Chapter

Changing Climate and Advances on Weeds Utilization as Forage: Provisions, Nutritional Quality and Implications

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Abstract

Under changing climate, growth and prevalence of many invasive and indigenous weeds are expected to boost up owing to their greater genetic diversity, competitive superiority and better plant architecture. Atmospheric CO_2 enrichment and elevating global temperature are causing weeds invasion to new localities making prevalent weed management strategies ineffective. Weed utilization as forage for ruminants provided that their nutritional profile is available and can be a biologically feasible and economically viable approach compared to existing management system of eliminating them from agro-ecological systems. Different weeds like Bermuda grass (*Cynodon dactylon*), Johnson grass (*Sorghum halepense*), canary grass (*Phalaris minor*), nut sedge (*Cyperus rotundus*), yellow duck (*Rumex crispus*), drooping brome (*Bromus tectorum*), burr clover (*Medicago polymorpha*), button weed (*Diodia scandens*), and purslane (*Portulaca oleracea*) had acceptable nutritional profile with organic matter (89.0–91.3%), protein (7.1–19.5%) and fats (2.1–3.7%). Those were also rich in micro-nutrients (calcium, magnesium and zinc), while anti-nutritional factors (saponins, tannins, phytates and oxalates) were in safer limits for dairy animals. Lack of nutritional profiling and presence of anti-nutritional factors decreased feed intake and led to malnutrition, while higher concentration of tannins caused digestibility depression in small ruminants. There is need to conduct further studies for nutritional profiling of local weed species and development of techniques for reducing their anti-nutritional factors.

Keywords: anti-nutritional factors, global warming, protein content, saponins, tannins

1. Introduction

Climate change has been feared to incur frequent drought spells and floods, while temperature fluctuations and shifting of rainfall patterns are projected to alter growth habits of weeds flora globally. There is an emerging rhetoric that most of invasive and indigenous weeds have the potential and botanical superiority to adjust and acclimatize to atmospheric CO_2 enrichment through the optimization of photosynthesis process leading to significant boost in their biomass production.

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In this way, some of the weed species can increase their establishment and dominance in indigenous agro-ecosystems along with invading adjacent as well as far flung terrestrial ecosystems. Thus contrary to notion that weeds are menace and agro-ecological systems must be kept free of indigenous and invasive weeds, their utilization as forage for dairy animals has the potential to become the most feasible and pro-environment strategy [1–3].

Globally, large ruminant's performance is directly influenced by the nutritional value of feed which accounts for over 50% of total expenditures. It deserves mentioning that dairy animals confront forage shortage owing to temperature extremes leading to drastic fall in milk production especially in developing countries. The shortage of forage and rising population of dairy animals has necessitated identifying and evaluating alternate feed resources which are cheap and can also fulfill animal's dietary needs. It has been established that weeds can inflict drastic influence on crops productivity and use of chemical herbicides for keeping them below threshold level, has led to serious concerns pertaining to their residual persistence in crops, soil and environment. Weeds utilization as animal feed holds potential because these are cheap owing to their abundance on field paths and water channels. Weeds harvested from cropped and non-cropped area may constitute an effective and biologically viable approach to keep weeds below the threshold level. Weeds utilization for feeding animals can also reduce herbicides use in agricultural lands which has the potential to curb environmental pollution. Many weeds have been reported to be resistant and better adapt to dynamic environmental conditions, and thus making them less prone to drastic impacts of climate change. In addition, it was reported that animals preferred naturally grown mixtures of weeds over crop residues and roughage during dry season. Furthermore, rapid regeneration favors many weed species for their inclusion as a source of vegetable protein in animal's diet [4–10].

Weeds such as Bermuda grass (*Cynodon dactylon*), Johnson grass (*Sorghum halepense*), canary grass (*Phalaris minor*), nut sedge (*Cyperus rotundus*), cheat-grass or drooping brome (*Bromus tectorum*), burr clover (*Medicago polymorpha*) and pigweed (*Amaranthus viridis*) contained organic matter over 90% indicating that these weeds can fulfill the dry matter requirement of animals. In addition, spotted knapweed (*Centaurea stoebe ssp. micranthos*), a weed of rangelands in Northern America was reported to displace local plant species, degraded wildlife habitats, altered biogeochemistry of soil and triggered soil erosion and thus its control through grazing was found to be biologically and economically viable. Similarly, broom snakeweed and medusa-head (*Taeniatherum caput-medusae*) were effectively controlled through controlled grazing with reasonably good palatability [11–17].

