies wheat yields were 50% higher from land previously cropped to alfalfa for 3 years than from land previously cropped to non-legumes such as maize, or wheat.

Reduced Weed Populations

The use of forages in crop rotations will reduce weed infestations in your subsequent crops, thereby reducing your need for additional herbicide inputs. This in turn may reduce the problem of herbicide-resistant weeds. Following are the results of recent studies that show the benefits of forages in controlling weeds.

- Eighty-three % of producers in a University of Manitoba survey indicated fewer weeds in annual crops after alfalfa compared to rotations with annual crops only. Good control of wild oat, green foxtail and Canada thistle was observed for up to three years after alfalfa, although the alfalfa stands did have higher dandelion and shepherd's purse populations.
- In long-term crop rotation trials using a 3- year alfalfa hay crop in a 6-year crop rotation, wild oat densities were substantially reduced compared to rotations with only annual crops.
- Herbicide-resistant wild oats and green foxtail can be controlled when forages are included in the rotation.
- One year of forage harvested as a hay or silage will remove weeds with the forage, and therefore can reduce some weed populations to the same extent as herbicides in subsequent cereal grain crops.
- When forages are used in a no-till system, benefits include reduced annual weed density and longer suppression of weeds in following crops.
- In one study, no-till forages reduced populations of green foxtail by 98% and lamb's quarter by 17% compared to conventionally tilled forage.

Crop residues and Feed for Livestock[5]

The vast amount of crop residues/fibrous byproducts available as potential ruminant feed–some 2.0 TDM per 500 kg live stock unit annually in developing countries, is now generally acknowledged. With the world population predicted to double by 2025 (even treble in the

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[5] E. Owen and A.A.O. Aboud. 2002. Practical problems of feeding crop residues. Department of Agriculture, University of Reading, Early Gate, P.O. Box 236, Reading RG6 2AT, UK
http://www.ilri.org/InfoServ/Webpub/Fulldocs/X5495e/x5495e08.htm#practical%20problems%20of%20feeding%20crop%20residues

developing tropics), cereal production, and hence straw production, will have to increase. With the increased pressure on land for food production, less land will be available to produce animal feed, either from pasture or fodder crops, and crop residues will assume even greater importance as animal feed. This will lead to greater integration of crop and animal production.

The importance of ruminants both big and small, in a developing country's agriculture is now widely recognized. However, cattle and other ruminants are now increasingly associated with small-scale farmers and that small-scale farmers predominate in developing-country agriculture. It will be these farmers who will need to practice crop-animal integration. A major constraint to crop-livestock integration is the potential damage to food crops from indiscriminate grazing.

Post-harvest and pre-feeding constraints

Decisions on whether or not to conserve crop residues for feed have to be taken soon after harvesting and often long before feeding them. Lack of convincing economic evidence in favour of their greater use as feed is undoubtedly a restraining factor. Animal scientists in general have given more emphasis on biological rather than economic responses to upgrading and supplementing crop residues. A problem which has a bearing on this is the difficulty of accurately predicting the nutritive (and therefore economic) value of crop residues from simple laboratory techniques.

Cereal straws/ stovers generally either are left in the field or accumulate where the crop is threshed. This is often far from where animals are kept and either the animals must be brought to the field for stubble grazing, or crop residues have to be transported to the animals. The bulk of straws and stovers and lack of transport discourage greater use of straws and stovers as feed. Transporting crop residues, even over short distances, may be uneconomic for small farmers.

More research and development is required to alleviate problems associated with storage of crop residues. These include risk of loss due to fire, and reduction in nutritive value due to moulding (especially in humid conditions) and damage by vermin and insects. Straws and stovers comprise stem and leaf plus leaf sheath, and harvesting, handling and storing systems should minimize the loss of the more nutritious leaf and leaf sheath. In this regard delayed harvesting, or relay harvesting in an intercropped field, would be expected to cause greater loss of leaf and leaf sheath, with a consequent reduction in nutritive value.

Systems of Fodder Production[6]

The system of fodder production vary from region to region, place to place and farmer to farmer, depending upon the availability of inputs, namely fertilizers, irrigation, insecticides, pesticides, etc. and the topography. An ideal fodder system is that which gives the maximum outturn of digestible nutrients per hectare, or maximum livestock products from a unit area. It should also ensure the availability of succulent, palatable and nutritive fodder throughout the year. Some of the important intensive fodder-crops rotations and the expected yields are given in Table 3 for different regions.

