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Improved Agronomic Practices on Enhancement of Quality Forage Production for Livestock Farming

Sajana Rai*

Livestock Service Office, Bharatpur, Chitwan, Nepal
*Corresponding author's email: raisajana2079@gmail.com

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ABSTRACT

The lack of nutrient-rich fodder and forage is one of the problems of livestock farming. Adequate tillage operations, timely and suitable water management, weed management, insect pests and disease management, fertilizer management, seeding at the proper time and seed rate, timely harvesting, and other agronomic techniques can all help to increase the nutritional content and yield of fodder and forage crops. A number of research and review papers have been systematically reviewed in this study. The use of tillage practices such as primary, secondary, conventional, and deep tillage enhances dry matter and yield of green fodder as compared to zero tillage. The organic matter (OM) content and dry matter (DM) of fodder crops are increased by regular and appropriate irrigation. The DMD (dry matter digestibility) and CP (crude protein) contents of early harvested forages are higher than those of late harvested forages. The application of nitrogen promotes crop development and growth, increasing the production of green fodder and improving its quality. Intercropping is essential for increasing the yield of fodder crops. Compared to sole cropping of maize and cowpea, the yield is found higher in intercropping of maize + cowpea. The production and quality of fodder are decreased by late seeding. The management of insect pests and diseases enhances the production and quality of fodder and forage. Thus, we draw the conclusion that fodder and forage crops production and their quality parameters are greatly influenced by agronomic practices.

Keywords: Variety, seed rate, sowing, irrigation, cutting time

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INTRODUCTION

An essential source of nutrition for ruminants are fodder and forage crops. The milk production is affected by quantity and quality of fodder and forage production. In commercial farms, farmers add costly concentrate feeds to make up for fodder shortages. Tree species namely badahar (*Artocarpus lakoocha*), dudhilo (*Ficus nemoralis*), nemaro (*Ficus roxburghi*), tanki (*Bauhinia purpurea*), bakaino (*Melia azedarach*), neem (*Melia azadirachta*), raikhanayo (*Ficus semicordata*), mulberry (*Morus spp*.), ipil ipil (*Leucaena diversifolia*), gajuma (*Gauzuma ulmitolica*), Shrub species such as bhatamase (*Flemingia congesta*) and Grass species like stylo (*Stylosanthes* spp.), dinanath (*Penisetum* spp.) molasses, Napier grass NB21 (*Penisetum purpureaum*) are important forage crops in Nepal. Forage development stage, species, environmental condition (temperature, sunshine, relative humidity, and precipitation) and agronomic treatments (storage conditions) are the variables that affect fodder quality (Jancik et al 2009). Adopting improved agronomic practices, such as choosing high-yielding genotypes, planting at the optimum time, spacing and rate of seeds, managing nutrients and irrigation, using cropping systems based on food crops, and harvesting at the ideal time, are some ways to boost the productivity of fodder crops. Since prospective fodder crops are now maintained unscientifically by farmers in country, all of these approaches play a significant role in improving the yield and quality of such crops. The intercropping system of cereal and legumes effectively utilizes the available resources to enhance fodder availability and quality on a given land area. There is no scope to expand the area planted with fodder crops. In order to effectively use the resources at hand, strategies or practices that improve the quantity and quality of fodder crops per unit area and time are required. Adopting improved agronomic approaches to boost fodder quantity and quality is one such crucial alternative (Manoj and Shekara 2020). The review highlights the different agronomic practices which enhance the yield and quality of fodder and forage production (Figure 1). This review may be useful guide for livestock growers, students and researchers.