Along with substantial quantity, nutritional quality of weeds is of the utmost importance for dairy animals in order to produce milk on sustainable basis. Field bindweed (*Convolvulus arvensis*) and yellow duck (*Rumex crispus*) were reported to have significantly higher protein content (27 and 22% respectively) [11] which were greater than all cereal forages and most of the legumes, while button weed (*Diodia scandens*) contained 7.7% protein [18]. Although, a number of species belonging to *Commelinaceae* family such as climbing dayflower (*Commelina diffusa* L.), tropical spiderwort/wandering jew (*Commelina benghalensis* L.), Asiatic dayflower (*Commelina communis* L.), African dayflower (*Commelina africana* L.), white mouth dayflower/slender dayflower (*Commelina erecta*) are considered weed but constituted a major chunk of animal feed in Tanzania [19], rural regions of Mauritius [20], USA [21] and in Kenya owing to reasonably good palatability [14, 18, 22, 23].

It is pertinent to mention that anti-nutritional factors (saponins, tannins, oxalates, etc.) of weeds constitute as the most crucial concern as far as animal nutrition is concerned. Tick weed (*Cleomea viscose*) recorded safer limits of anti-nutritional factors such as condensed tannins (0.0491%), saponins (0.23%), phytates (1.2%)

and oxalates (3.3%), but unfortunately in-depth studies are lacking in this context. Furthermore, narrow leaf weeds (nut sedge, wild oat, etc.) were recommended to be a good source of fiber, while broad leaf weeds (pigweed, field bindweed, etc.) provided cheap vegetable protein to dairy animals [1, 11, 13, 20].

To date, very few studies have been done to assess the nutritional status, digestibility and intake of indigenous and exotic (invasive) weeds and their utilization in sustainable ruminant's production systems, but not a single study has so far synthesized and evaluated the literature on weeds utilization as forage. This chapter attempts to synthesize as well as assess the potential of weeds for supplementing traditional feedstuffs (forages, crop residues and concentrates) partially without compromising the productivity of large ruminants in terms of milk production. Weeds mineral constituents and anti-nutritional factors and various implications in weeds utilization as animal feed have also been evaluated.

2. Materials and methods

In order to synthesize published findings pertaining to nutritional quality of weeds, search was performed on Google Scholar (http://scholar.google.com) and PubMed (http://www.PubMed.gov) using the below mentioned search strings:

1. Weeds and forages.
2. Weeds nutritional value.
3. Weeds, animal feed.
4. Anti-nutritional factors in weeds.

The search was time-restricted to 2000–2019, however owing to limitation of published findings; it was later on relaxed to 1990–2019.

The research studies were screened based on following criteria;

1. Reporting at least one weed's biomass production under changing climate.
2. Describing one or more nutritional quality parameters such as protein content of indigenous or invasive weeds.
3. Stating anti-nutritional factors of weeds species.
4. Reporting mineral constituents of at least one or more weeds.

The screening process resulted in 55 studies which fully fit in the objectives and selection criteria.

3. Weeds under changing climate

The rising temperature and carbon dioxide level along with the rapidly altering dynamics of rainfall and evaporation are the most important factors for determining management and utilization of weeds under changing climate. Weeds have been reported to have a greater genetic diversity compared to crops and thus can respond positively to agro-environmental changes. Owing to CO_2 enrichment of atmosphere and rising temperature, some of the weed species can invade new geographical localities while making the existing weed management strategies ineffective. In addition, weeds can have superiority over crop plants by virtue of better plant architecture and incorporating nitrogen and carbon in seeds. Rag weed (*Ambrosia artemissifolia*) developed more number of branches and leaf area along with producing greater number of pollens under increased temperature. Similarly, comparatively higher production of spines by Canada thistle (*Cirsium arvense*) in response to elevated CO_2 level was reported [10, 24–27].