Fodder production for intensive dairy farming

The requisites for intensive dairy-farming are that (*i*) fodder is required in uniform quantity throughout the year, (*ii*) the fodder crops in the rotation should be high-yielding, (*iii*) the area for production of fodder should be fully irrigated, and (*iv*) other inputs, such as fertilizers and pesticides, should be available in optimum quantity. The different systems of fodder production fall into two categories, viz. the overlapping cropping and the relay-cropping. In the overlapping system, a fodder crop is introduced in the field before the other crop completes its life-cycle. In relay-cropping, the fodder crops are grown in successions, i.e. one after another, the gap between the two crops being very small.

Overlapping system.

The overlapping cropping system evolved by taking advantage of the growth periods of different species ensures a uniform supply of green fodder throughout the year. One such system continues for three years. The best rotation in this system is *berseem* + Japan *sarson* - Hybrid Napier + cowpea - Hybrid Napier; (October-April) - (April-June) - (June-October).

How to Adopt the System.

(*i*) In this cropping system, *berseem* + Japan *sarson* seed mixed in the ratio of 25 : 2, are sown in the first week of October, using a basal fertilizer dose of 20 kg of N and 80 kg of P_2O_5 per ha. The sowing is done by broadcasting the mixed seed in the seedbeds, flooded with water. Care should be taken to inoculate the *berseem* seed with *Rhizobium* culture before sowing, especially when the crop is being sown for the first time. However, if the culture is not available, soil from

[6] Source: http://www.krishiworld.com/html/for_crop_grass1.html

the top 5 to 7 cm layer is collected from the field in which *berseem* was grown in the previous year and broadcast along with the seed. Irrigation may be given at intervals of 7-8 days, depending upon the soil and climatic conditions.

(*ii*) The first cut from the mixture is taken in 50-55 days after sowing. Japan *sarson* being quicker in growth boosts the yields in the first cut, whereas in the subsequent cuts *berseem* takes over.

(*iii*) Hybrid Napier is introduced in the standing crop of *berseem* after taking the third or fourth cut from *berseem*. Rooted slips are planted in February (central India) and in March (northern and north-western parts) in lines by keeping a distance of one metre between the rows and 30-40 cm between the plants. The planting of a hectare would need about 33,000 rooted sets of Hybrid Napier. Hybrid Napier starts growing actively after March and should be cut 8-10 weeks after transplanting and the subsequent cuts are taken at intervals of 40-45 days. After the *berseem* crop is over, a basal dose of 100 kg of P_2O_5 and 50 kg of N per ha is applied.

(*iv*) *Berseem*, being an annual crop, completes its lifecycle in April and then the inter-row spaces of Hybrid Napier are prepared with a *desi* plough and cowpea is sown in lines, 25 cm apart. In this way, in each set of two rows of Hybrid Napier, there will be two rows of cowpeas. Cowpea is cut 60 days after sowing and thereafter Hybrid Napier does not allow any other legume to grow along with it.

(*v*) Hybrid Napier continues to supply green fodder during the monsoon season. At the time of the last cutting in October, the inter-row spaces are again ploughed up and the land is prepared for sowing *berseem* and Japan *sarson* to start the second cycle of the rotation.

(*v*) This system of intensive fodder production is economically viable only for 3 years. After three years. Hybrid Napier is uprooted and fresh planting is taken up. The stumps of Hybrid Napier become old and the tillering capacity diminishes considerably.

Advantages.

(1) This system ensures green fodder throughout the year.
(2) It takes care of the dormancy period of Hybrid Napier during winter.
(3) The inter-row spaces of Hybrid Napier are efficiently utilized for raising *berseem* in winter and cowpea in summer.
(4) The growing of legumes enriches the soil.

(5) Hybrid Napier gets established without much care and cost.

(6) Green fodder in the first cut is increased up to 50 per cent by Japan *sarson*.

Intensive fodder production under relay cropping

There is ample scope for increasing fodder production from the high-input areas, either by growing high-yielding fodder crops singly or in mixture. The growing of three or four successive fodder crops, helps to boost fodder production per unit area. Some of the important intensive fodder-crops crop- rotations and the expected yields from each are summarized in Table 3.