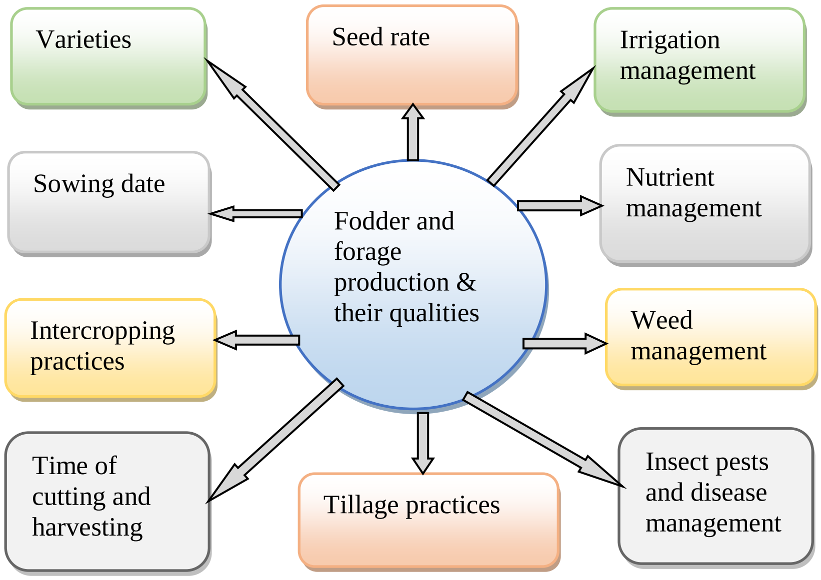

Figure1: Different agronomic practices that affects the fodder and forage production and their qualities

Varieties of fodder and forage

Types of varieties affect the fodder and forage production and their qualities. Differences in other biomass-related characteristics and fodder yield may result from this variation (Upreti et al 2022). According to Pachauri and Mojumdar (1994), the average DMI (2.25% of body weight) increased in milk cows fed sorghum silage as baseline roughage. Total digestible nutrients (TDN) were seen to be lower in sheep fed sorghum silage of HC-136 variety compared to both J. Sel-10 and HD-15 types. This finding may be explained by the silage's higher fiber content and reduced CP (Mahanta and Pachauri 2005). The different cultivars of different fodder and pasture crops along with their yield and recommended domain are given in Table 1.

Table 1: Released cultivars of different fodder and pasture crops in Nepal

Crop	Cultivar	Green biomass (t ha^{-1})	Recommended domain
Berseem	Green gold	72-78	Terai and inner terai
Napier	Hattighans-1	100-150	Terai to mid hills
White clover	Pyauli seto clover	30-45	Mid hill to high hills
Rye Grass	Dhunche Rye ghans	30-40	Mid hills and high hills
Cocksfoot	Rasuwa Cocksfoot	30-40	Mid hills to high hills
Teosinte	Makai chari-1	35-45	Terai to mid hills
Oat	Kamdhenu	51-75	Terai to mid hills
	Netra	32-91	Terai to mid hills
	Parbati	61-70	Terai to mid hills
	Ganesh	50-57	Terai to mid hills
	Amritdhara	55-57	Terai and mid hills
	Nandini	90-97	Terai and inner terai
Setaria	Khumal banso	60-80	Terai to mid hills
Stylo	Palpa Stylo	72-90	Terai to mid hills
Vetch	Kutilkosha-1	35-40	Terai to mid hills

(Source: Ghimire 2021)

Swan (cultivar of oat, 55-85 t ha^{-1} biomass, recommended to terai to high hills) and Mescavi (cultivar of Berseen, 77-85 t ha^{-1} biomass, recommended to terai to mid hills) are registered cultivars of pasture crops in Nepal (Ghimire 2021). Due to climate change effects, it is necessary to grow climate resilient fodder and pasture corps. Barley is the fodder crop that can withstand droughts and salinities the best, followed by sorghum, pearl millet, maize, oats, and berseem.

Seed rate

The seed rate of fodder and forage crops in Nepal is given in Table 2. The production and quality of fodder and forage crops are greatly affected by seed rate. The seed rate determines plant density, which affects competition for light, water, and nutrients. Proper spacing helps maximize resource utilization and minimize stress among plants. Each fodder species has an optimal seed rate for maximizing yield. For instance, legumes may require different densities compared to grasses due to their growth habits and nutrient needs. Appropriate plant density can enhance airflow and reduce humidity, minimizing pest and disease incidence. This contributes to healthier crops and higher yields. Optimal seed rates can enhance the nutritional profile of fodder, increasing protein content and digestibility. Dense plantings may result in more stems, which can decrease quality. Pyati (2021) found that the digestible energy (DE) in fodder oats was found to be considerably more at 75 kg ha^{-1}. Furthermore, Metabolizable Energy (ME) was substantially greater for 75 kg ha^{-1} of seed rate (10.19 MJ kg^{-1}) than for 90 kg ha^{-1} (10.15 MJ kg^{-1}) and 105 kg ha^{-1} (10.09 MJ kg^{-1}).