In addition, biomass production of bitter vine/American rope (*mikania mikrantha*), creeping oxeye (*Wedelia trilobata*) and Cairo morning glory (*Ipomea cairica*) was enhanced with increasing CO_2 level [28]. Spurred anoda (*Anoda cristata*) gave the highest green biomass at CO_2 fertilization up to 700 ppm and 32°C temperature, while barnyard grass (*Echinochloa crusgalli*) and Indian goose-grass/wire grass/crowfoot grass (*Eleusine indica*) remained non-responsive to elevated temperature and CO_2 concentration. It was concluded that elevated CO_2 effectively enhanced the photosynthetic process even under water limited conditions indicating higher water use efficiency of weeds under drought stress which led to higher to biomass production. However, weeds response to elevated CO_2 and temperature under well watered conditions continues to remain an unexplored aspect which demands further research to determine the physiological plasticity of different weed species [25, 26].

The temperature elevation as a result of global warming is feared to trigger weeds migration. Cogon grass *(Imperata cylindrica*) prickly acacia (*Acacia nilotica*) and witch weed (*Striga asiatica*) were reported to invade cooler areas of Europe owing to global warming, while some of the invasive weed species such as mesquite (*Prosopis juliflora*) can become more hardy and difficult to control owing to greater portioning of assimilates to roots under elevated temperature particularly under agro-ecological conditions of Indo-Pak subcontinent [27, 29–32].

4. Nutritional quality of weeds

Although, weeds presence in and around the cultivated fields has never been deemed desirable, but these can contribute significantly to the production of quality organic feed for dairy animals. The nutritional profile of weeds determines feasibility and scope for their inclusion in ruminant's feed. The nutritional quality of weeds encompasses digestibility, chemical composition, energy and extent of presence of anti-nutritional factors and such information can assist to determine the allowable proportion of weeds in ruminant's feed [10, 33–35].

Dry matter digestibility has direct relationship with the quality of forage. Different weeds such as Barnyard grass (*Echinochloa crusgalli*) and Jerusalem artichoke (*Helianthus tuberosus*) had significantly higher digestibility compared to many cereal forages. The comparative dry matter digestibility of many weeds and forages crops is presented in **Table 1**. Digestibility was reported to be an important indicator of any forage's quality, while Lamb-squarters (*Chenopodium album*), barn-yard-grass (*Echinochloa crus-galli*), dandelion (*Taraxacum officinale*), Jerusalem artichoke (*Helianthus tuberosus*), yellow foxtail (*Setaria glauca*), perennial sowthistle (*Sonchus arvensis*) and Canada thistle (*C. arvense*) had in-vitro dry matter digestibility equal to alfalfa (*Medicago sativa*). In addition, common ragweed (*Ambrosia artemisiifolia*) and redroot pigweed (*Amaranthus retroflexus*) had even greater in-vitro dry matter digestibility compared to alfalfa [11, 39–41]. There is dire need to determine the digestibility of local weed flora in order to find out their suitability as an alternate animal feed.

Protein (CP) is the most important nutritional quality attribute having direct impact on milk production. Testing of 102 weed species belonging to *Poacea*,

Weeds	DMD (%)	Forage crops	DMD (%)
Barnyard grass (*Echinochloa crusgalli*)		Alfalfa (*Medicago sativa*)	64–75
Canada thistle (*Cirsium arvense*)	68–74	Sorghum (*Sorghum bicolor*)	59–61
Dandelion (*Taraxacum officinale*)	78–84	Maize (*Zea mays*)	63–68
Sowthistle (*Sonchus arvensis*)	76–82	Oat (*Avena sativa*)	60–63
Swamp smartweed/knotweed/tanwed (*Polygonum amphibium*)	54–62	Barley (*Hordeum vulgare*)	59–64
Quackgrass (*Elymus repens*)	58–68	Pearl millet (*Cenchrus americanus*)	58–60
Brome grass (*Bromus tectorum*)	66–76	Cowpea (*Vigna unguiculata*)	68–76
Curly dock (*Rumex crispus*)	50–58	Soybean (*Glycine max*)	70–76
Jerusalem artichoke (*Helianthus tuberosus*)	81–86	Cluster bean (*Cyamopsis tetragonoloba*)	70–79

Table 1.
Dry matter digestibility of some weeds and common forage crops grown under varied agro-climatic conditions [11, 28, 33, 36–38].