Fodder production in arable farming

There is ample scope for fitting in the short-duration fodder crops, either single or in mixture, with the other crops during the gap period between two main cash crops. Two distinct fallow periods are available for raising short-duration fodder crops, provided adequate resources are available. In the case of the wheat-jowar rotation, gap periods between April and June and between October and November are available for each crop as fodders. Thus in the first rotation. M.P. chari + cowpea, maize + cowpea, *bajra* + cowpea is successfully grown and an additional green-fodder yield to the tune of 300-350 q per ha is obtained. Similarly, in the second gap period (October-November), which is rather short, the growing of fodder turnips and short-duration mustard varieties helps to get 250-300 q per ha of fodder without disturbing the normal cropping systems.

Table : Different cropping sequences for fodder crops production

1. Maize + cowpea - maize + cowpea + *berseem* + mustard (300 q/ha) - (450 q/ha) - (1,000 q/ha)
2. Sweet sudan + cowpea - *berseem* + oats (1,000 q/ha) - (1,000 q/ha)
3. Hybrid Napier + Lucerne (1,250 q/ha) - (850 q/ha)
4. Maize + cowpea - *jowar* + cowpea - *berseem* + mustard (300 q/ha) - (400 q/ha) - (1,000q/ha)
3. Teosinte + *bajra* + cowpea - *berseem* + oats (1,000 q/ha) - (1,000 q/ha)
2. Sweet sudan + cowpea - mustard - oats + peas (1,000 q/ha) - (250 q/ha) - (500 q/ha)
3. *Jowar* - turnips - oats - 1800 q/ha Other high-yielding fodder crops for different regions are given in table 4.

Fodder production under dryland farming

A large proportion of the area of our country is located in the dryland regions. In these areas, the farmers usually grow at least one crop in the *rabi* season after conserving the soil moisture. Thus there is a great scope for raising two crops under such situations. First, the growing of a fodder crop which gets ready in 45-50 days after sowing (cowpea, *jowar*, *guar*, *sanwa*, *moth*, etc.), yield 150-250 q per ha of green fodder. After harvesting the fodder crops, crops such as gram, linseed, barley, wheat and safflower are raised on the conserved moisture.

Economic aspects of forages and fodder production[7]

Forages are an essential part of ruminant's and other grazing animal's diets and are an important part of a profitable livestock enterprise. Growing forages represents a significant cost. This cost is affected by the choice of forage crop and how it is produced, harvested, stored, and fed. Forage availability and quality affects livestock performance, including growth rates, milk production, and body condition. Variable weather conditions can cause low yields and risk management strategies create added costs.

When making decisions about forage, consider the:

- Cost of production, measured at the point where the animal consumes the forage,
- Impact of forage choices on total feed cost,
- Impact on animal performance, and
- Impact of year-to-year variations in yield and quality.

Cost and quality considerations are important considerations when choosing among alternatives. Production costs range from around two cents per pound of dry matter for perennial pastures for grazing to six cents per pound for grass hay. Yields and moisture content at harvest have a big impact on dry matter production and costs. However, in addition to these production costs, there are hidden costs in the form of crop losses through chemical changes, spoilage, and waste. Losses will vary among different crops and different harvesting, storage, and feeding systems. Field to mouth losses can range from 15 to 50 percent and have a significant impact on costs. Farm equipment and labor cost estimates can be helpful when evaluating the cost and profitability of custom work alternatives. Also consider the reliability of the custom operator and the timeliness and quality of his or her work.

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[7] Geoffrey A. Benson and James T. Green, Jr., 2006. Forage Economics. Department of Agricultural and Resource Economics, College of Agriculture and Life Sciences. P-11 http://www.ag-econ.ncsu.edu/faculty/benson/tb305.pdf

The most effective way to compare alternative forage crop production or procurement options is to develop balanced rations capable of achieving animal performance targets, using the various forage alternatives and other available feedstuffs. Evaluate the total feed costs, including all the ration components. Forage type and forage quality can affect animal performance. If this is the case, consider the impact of different levels of animal performance on profitability as well as any differences in forage production costs and total feed costs.

Strategies to cope with short crops include buying additional forages or stretching the forage supplies already on hand by purchasing commodity and by-product feeds with significant effective fiber content. Or, farmers can plant additional acreages of forage crops. In normal or above-normal years, the surplus can be used to build buffer stocks for future use or can be sold. Additionally, they can also diversify the types of crops grown. Each of these risk-management strategies has associated costs that you must analyze to identify the most cost-effective strategy.

Clearly, there are no simple answers to questions on the economics of alternative forage crops and different production and procurement systems. Each alternative has several aspects that should be considered. However, every decision must start with a clear understanding of the costs involved and the impact on animal performance and income.