Sowing date

The timing of sowing is a critical factor in the successful cultivation of fodder crops. Sowing time affects the plant exposure to optimal growing conditions, including temperature, moisture, and sunlight. Crops sown at the right time tend to achieve their maximum yield potential. Early or late sowing can lead to reduced yields due to unfavorable weather conditions, such as frost or drought. The nutritional quality of fodder crops can vary significantly with sowing time. Early sown crops often have higher protein content and digestibility, while late sowing can lead to more fibrous, less palatable forage. The sowing time of different fodder and forage crops is given in Table 2. According to Sood et al (1992), CP (crude protein) content of oats was significantly decreased when the sowing period was extended from October 31 to December 30. Shin et al (1992) found that oats sown on September 20th had a greater CP content on a dry matter basis compared to those sown on August 31st and September 10th. The optimal window for dual-purpose barley seeding is from mid-October to mid-November (Singh et al 2017). Sowing times in barley had a significant effect on both the overall dry matter and the dry matter of straw (Abdel-Raouf et al 1983). Verma et al (2012) found that early sowing (i.e., October 25th) had a significant effect on CP and fiber content. But by March 15th, the CP content had considerably grown. According to Kumar et al (2017), there is a statistically significant variation in the way that planting dates affect plant growth indices in alfa-alfa. Plant height (69.46 cm), fresh weight (609.43 kg ha^{-1}), and dry weight (128.26 kg ha^{-1}) were all significantly higher in the crop sown on July 1st; however, these attributes dropped (by 8%, 4.2%, and 8.6%, respectively) in the crop sown on August 15th. The data shows that growth parameters significantly diminish with each successive planting date delay. The optimal duration of vegetative development under favorable climatic conditions may be the cause of this, as it encouraged root and vegetative growth, which raised the plant's yields of dry matter and green feed. Tiwana and Chaudhary (2014) discovered that when the Sorghum cv. HC 308 variety was sown later in May, the content of crude protein, ash, and IVDMD (In vitro dry matter digestibility) increased but the content of crude fiber decreased.

Table 2: Recommended grass/legumes for the hills

Species	Sowing Time	Seed Rate (kg ha^{-1})	Method of sowing	Fertilizer rate (kg ha^{-1}) N P K	Availability of green forage
Oats	Mid Oct - Mid Dec	80 kg	Through land preparation as for crop cultivation	80:60:40	Up to the 2nd week of Dec
Vetch	Mid Oct - Mid Dec	40 kg	Loose cultivated soil	25:60:30	Mid Dec - Mid April
Teosinte	Mid Mar - Mid March	40 kg	Loose cultivated soil	90 :60: 40	Mid June - Mid Oct
Pea	Mid Aug- Mid Sep	35 kg	Loose cultivated soil	15:50:00	Mid Oct - Mid Dec
Napier grass	Mid May - Mid July	2400 cuttings	Line planting 75 cm apart	180: 60: 40	Mid April to Mid Nov
Berseem	Mid Sep - Mid Oct (3 weeks before of rice harvesting	25kg	Relay cropping	15:50:00	Mid Dec - Mid April

(Source: Shrestha et al 1991, Poudel and Tiwari 2024, Pant et al 2022, Barsila et al 2024)

Nutrient management

Nutrient management is essential for optimizing the growth, yield, and quality of fodder crops. Adequate nutrient supply directly influences plant health, forage palatability, and nutritional value for livestock. When compared to control (0 kg N ha^{-1}), 40 and 80 kg N ha^{-1}, which were comparable to 160 kg N ha^{-1}, application of nitrogen at a rate of 120 kg ha^{-1} significantly increased the yields of both dry and green fodder in pearl millet (Hooda et al 2004, Tiwana et al 2004). Higher crop growth and development were probably stimulated by increased nutrient uptake from nitrogen application, which increased the output of fodder. The ether extract greatly enhanced at 120 kg N ha^{-1} in pearl millet feed. Crude fiber was significantly reduced as a result of applying nitrogen. This might be as a result of nitrogen treatment increasing the intake of nitrogen, which is a component of amino acids and proteins, while reducing the amount of pectin, cellulose, and hemicelluloses—all important components of fiber (Babu et al 1995). According to Dahiya et al (1986), mulching Pearl millet somewhat improved the quality of the grain and feed. After nitrogen treatment, crude protein content and IVDMD (In Vitro Dry Matter Digestibility) were further enhanced by seed inoculation with Azospirillum or Azotobacter (Tiwana et al 1992). The average result of a two-year study on phosphorus treatment increased the contents of DMY (dry matter yield), CPY (crude protein yield), TDN (Total digestible nutrients), and RFV (relative feed value), but decreased the contents of ADF and NDF (Yuksel and Turk 2019). Increased fertilizer dosages led to a progressive rise in oats' RFV, RFQ (relative forage quality), and NEL (net energy of lactation). The RFV and RFQ indexes can be used to assess forage intake and energy values using DMD and DMI (Lithourgidis et al 2006). Dambiwal et al (2017) reported that sorghum grain yield increased by 3.24% when Zn @ 5 kg ha^{-1} was applied to the soil along with two foliar sprays of $ZnSO_4$ @ 0.5%. For healthy growth, yield, and physiological and metabolic processes, the sorghum plant needs remarkably little zinc. Ahmad et al (2018) discovered that putting 10 kg ha^{-1} of zinc on the field enhanced the production of green fodder by 7.15% in 2014 and 7.41% in 2015.