Asteraceae, *Fabaceae* and *Euphorbiaceae* families commonly found in central Mexico revealed that only 25 had balanced nutritional profile. Weeds CP content depend on growth stage as matured weeds recorded lesser protein compared to harvestings done at pre-bloom stage. Asthma plant (*Eurphobia hirta*) recorded 16.7% protein content while tick weed or Asian spider-flower (*Cleomea viscose*) with 14.7% followed it, while yellow nutsedge or nut grass (*Cyperus esculentus*) and button weed (*Diodia scandens*) contained 9.8 and 7.7% CP respectively. Bluegrass (*Poa annua*) was found to have over 14% which is higher than maize, sorghum and oat, while common purslane (*Portulaca oleracea*) (8%) was also suggested to be an equally good forage weed as far as CP content is concerned. Another study suggested that weeds including bush sunflower (*Simsia amplexicaulis*), creeping false holly (*Jaltomata procumbens*) and mosquito flower weed (*Lopezia racemosa*) contained CP in the range of 6.5–16.9% and could be used solely or as supplementary feed mixed with maize straw to feed dairy cattle. Mixtures of weeds (*Commelinaceae* + *Amaranthaceae*) recorded crude protein twice than most of the roughages. Another study reported that bush sunflower (*Simsia amplexicaulis*) weed supplemented with maize straw based animal diets resulted in higher protein content successfully met dairy animals dietary needs. Similarly, climbing dayflower (*Commelina diffusa* L.) recorded appreciably higher content of protein (17.7%) which is comparable to commonly used forage crops. In addition, its rumen degradability of protein was recorded over 72% making it forage with balanced nutrition [11, 36, 42–44].

Higher content of fiber increases the bulkiness of feed which results in reduced intake. The lowest crude fiber content was recorded by button weed (18.7%) and nut grass yielded the highest fiber (27%). The minimum lignin content (9.6%) of asthma plant favored its inclusion in animal feed [18]. Similarly, common dandelion (*Taraxacum officinale*) recorded significantly lower crude fiber content (15%), while Bermuda grass (*Cynodon dactylon*) gave the lowest fiber content of just over 6% [11]. In contrast, barnyard grass (*Echinochloa crusgalli*) recorded the highest neutral detergent fiber (NDF) compared to trans-pecos drymary (*Drymaria laxiflora*) [45]. It was reported that climbing dayflower (*Commelina diffusa* L.) recorded 36% and 22% NDF and acid detergent fiber (ADF) respectively and thus compares well to commonly used grasses such as sorghum-Sudan grass and napier grass (*Pennisetum purpureum*) [9]. Similarly, spiderwort (*Tripogandra purpuracens*), a weed of South America recorded reasonably good concentration of carbohydrates which was higher compared to *Tridax coronopifolia* and was recommended to be fed to dairy animals [10, 11, 13, 19, 37, 46].

Digestibility is an important indicator of any forage's quality. Lamb-squarters (*Chenopodium album*), barn-yard-grass (*Echinochloa crus-galli*), dandelion (*Taraxacum officinale*), Jerusalem artichoke (*Helianthus tuberosus*), yellow foxtail (*Setaria glauca*), perennial sowthistle (*Sonchus arvensis*) and Canada thistle (*C. arvense*) had in-vitro dry matter digestibility equal to alfalfa (*Medicago sativa*). In addition, common ragweed (*Ambrosia artemisiifolia*) and redroot pigweed (*Amaranthus retroflexus*) had even greater in-vitro dry matter digestibility compared to alfalfa. Similarly, it was reported that high protein and low fiber contents are indicative of high energy and high productive value feeds. Field bindweed (*Convolvulus arvensis* L.) and common amaranth (*Amaranthus retrofl* exus L.) recorded the highest protein (18.8 and 13.0% respectively) and the lowest fiber (14.7 and 17.6% respectively) which was comparable to alfalfa (*Medicago sativa*) hay having 16.9% protein and 27% fiber. In addition, especial emphasis was paid to palatability of weeds as high nutritional value becomes irrelevant if animals have little likelihood for the weeds species. The hay of different weeds was given to sheep to determine their palatability by using cafeteria of manger technique and biomass consumed in 15 minutes was recorded. Alfalfa had the highest palatability followed by field bindweed (*Convolvulus arvensis* L.)