Production Costs[8]

Production costs are important considerations when choosing among alternative forage crops. These costs include operating expenses for items that are used up within one cropping season and fixed costs associated with investments in machinery and equipment. The cost structure is different when comparing annual crops, such as corn silage or winter rye for grazing, to perennial forage crops, such as fescue and Bermudagrass. For annual forage crops, all the production costs are incurred during the production cycle for a single crop. For perennial crops, costs can be separated into the start-upor establishment costs and the annual costs incurred thereafter. Enterprise budgets are only guidelines and should be carefully evaluated and modified for your specific farm situation. They are not intended to be used "as-is." These establishment costs can be thought of as an up-front investment that must be allocated over the life of the crop.

[8] Department of Agricultural and Resource Economics at NC State University http://www.ag-econ.ncsu.edu/extension/Ag_budgets/html

The costs are defined as follows:

- **Materials and services** include seed, suckers and other planting materials.
- Inoculants, herbicides, lime and fertilizer, and custom application.
- **Labor** costs -if the work is done by own self, then the opportunity cost of alternative uses for own labor.
- **Machinery operating** costs consist of fuel, lubricants, and maintenance and repairs.
- **Machinery ownership** costs, also called fixed costs, include depreciation, property taxes, insurance premiums, and an interest charge on the investment.

For perennials, these include the amortized cost of establishing the crop. Many forage crops are grown for grazing and hay production. Because moisture content varies widely and because nutrients are contained in the dry matter of the forage, these cost estimates are calculated on a dry matter basis for ease of comparison. However, the nutrient composition of the dry matter varies among forages, so cost per ton of dry matter should not be the only criterion for selecting among forage types.

Forage Procurement Options

Farmers have several choices for obtaining fodder and forages. They may grow own forage, purchase hay or silage, purchase by-product feed as forage substitutes or forage extenders. Depending on the farm's situation, there may be more profitable alternatives to growing own forages. Changing from producing own forages, contracting can affect many parts of the business, including production costs, level of investment, cash flow, income, risk, and workload. The impact on profitability and cash flow cannot be evaluated unless one has a good grasp of current forage production costs, quality, total ration costs, and livestock performance.

Ownership costs include depreciation, interest on the investment, insurance, and taxes. Operating costs include repairs, maintenance, and fuel and lube for tractors and other self-propelled equipment. Each farm is different and will have different costs. For example, if you buy used equipment, you would have lower ownership costs but higher operating costs, particularly for repairs. When labor costs for hired employees are calculated the fringe benefits are also included in cost calculations in addition to the actual cash wages paid. Generally the prevailing market rate for hired labor is used for such calculations.

Contract production of forages is growing in popularity, particularly among dairy farmers. There is some interest in contract hay production also. No standard contract or price exists, so the terms of each contract must be negotiated. Begin with a clear understanding either of what you expect the contractor to do or of what the contractor is offering, depending on who makes the initial contact. The specific details of the arrangement will affect what it is worth to each party, the production costs for the grower, and what the buyer can afford to pay. However, as with all business deals, the final agreement must be acceptable to both parties. Reliability and continuity of supply is an additional area of concern for contract forage production, as it is high in moisture and bulky, transportation costs are high. One way is to go for a long-term, written agreement. It can be useful to include an arbitration procedure in this agreement for resolving any disagreements that might arise.

Harvesting, Storage, and Feeding

The methods used for storage and feeding also affect the cost of feeding livestock. Each alternative has different operating, labor and investment costs. This includes the cost of labor and the full cost of the equipment used to move hay from storage to livestock on pasture fields or a sacrifice area. Considerable variation will occur from farm to farm, however.

Similarly, the budgeted cost of pasture for grazing does not include any charges for managing cattle on pastures. This includes the cost or value of time spent traveling to the pasture fields and moving cattle. It also includes the full cost of equipment used for transportation. These costs do not include the ownership or fixed costs associated with investments in fencing, lanes, and watering systems.

In addition to the costs described above, there are “hidden” costs in the form of crop losses through spoilage, and waste. The losses will depend on many factors including the specific crop; the particular harvesting, storage, and feeding systems in place on the farm; and the level of management. Total losses for forage crops range from 15 to 50 percent of the standing crop at the time harvesting begins. Storage and feeding losses for concentrate feeds are likely to be around 5 percent of the purchased amount in a well-managed storage and feeding system. However, treat these loss estimates as guidelines; there is likely to be wide variation from farm to farm. Clearly, these losses can have a major impact on costs, if storage and feeding losses increase, then the cost of the hay actually consumed by the livestock also increases significantly.