Tillage practices

Tillage practices play a vital role in the establishment and productivity of fodder and forage crops. They influence soil structure, moisture retention, weed management, and overall crop health. Tillage affects soil properties such as structure, aeration, and microbial activity. Soil qualities, both biological and chemical, are affected by tillage. The choice of tillage greatly impacted the amount of crude protein produced; conventional tillage produced the highest value, which was followed by two cultivations using a rotavator. Under zero tillage, the lowest crude protein yield was observed. Crude protein synthesis was lower and about equal in all other treatments (Pal and Joshi 2017). There is a higher amount of total nitrogen and soil organic matter in soils treated to conservation tillage techniques (minimal and no-tillage) compared to conventional tillage (Bilalis et al 2012). Lower productivity (315.9 and 301.1 q ha^{-1}, respectively) was obtained with tillage containing primary and secondary tillage along with deep and conventional tillage compared to zero tillage (223.1 q ha^{-1}) (Ayub et al 2003). In fodder sorghum, deep tillage produced significantly higher yields of DM (5.66 t ha^{-1}) and GFY (31.59 t ha^{-1}) than zero tillage. Ayub et al (2003) found that the best seed rate combination for sorghum was 120 kg ha^{-1} when planted on deeply tilled soil. This combination increased the amount of feed produced by 35.15 t ha^{-1}. Zero tillage (ZT) improved available nitrogen, fodder output, and growth characteristics in cowpea. ZT produced a larger yield of cowpea fodder than CT, while the raised bed approach produced a statistically equivalent yield (Mallikarjun et al 2021). The effect of different tillage practices on productivity of fodder at is given in Figure 2.

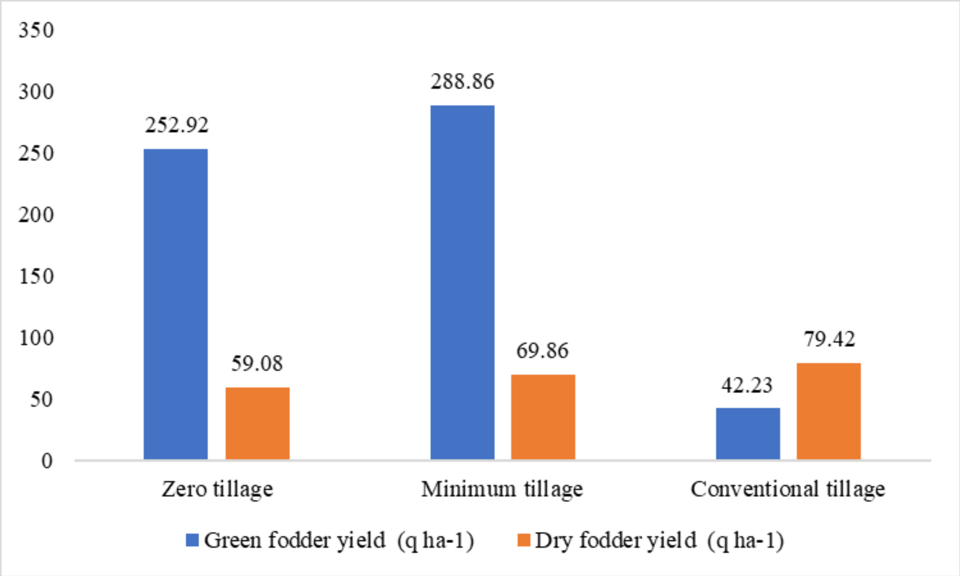

Figure 2. Effect of different types of tillage practices on productivity of fodder oat in 2011-2012 (Deva et al 2014)