Weeds	OM (%)	CP (%)	ADF (%)	NDF (%)	F (%)	A (%)
Knapweed (*Centaurea stoebe*) [43]	—	19.5	—	29.5	—	—
Nut sedge (*Cyperus rotundus*) [11]	91.03	16.3	57.8	64.5	—	12.8
Red dead-nettle (*Lamium purpureum*) [43]	—	9.7	25.8	—	2.1	9.8
Field bindweed (*Convolvulus arvensis*) [11]	90.30	27.0	41.0	35.5	—	10.4
Pigweed (*Amaranthus viridis*) [11]	91.00	26.2	57.7	31.0	—	13.2
Johnson grass (*Sorghum halepense*) [46]	—	5.3	30.2	—	1.5	5.5
Field mustard (*Brassica rapa*) [46]	—	9.8	49.5	63.7	—	—
Chicory (*Cichorium intybus*) [46]	—	7.1	35.2	—	3.34	7.5
Bermuda grass (*Cynodon dactylon*) [11]	90.90	13.5	47.0	76.5	—	13.3
Mexican aster (*Cosmos bipinnatus*) [40]	—	10.5	43.5	41.7	—	—
Tick clover (*Desmodium molliculum*) [40]	—	16.2	42.9	41.6	—	—
Yellow foxtail (*Setaria glauca*) [10]	—	20	30.0	—	—	—

Table 2.
Nutritional quality (organic matter, crude protein CP, acid detergent fiber ADF, neutral detergent fiber NDF, fats F, total ash A) of weeds [11, 17, 21, 31, 35, 39, 41, 48, 49].

and common amaranth (*Amaranthus retrofl* exus L.) owing to higher protein and lesser fiber contents. Thus, it was inferred that protein and fiber content of feeds can be used as predictors of palatability and it was also concluded that weeds leaves had 2–3 times higher protein than stems and thus leafy weeds such as field bindweed (*Convolvulus arvensis* L.) recorded higher palatability [11, 45, 47]. The nutritional quality of some weeds has been presented **Table 2**.

5. Mineral constituents of weeds

Minerals in appropriate quantity are essential for dairy animals to be utilized in various metabolic processes, for boosting immunity level against diseases and reproductive health. Asthma plant (*Eurphobia hirta*) was recommended to be included in animal feed for having reasonably higher concentrations of major minerals including calcium (Ca) (13.6%), magnesium (Mg) (3.0%) and potassium (K) (2.5%), along with many trace elements such as iron (Fe) (0.7%), copper (Cu) (0.1%) and manganese (Mn) (0.1%). Common chicory (*Cichorium intybus*) was also suggested as forage weed for having a comparable mineral composition including Ca (6%), Mg (2%), Fe (0.5%) and Cu (0.06%). In addition, pink sorrel (*Oxalis debilis*) was found to be poor on animal nutrition scale for being deficient in Ca (4%), Mg (2.3%), Fe (2.4) and Zinc (Zn) (0.15) compared to other forage weeds [10, 21, 48]. Very limited information has been reported so far regarding mineral constituents of weeds which limit their utilization as a feed source for ruminants. **Table 3** contains mineral constitution of some weeds.

Weeds	Ca	Mg	Zn
Wild oat (*Avena fatua*) [11]	1.8	1.10	0.06
Burr clover (*Medicago polymorpha*) [11]	10.2	2.42	0.14
Morning glory (*Ipomoea purpurea*) [40]	9.0	0.63	2.99
Yellow duck (*Rumex crispus*) [11]	4.7	2.70	0.20
Cheese weed (*Malva parviflora*) [40]	19.3	1.22	4.59
Wood sorrel (*Oxalis decaphyllai*) [40]	5.1	1.43	2.76

Table 3.
Mineral constituents (calcium Ca, magnesium Mg and zinc Zn) of different weeds grown under varied agro-climatic conditions [11, 18, 22, 32, 40].