Impact on Animal Performance, Total Feed Costs, and Profitability

Forage type, quantity, and quality determine the amounts and balance of specific nutrients available to the animal. Sample and analyze each of the major forages used on your farm every year in order to develop balanced and economically formulated rations needed for animal performance. Use the analysis to evaluate the impact of different forages on animal performance, including growth rates, milk production, reproduction, and body condition.

The most effective way to compare alternative forage crops and procurement options is to develop nutritionally balanced rations capable of achieving the desired level of animal performance. Consider the various forage alternatives, and other feedstuffs and their costs. The value of different forages and feeds can change over time. Many ration balancing programs generate a “shadow price,” which is the break-even price for any one of the available feedstuffs or ingredients. Use this shadow price to evaluate the maximum economic value of individual forages. If the price or cost of particular forage is greater than its shadow price, there is a more economical way of feeding the animals to achieve a target level of performance. Repeat this analysis periodically because the shadow price (value) of one feed is affected by the prices of other feeds and ingredients. Rethink your forage production strategy if the costs of production exceed the value of the forage. Budgets can be developed to compare the profitability of alternative forage production and feeding systems. These budgets should incorporate any animal performance differences and the resulting effects on income or costs.

Risk Management

One approach is to plan on buying additional feed, either as forages or as by-products with a significant fiber content to stretch forage supplies. Some producers grow extra forage and this extra forage may be used to meet livestock needs during the periods of scarcity. In years of normal or better than normal yields, the surplus can be used to build buffer stocks for future use. However, this strategy requires additional storage facilities and incurs carrying costs in the form of spoilage and interest on the crop investment. Alternatively, any surplus available can be sold and forages purchased when actually needed.

Another strategy is to diversify the types of crops grown. The different crops, planting dates, and growing seasons allow you to spread the risk of a major shortfall. However, the total cost of the mix of forages produced under this approach may be higher than the cost of specializing in one crop alone.

Strategies

Keeping in view the constraints in fodder production and in order to overcome the gap between demand and supply, the emphasis need to be given on several steps for augmenting the fodder production. Existing resource utilization pattern needs to be studied in totality according to a system approach. Fodder production is a component of the farming system and efforts need to be made for increasing the forage production in a farming system approach. The holistic approach of integrated resource management will be based on maintaining the fragile balance between productivity functions and conservation practices for ecological sustainability. The strategies for improvement and conservation of Himalayan resources particularly the forage resources will have to be dictated by actual customers-the native inhabitants of the region. Some of the scientific interventions, which could help in improving the productivity of forages, are described here.

(A) Agronomic management

The herbage production from grasslands and meadows can be enhanced with the adoption of improved technology. Important components of this technology are:

(a) Control of bushes and weeds
(b) Pasture establishment
(c) Introduction of legumes/grasses
(d) Fertilizer application
(e) Cutting and grazing management

(a) **Control of bushes and weeds**

Bushes and noxious weeds and poor quality grasses may offer severe competition for light and nutrients. These weeds can be controlled by cutting and stems treated with herbicides to prevent re-growth. The herbicides like Weedon 64, Picloram, Paraquat and Glyphosate etc @ 1.0-2.0 Kg/ha could be applied around the bush. Sood and Singh (1986) have found that paraquat spray in the 15 cm band @ 0.6 lt./ha reduced the weed incidence in the grasslands and the fresh herbage yield increased by 26.8%.

(b) **Pasture establishment**

The successful establishment of a pasture requires more skill and care, as compared to other crops. The method of introduction of improved grasses and legumes in the natural grasslands should be cost effective with minimum soil working. The following methods of establishment could be considered.

(i) Scratching or pitting

Singh (1995) found that planting Nandi grass and Guinea grass in circular pits was superior over local practice. Similarly Sood and Kumar (1995) has found that pit method of introduction is superior to scrapping.

(ii) Hoof and teeth method

The pasture could be heavily grazed; followed by throwing seeds, then allowing the animals to trample the area when soil is wet.