Irrigation management

Effective irrigation management is essential for optimizing the growth and yield of fodder and forage crops. Adequate water supply enhances plant health, improves forage quality, and maximizes biomass production. Good agricultural practices include managing water resources carefully and using water effectively for cattle, irrigation, and the development of rainfed crops and forages. In addition to reducing waste, excessive leaching, and salinization can be prevented with the use of efficient irrigation technology and management. It is important to control water tables to avoid unnatural rise or decline. The furrow irrigation produced a larger yield of green biomass as compared to drip irrigation. Because high-quality water is more readily available, plants are able to absorb more macro- and micronutrients, which increases their output of dry matter due to the positive effects on photosynthesis. The higher salinity in the irrigation water stunted the growth of the plant roots, reducing their ability to absorb nutrients. This led to leaf chlorosis, which may have affected the crop's capacity for photosynthetic activity and, ultimately, its yield of dry matter. Similar findings of lower DM yield with higher saline levels were reported by Makarana et al (2017), Yadav et al (2004) and Kumari et al (2014). When applying high-quality water to pearl millet throughout both cuttings, the crop's OM content was quantitatively higher than in other treatments (Robinson et al 2004, Ben-Ghedalia et al 2001). Increased concentrations of soluble salt may have contributed to the greater NDF (Neutral Detergent Fibre) content linked to higher salinity levels of irrigation water, resulting in improved deposition (Fahmy et al 2010, Robinson et al 2004). The amount of acid detergent fiber (ADF) in the water increases somewhat when irrigation levels rise at the same time. Reddy et al (2003) found that increasing the frequency of irrigation and dividing the same amount of water into smaller irrigations at crucial times led to higher yields of both CP and dry matter. According to Yadav et al (2014), pearl millet genotypes HHB-197 and HHB-223 yielded and grew better when grown under irrigation than when they were rainfed. The qualitative characteristics of the output of oats were significantly impacted by irrigation levels. CP yield (939.9 and 994.0 kg ha^{-1}), CF (crude fat) production (147.0 and 159.0 kg ha^{-1}), and total mineral yield (632.0 and 658.4 kg ha^{-1}) in the first and second cut, respectively, were the outcomes of five times the irrigation provision (Amandeep et al 2010, Jat et al 2017, Bhilare and Joshi 2007).

Insect pests and disease management

Anthracnose and Red rot: Everywhere sorghum is planted, this disease is common and has a global spread (Jain 2001). The fungus *Colletotrichum graminicola* causes both leaf spot (anthracnose) and stalk rot (redrot). To control diseases, it is advised to treat seeds with 4 g kg^{-1} of Captan or Thiam and to spray 1.25 kg ha^{-1} of mancozeb.

Cowpea Mosaic: This is disease of cowpea. The cowpea mosaic virus, which is spread by aphids (*Aphis craccivora, A. gossypiand Myzus persicae*), is the cause of the disease. The disease can be minimized by using healthy seed and misting the crop with 0.1% Metasystox or any other systemic insecticide to control aphids (Singh 2001).

Rust: Cowpea is susceptible to bean rust, which is caused by *Uromyces phaseoli typica*, despite the fact that other rust species also target legumes. This rust disease damage can be lessened by praying the crop with

Dithane M-45 @ 2 kg ha^{-1} in 1000 liters of water (Singh 2001).
Dry Root Rot: It is disease of cowpea. *Macrophomina phaseolina* is the pathogen that causes dry root rot. Applying a bioagent (*Trichoderma viride* or *T. harzianum*) after treating seeds with a combination of 0.25 percent Thiram and 0.1% Bavistin has also been shown to be successful (Jain 2001).
Smuts: It is disease common in sorghum. According to Rangaswami and Mahadevan (1999), modifying the sowing dates appears to aid in preventing the disease. Use 0.5-3% copper sulphate solution for 10-15 min then dried and sowing of seed control this disease.
Green ear or downy mildew: It is caused *Sclerospora graminicola* is a serious disease of pearl millet (*Pennisetum typhoides*). Additionally, Apron SD-35 (2.5 g kg^{-1} seed) seed treatment was proven to suppress the disease for up to 30 days after sowing by Gupta and Verma (1991).