(c) **Introduction of legumes/grasses**

Forage legumes are important because they enrich the N content of the soil and have a high nutritive value. Legumes can be grown in mixtures with grasses in grasslands. They supply associated grasses with nitrogen and thereby contribute to the conservation of energy by reducing the need for N fertilization. By introduction of legumes the quantity as well as quality of herbage production can be substantially increased. Among the legumes, Siratro (Macroptelium atropurpureum), Stylosanthes hamata, S. scabra, Glycine javanica, Dolichos auxilaris, Desmodium spp and Centrosema pubescens etc. have shown good performance (Melkania, 1995). Indigenous legumes such as clovers (Trfolium pratens, T. repens), Medicago denticulata, Melilotus alba, white clover var. Ladino and Lousiana and red clover var. Montgomery have proved successful in Kashmir valley apart from Lucerne (Medicago sativa cv. T- 9, and Hunter river) and berseem (Gupta, 1977). Legumes and grass species can be introduced during July by seeding and tussock planting, respectively. A combination of Siratro has been found quite successful for the mid altitude region (Melkania, 1987). The herbage yield and nutritive value of the hay from grasses-legume mixtures were found five and two times higher, respectively than the hay of local species. It is essential that during the first year of seeding/tussock planting, grazing is restricted in treated sites and the grass cutting is done carefully to help the establishment of introduced fodder species.

Some of the grasses; Cenchrus ciliaris, Dactylis glomerata, Dicanthium annulatum, Festuca sp., Lolium sp., Pennisetum pedicellatum, etc. and legumes; Desmodium intortum, Dolichos lablab, Phaseolus artopurpureus, Stylosanthes humilis, Trifolium sp. etc. have been found adapted to different agro-climatic regions of Indian Himalaya (Shastry and Patnaik, 1990).

Legumes introduced in the pastures generally do not establish well due to ineffective nodulation. Hazra (1998) observed that the Rhizobium inoculation of the pasture legumes provides synergistic effect for better establishment and obtained 59% and 72% higher green and dry herbage yield as compared to control.

(d) **Fertilizer management**

The present poor production potential of pastures could also be attributed to poor fertility of soils. To raise the fertility status and rectify the deficiencies, soil testing coupled with field trials need to be conducted to work out the fertilizer requirement of different pastures. Generally, no fertilizer is added to rangelands except the dropped excreta by animals. Judicious use of fertilizer for pasture can boost the vegetative growth and is also economically feasible. Application of nitrogen fertilizer must be given in split doses for better utilization, whereas phosphorus and potash should be supplied as basal dose in case of grasses. In legumes the full dose of nitrogen, phosphorus and potash should be given as a basal dose in furrows or by broadcasting at the time of sowing. Dogra et al. (1997) found 120 Kg N/ha and 40 Kg P/ha as the most economical dose. Herbage yield increased significantly with the application of nitrogen @ 60 Kg/ha and phosphorus @30 Kg/ha (Sood and Sharma, 1996). Nitrogen @ 40 kg/ha and Phosphorus @ 30 Kg/ha applied as basal and two splits (onset of Monsoon and 45 days after first application) in natural grassland increased the forage yield significantly. Two splits were significantly superior to single application (Singh, 1995). The experiments on N and P requirement in Himachal Pradesh reveal that application of 80 Kg/ha each of nitrogen and phosphorus was found to be the best (Sood and Bhandari, 1992).

(e) **Cutting and grazing management**

The response to cutting of a forage plant depends upon its seasonal yield of carbohydrate storage, its growth habit and extent of inflorescence development. Frequency of cutting also significantly influences the yield and quality of herbage produced. The areas with high temperatures may require larger interval and low intensity of cutting to build up sufficient carbohydrate storage for regrowth. Singh et al. (1993_b) concluded that tall fescue (Festuca arundinacea) produced highest dry matter, when it was cut at 30 days interval during second year. Cutting grasses twice from natural grasslands recorded higher fresh forage yield (14.54 t/ha)than one cut (12.08 t/ha) and three cuts(13.30 t/ha). The crude protein content was higher with two cuts compared to one cut (Kaul and Sood, 1986). Studies undertaken by Singh (1995) on cutting management of grasslands suggest that the herbage biomass yields can be doubled if harvested twice during July – October.

The Himalayan grasslands experience intense grazing pressure on account of being the prime source of forage. Grazing contributes more than 50% of the herbage requirement for sedentary and semi-migratory flocks, while for migratory flocks 100% herbage is provided by grazing. Controlling the time, duration and intensity of grazing appears to be the key factors in grazing management. Periods of rest allow grazed perennials to replenish leaf area, seed set and store food reserves in their roots (Merrill, 1983; Adams et al., 1991). Continuous or too frequent access by large numbers of cattle to the same range impedes the ability of new growth to store food. The grazing can lead to the disappearance of nutritive species and infestation by less palatable species and weeds. Deferred rotational grazing system was found superior in Sehima dominated grasslands (Upadhyaya et al., 1971), resulting in greater number of animal days as compared to continuous approach. Rotational grazing has steadily gained the popularity in last two decades, because it offers better control over livestock distribution and feeding pattern with goals of periodically resting vegetation (Adams et al., 1991).

(B) Growing of fodder crops and fodder trees

For augmenting fodder availability, emphasis needs to be given to cultivated fodder crops on large area. Important fodder crops of temperate region are; Avena sativa, Brassica sp., Medicago sativa, Pisum sativum etc. (Singh, 1987).

Foliage of fodder trees could be fed to the livestock in mixture with crop residues and hay. Mixing of tree foliage with dry roughage improves their palatability and nutritive value. Shankar and Singh (1997) and Singh (1982) have suggested the different fodder trees for sub-tropical Himalaya and sub-temperate Himalaya.

(C) Silvipastoral System

Silvipasture implies sustained and combined management of the same land for herbaceous fodder, top feeds and fuelwood, thereby leading to optimization of production. The Himalayan rangelands exhibited enormous gain in forage production over existing situation due to multi-tier silvipasture techniques amalgamated with an adaptable complementary plant species. Silvipastoral systems are the most important for increasing fodder production from the marginal, sub-marginal and other wastelands, which comprise about 50% of the total land area. It involves planting of multipurpose trees in the existing pastures/grazing lands or planting such trees on wasteland/denuded lands followed by sowing /planting of grasses and or legumes in between the inter-spaces of trees. Atul (1996) obtained 5-7 t/ha green fodder under silvipastoral system, where as it was only 3-4 t/ha with out a tree component. Sharma and Koranne (1988) found that maximum production of 300 g/m^2/annum under the existing grasslands, while under modified network of silvipastoral system of Digitaria decumbens + Bauhinia pupurea/Quercus incana/Grewia optiva/Celtis australis the production varied from 1800-2450 g/m^2/annum.

(D) Agrisilvipastoral system

Under the agrisilvicultural system multipurpose trees (MPTs) including fodder cum fuel trees can be grown in association with crops. Trees are pruned annually, yielding fodder as well as fuelwood. In addition to annual pruning, few trees are also cut down in order to allow light penetration and minimization of competition with the crops. Under alley cropping system MPTs like Leucaena leucocephala and even perennial pigeon pea etc. are pruned frequently to provide leaf fodder to get better crop production.

(E) Agrighorti-silvicultural system

Under this system besides growing fruit trees and fodder crops, fast growing NFTs like Leucaena leucocephala can be lopped two to three times in a year to provide fodder (2.5-3.0 t/ha) and fuelwood (1.8-2.5 t/ha). These fodder trees also provide some protection to the fruit trees during summer and cold winters.

(F) Hortipastoral system

In this system forage are grown in wide inter-row spaces of fruit trees for economic utilization of orchard lands. Hortipasture up to an elevation of 2000 m is catching up with the orchadist. Forage from hortipasture is consumed fresh and is also conserved as hay for winters. Sharma and Jindal (1989) found that the introduction of Fescue in apple orchard gave 83.5% higher fodder yield over local grasses in Shimla hills of Himachal Pradesh.

There is considerable area under orchards in temperate regions. Inter spaces between fruit trees could be utilized for the production of fodder by growing perennial grasses and legumes. In U.P hills (Singh, 1995) reported that rye grass and orchard grass are the best perennial grasses for introduction in apple orchards. Soil N build up was maximum with white clover introduction.

(G) Forage production in various land use systems

Singh et al. (1193_a) has recommended various interventions that may find place under different land use systems and has also reported their potential to produce green forage from experimental findings.

(H) Forage production on terrace risers or bunds

A non- competitive land use systems for forage production in the hills is to grow forage on terrace bunds and risers (Singh et al., 1993_a). Forage grasses/legumes/fodder trees grown on terrrace risers and bunds arrest the nutrient loss in run off water under high rainfall conditions of this region. This gives an added advantage to produce forage with out any fertilizer or manure.

Forage Production Tips:

The following production suggestions can help you get an edge on establishment, and when appropriate, to terminate the stand in the most efficient manner. Stands should be terminated sooner rather than later for maximum nitrogen benefits; two to three years is usually optimum.

Consider No-Till Seeding

Forage establishment in a no-till situation is usually better than in a conventional system, especially in drier years, because forage seeds are small and are vulnerable to dry seedbeds and erosion that often occur with conventional techniques. Some residue on the soil surface can provide some of the same benefits (shading, lower soil temperatures and reduced blowing soil) as companion crops, although excessive residue from the previous crops should be removed for better establishment. The relative firmness of no-till soils also provides firm seed beds for excellent soil-to-seed contact.