In the order Coleoptera, the first four species—*Hypera postica* Gyllenhal, *Sitona* genius, *Apion seniculus* Kirby, and *Otiorrhynchus ligustici* L.—are the most frequently occurring insect pests of alfalfa. The following species are members of the Thysanoptera and Hemiptera orders. As alfalfa pests, the leaf aphids (order Hemiptera, Sternorrhyncha: Aphidodea) is also common. The most common pest species in cowpea are Lepidopterous, Coleoptera, Homoptera, Thysanoptera, Diptera and Hemiptera that cause yield loses. Application of chlorpyrifos (Lorsban) 4 E as a broadcast foliar spray with 20 gal of water per acre is recommended to control alfalfa weevil. Armyworm is insect of maize, alfalfa and clover. To control armyworm, chlorpyrifos (Lorsban) 75 WG is applied as a broadcast spray. The use of chemical pesticides on forage crops can reduce disease and pest populations, but excessive use of these pesticides can have negative consequences as well. These include the buildup of toxic residue in feed, a decrease in soil fertility, a disruption of natural biodiversity, and ultimately negative effects on the production of fodder and forage, including harm to the soil, animals, and public health. In order to combat insect pests and diseases, alternative bio-management—which is simple, affordable, and environmentally friendly—evolved and is being applied in sustainable agriculture. For farming to be successful in terms of both produce quality and yield, crop health must be maintained using integrated pest management principles. Crop and fodder crops rotations, the use of disease- and pest-resistant varieties, and careful use of agrochemicals to control weeds, pests, and diseases after harvest are all examples of long-term risk management techniques.

Time of cutting and harvesting

A forage crop productivity and quality are determined by the appropriate stage of harvesting. The amount and caliber of herbage generated are also strongly influenced by the frequency of cutting. All forage crops are harvested at the proper time of growth in order to produce sufficient amounts of fresh biomass, along with a suitable amount of dry matter and nutrients, especially crude protein. Throughout the crop's life cycle, the number of cuttings is determined by the temperature and growth rate. This stage is reached at 50% flowering stage to dough stage in the majority of forages. This is adhered to closely in single-cut varieties; however, in multi-cut types, pre-flowering stage is recommended in order to obtain more future cuts. When it comes to forages, cutting management affects both yield and quality. To ensure prompt regeneration and sufficient recovery from ratoons, multi-cut forages should be picked with an 8–10 cm stubble left behind. Cutting fodder crop too early for fodder produces less high-quality fodder than cutting it at an advanced stage. High production and high-quality napier grass depend on proper cutting management (Tessema et al 2010, Pathan et al 2012). According to Van Soest (1994), as napier grass ages, there will be a sudden rise in the amount of carbohydrates it accumulates, which may cause its digestibility and crude protein content to drop. The crude protein levels were shown to drop by 27% from the 60-day harvest to the 120-day harvest, according to Ansah et al (2010). The crude protein likewise declined as the harvest day increased. According to a study conducted by Yang et al. (2008), cutting times boosted alfalfa hay production. Because forage species have a higher capacity for regeneration, multiple cuttings have a better production benefit (Aoki et al 2013). Multiple cuttings increased the forage yield for *Medicago sativa* , *Avena sativa* and Sorghum Sudangrass by 82 %–114 %, 7.5 %–51 %, and 21 %–150 % compared to the single harvest (Li et al 2023).The results of a barley experiment showed that forage harvested at 60 days after sowing produced significantly more dry fodder (24.2 q ha^{-1}), crude protein (2.1 q ha^{-1}), crude fiber (6.4 q ha^{-1}), ether extract (0.62 q ha^{-1}), mineral matter (2.31 q ha^{-1}), and nitrogen free extract (0.62 q ha^{-1}) than forage harvested at 45 days after sowing. But when grass was collected at 45 DAS, notable DMD (76.06%) and CP content (13.3%) were noted. For the oats shown in Table 2, similar outcomes were noted (Kaur et al 2013, Mohammad et al 1994, Singh et al 1997). Higher fodder yields were obtained by harvesting wheat fodder later in the growing season (Dunphy et al 1982). According to Shehzad et al (2012), harvesting dates significantly affected the fodder maize quality attributes. The DM, DMY, GFY, and CF content increased with a 20-day harvest delay to 33.75%, 16.88 t ha^{-1}, 76.99 t ha^{-1}, and 32.17%, respectively. However, the ash content (8.60%), crude fat (2.08%), and CP (7.84%) decreased. According to Boss and Carlson (2001) and Hussain et al (1998), barley that is harvested early usually yields better-quality fodder than that which is harvested later. In Geomjeongsaeol and Pungwon, soybean cultivars harvested at the full seed stage have higher DDM, DMI, and RFV than those collected at the early seed development stage, according to research by Park et al (2017). For the OT93-26 variety, these values were lower throughout the full seed harvesting stage than they were during the early seed development stage. When hay was harvested in late October as opposed to other harvesting times, the yields of DMY (6.83 t ha^{-1}), CPY (0.48 t ha^{-1}), and digestible OM (3.77 t ha^{-1}) were significantly higher. This suggests that late October is the optimal time to harvest large amounts of high-quality hay that was obtained from natural pasture in the area (Feyissa et al 2014). Dual-purpose barley yields high-quality grain and feed, according to Singh et al (2017). Good quality fodder for feeding the animals, particularly during the lean season (mid-December to mid-January), is produced by early harvesting, at 50–55 DAS. The revitalized crop was left for grain use after the fodder crop was cut, and it was treated similarly to a grain crop without lowering grain output. Cluster bean harvesting at 80 DAS yielded the highest DMY (68.5 q ha^{-1}), while harvesting at 50 DAS produced the lowest DMY (29.2 q ha^{-1}). It might be connected to the additional time available for photosynthesis, which led to the crop's development and output at 80 days, as opposed to 50, 60, and 70 days (Pandey et al 2019).

Intercropping practices

Various planting structures were used to calculate the dry matter yields of both solo maize and maize with soybean intercropped (SoeHtet et al 2021). When comparing solo maize to other intercropped crop treatments, DMY (14.3 t ha^{-1}) was significantly greater. Between the harvesting dates, there were notable variations in DMY. DMY was higher in the reproductive milk stage (14.2 t ha^{-1}) than in the reproductive maturity stage (13.2 t ha^{-1}). When maize and soybeans were interplanted, the crude protein production was considerably higher (2.1–2.5 t ha^{-1}) than when maize was grown alone (1.8 t ha^{-1}). Harvesting time had a similar effect on CPY; the reproductive milk stage had a higher CPY (2.3 t ha^{-1}), while the reproductive maturity stage had a comparatively lower CPY (1.9 t ha^{-1}). When maize is grown alone, more biomass and dry matter are produced than when cowpeas are interplanted with maize (Geren et al 2008). Owing to its tall and leafy appearance, maize intercropped in a row was found by Htet et al (2017) to have a significantly reducing effect on legume development. Patel and Rajagopal (2002) found that a 4:3 row ratio in sorghum + cowpea yielded significantly greater GFY (502.7 q ha^{-1}) and DMY (91.5 q ha^{-1}) than in sorghum alone in Madhya Pradesh. A 3:3 row arrangement of sorghum with a variety of legumes, such as cowpea, clusterbean, and mothbean, was the most productive method for providing fodder in Parbhani, Maharashtra. Different intercropping combinations affect the green fodder yield of maize and cowpea (Figure 3) (Arif et al 2020). The quality of the forage in a mixture produced by intercropping cereal with legume crops is higher than that of solitary planting (Ambhore et al 2008). Legumes had a substantially higher protein content than maize, hence intercropping them with legumes increased CP while decreasing NDF and ADF levels in forages. Cereals are added to the mixture of legumes and cereals for their yields, whereas legumes are added for their protein (Htet et al 2016).