Choose Less-Competitive Companion Crops

Although companion crops can often reduce forage yields in the second year by hindering stand establishment, they can also provide much needed shade and moisture conservation for new forage seedlings. There are situations where you may find a cover crop more economical than none at all, especially if you harvest the cover crop early for silage. In these cases, it is important to reduce the seeding rate of the companion crop to minimize the amount of competition for the forage stand being established.

Consider No-Till Stand Termination

You can often get more-efficient stand termination by substituting herbicides for tillage. Tilling is expensive, uses fossil fuel energy, dries the soil, and in wet years it may not kill the stand completely. However, depending on the forage species, herbicides use may be less costly and more effective. As well, because nitrogen release is slower, herbicides can improve the availability of nitrogen for uptake into subsequent crops.

Use an Effective Herbicide Combination

Glyphosate/2,4-D Amine, Lontrel/2,4-D or glyphosate/ Banvel are all highly effective combinations for stand termination, although higher rates of glyphosate are required for mixtures with higher grass content. Apply to at least 8 inches of growth for greatest kill efficiency. Most glyphosate products can be used as a pre-harvest treatment, but allow 3 to 4 days after spraying before grazing or cutting the treated crop for silage or hay. All glyphosate products are more effective when grasses have 3 to 4 or more leaves per stem, and when legumes are in the bud or later stage of maturity.

Evaluate When to Terminate

Although maximum agronomic benefits from forages can be obtain after two or three years of production, the cost of establishment may dictate that a stand be left longer. Costs of production should be considered, so that both agronomic and economic benefits are balanced. Weed and pocket gopher encroachment may also determine the useful life of the forage stand.

Economic Considerations:

To capitalize on the benefits of putting alfalfa into your rotation, it is critical to reduce N fertilizer applications on following crops. Do not rely on the soil nitrate-N test to measure nitrogen, but gauge N contribution through assessment of the legume stand and time of termination (see Manitoba Agriculture's Soil Fertility Guide).

Because of reduced inputs and fuel costs, the cost of production for rotations that include forages have proven to be lower than those for rotations based on continuous grain crops. Furthermore, net returns tend to be more stable across a range of crop prices for rotations that include forages. Studies continually show that including 2 to 3 years of forage crops in 6-year rotations significantly reduce income variability, even more than crop insurance (see page 4).

Marketing the Forage

In recent years, forage markets have opened up dramatically in the mid-west U.S. dairy industry. Our cooler and longer-day growing seasons produce forage that has a higher digestibility than the forages grown in the hotter, shorter days of the southern climates, and U.S. demand is increasing as our reputation grows. You can market your own hay or you can utilize the services of professional marketers that have accessed this market. You may also want to list your hay for sale on the Manitoba Agriculture, Food and Rural Initiatives' free Hay Listing website.

Interest in the use of high-quality forage for backgrounding (increasing the value of Manitoba beef calves) has also created a local market for high-quality forage as hay or silage. Manitoba studies have indicated feed efficiencies in the range of 6 to 8 lbs of feed per lb of gain from high quality, forage-only rations, in comparison to gains of 3 to 4 lbs of feed per lb of gain with more-costly grain rations. As a result, forages have provided more opportunities for value adding in the beef cow/calf industry.

Forage seed crops such as alfalfa, birds foot trefoil, tall fescue and perennial ryegrass can also produce good economic returns, and the residues from these crops are also a viable feed source for low-producing animals. Another new opportunity in forages exists because of the health benefits that have been found in forage-fed red meats, including the presence of healthy Omega-3 fatty acids and conjugated linoleic acids (CLAs).

Future Thrust:

- Forage production must be taken up as a first management goal and 25% of the forest area should be put under trees with regulated accessibility to the farmers.
- Growing forage grasses and fodder trees along village roads and panchayat lands
- Growing forage grasses and fodder trees on terrace risers/bunds- a non competitive land use system
- Conservation of native biodiversity for future improvement
- Breeding biotic, abiotic, stress tolerant cultivars of forage species suitable for area not used under arable agriculture
- Participatory techniques to be adopted to identify the problems and to carry out the improvement programme
- In-depth studies on migratory graziers
- Forage based agroforestry systems
- Controlled grazing to maintain the productivity of pasture (grazing should be allowed as per carrying capacity)

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