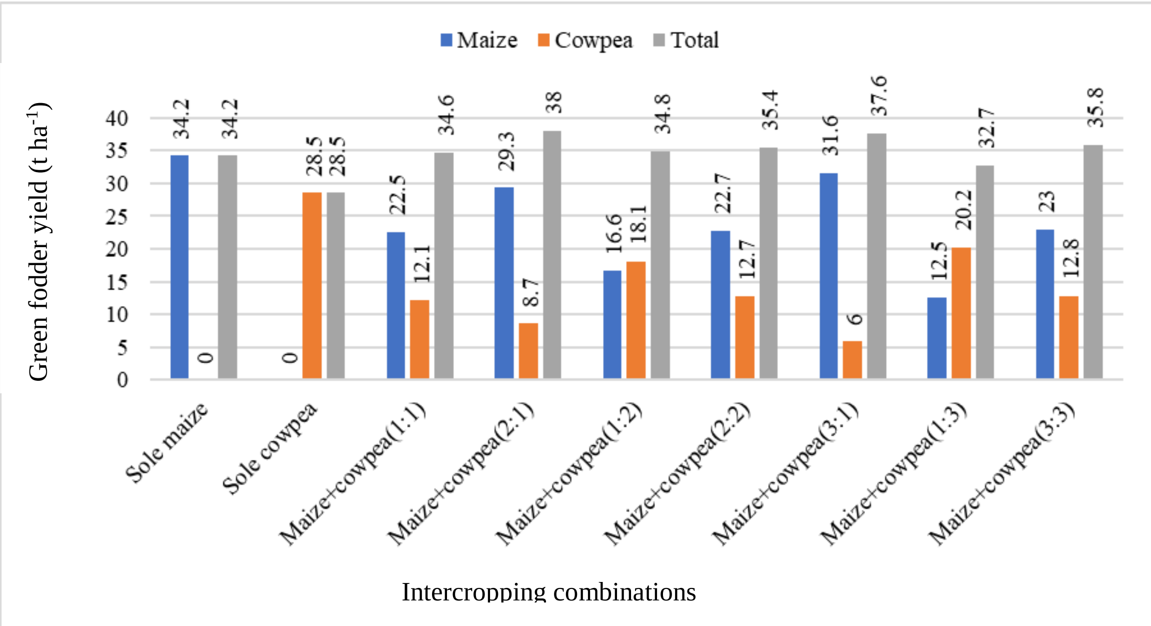

Figure 3. Green fodder yield of maize and cowpea as affected by different intercropping combinations in 2020 (Arif et al 2020)

Weed management

Considering the substantial financial costs involved in producing fodder, weed control is crucial and shouldn't be overlooked. Strong competition for growth factors since the emergence of crop seedlings is provided by weeds with high dry matter accumulation capacity to fodder crops. Weeds such as *Coronopus didymus* and berseem, *Coccinia grandis* and corn and sorghum, *Celosia argentea* and corn and sorghum, and Trianthema and corn and sorghum, are mixed with green feed during harvest, which lessens the palatability of the green feed and consequently impacts the amount of milk produced by milch animals. Forage crops suffer from production and quality losses as a result of weed competition for nutrients, water, light, and space. Weeds not only reduce yields but also have the potential to raise disease and insect problems, impair the quality of the feed, prematurely lose stands, and cause issues during harvest. Livestock find certain plants unpleasant or even potentially toxic. Although weeds can reduce fodder yield by up to 40% and utilize between 1/3 and 1/2 of applied nitrogen, weed management is not common in fodder crops because farmers view weeds as animal feed similar to fodder crops. This leads to a decrease in both fodder yield and crude protein yield (Singh et al 2020). Weed management is one of the important task in forage and fodder production in livestock sector. Different herbicides can be used for weed management. The yields of dry and green pearl millet, excluding weed-free plots, were significantly higher in plots treated with pre-emergence Pendimethalin @ 1.0 kg a.i. ha^{-1} and one hand weeding at 25 days after sowing (444.4 q ha^{-1} yield); and pre-emergence Atrazine @ 0.75 kg a.i. ha^{-1} and one hand weeding at 25 DAS (days after sowing) (108.7 q ha^{-1} yield). The yields of dry fodder and green fodder increased by 43.3 and 37.8%, respectively, when pendimethalin was used and one-handed weeding was performed; the yields increased by 40.3 and 42.7%, respectively, when atrazine was applied and one-handed weeding was performed (Chaudhary et al 2017). Twenty days after seeding, Singh et al (2021) observed that weed-free plots yielded higher GFY and DMY, after which Imezathyper, Propaquizafop, and Pendimethalin were applied and one hand weeding was performed. Higher GFY was produced by these three treatments by 40.1, 59.3, and 39.9%, respectively.

CONCLUSION

Different agronomic practices have an effect on the quality and productivity of fodder crops. The DMY and CPY are increased by irrigation when it is done regularly and during appropriate periods. DMY, CPY, TDN, and RFV are increased by applying nitrogen and phosphorus at the appropriate rates. Productivity of fodder crops can be increased through tillage. Weed management techniques enhance DMY. Higher quality and more quantity of fodder can be obtained by implementing cropping systems that include both legumes and cereals in the right proportion. The yield, growth, and quality characteristics of fodder can be improved by timely sowing at the ideal seed rate and spacing. Fodder crops can have their nutritional value increased by using appropriate agronomic techniques such tillage, irrigation techniques, weed management, insect pests and disease management, timing of planting and harvesting, intercropping, and nutrient management.

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AUTHOR'S CONTRIBUTION

S Rai conceptualized, reviewed the literature and prepared the manuscript.

CONFLICTS OF INTEREST

The author expresses no conflict of interest.

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