6. Anti-nutritional contents of weeds

Condensed tannins, saponins, phytate and oxalate are some of the anti-nutritional factors which reduce the nutritional quality and even impart toxicity to animal feeds. It was reported that button weed (0.029–0.052%) had the lowest tannin content, while nutsedge recorded the maximum tannin content. It was suggested that weeds having tannins 2–4% of dry matter did not pose a life threatening situation rather were found to be effective in improving protein flow towards duodenum which led to higher weight gain and reduced the parasitic infections. It was suggested that effective drying of weeds has the potential to significantly reduce the condensed tannins of weeds. Similarly, saponins which are generally produced by defense systems of weeds in response to pathogenic attacks impart a bitter taste and reduce nitrogen digestibility leading to lower palatability of weeds. Tick weed and nutsedge recorded similar saponins (0.22%), while button weed contained higher saponins (0.35%).

Phytates produce phytic acid which acts as a chelator of various macro-minerals (calcium and magnesium) and trace mineral (iron and zinc) leading to a severe deficiency of these minerals. Button weed with 1.18% phytates remained superior to nut-sedge and asthma plants. Oxalate is another important anti-nutritional factor which binds with calcium to form calcium oxalate leading to calcium unavailability. Asthma plant recorded the lowest oxalate concentration (2.36%) while button weed had the maximum oxalate concentration (2.92).

It was suggested that weeds such as Arizona sunflower (*Tithonia tubiformis*), wood sorrel (*Oxalis divergens*) and bush sunflower (*Simsia amplexicaulis*) commonly found in America, Mexico, Argentina and Chile contained tannins in safer limits and might be utilized to feed dairy animals. In contrast, a fatty acid called malvalic acid was isolated from cheese weed (*Malva parviflora* L.) which caused deaths of dairy animals. Similarly, different phenolic compounds were reported to be the major reason behind low palatability of many weed species. In addition, the presence of phytochemicals and free oxygen metabolites in weeds contributed to mastitis and ultimately led to udder edema along with deteriorating the reproductive performance of cattle. Similarly, spotted knapweed (*Centaurea stoebe ssp. micranthos*) in North American rangelands contained an allelo-chemical named cnicin (a sesquiterpene lactone compound) which reduced its palatability by imparting bitter taste and deterred grazing. In contrast, knapweed was readily consumed by small ruminants' preferably at rosette and bolting stages compared to flowering and seed-set phonological stages. This preference was associated with higher protein and lower fiber content at rosette stage in comparison to flowering or seed-set stages without any link between cnicin content and knapweed palatability [28, 49–51].

7. Nutritional comparison of weeds and forage crops

To the best of our knowledge, no comprehensive studies have been reported pertaining to qualitative analyses of different native and exotic weeds with forage crops. Some of the weeds such as Canada thistle, spotted knapweed, white-top, Russian knapweed and pigweeds contain protein in the range of 15–22% while typical grasses has only 2–11% protein, thus have the potential to become cost-free source of plant protein. In addition, higher leaf-stem ratio in weeds impart them superiority over grasses in terms of higher digestibility. Moreover, weeds provide nutrients rumen microbes which enable dairy animals to digest lower quality forages and thereby reducing overall feed cost. Weeds are always available even during periods of drought in arid areas and their utilization can help to obtain sustainable supplies of milk throughout the years with minimum cost. Dairy animals being fed on protein rich weeds tend to gain weight more rapidly and that too with no additional cost.

8. Limitations and implications

The studies regarding nutritional quality, presence of anti-nutritional or toxic substances and palatability of most of the native weed species is lacking. However, one of the most important limitations in utilizing tropical weeds for dairy animals is the presence of anti-nutritional factors such as tannins which are harmful and toxic to ruminants [13, 38, 51]. Animals being fed on weeds having high concentration of tannins witnessed digestibility depression. Weeds having exceptionally higher lignin content caused a sharp decline in feed intake leading to serious malnutrition in dairy animals. Similarly, significantly less palatability of weeds reduce their intake, which led to animal's weight loss along with sharp decline in milk production [52–54].

Moreover, some of the weeds species have thorns and spines due to which animal gets its mouths injured along with irritating of eyes which leads to pinkeye. In addition, there could be some weeds which can impart unpleasant odor and taste to milk and meat. Lastly, although weeds offer cost-free source of animal feed but centuries-long war against weeds has made it difficult to change the mind of ranchers and dairy farmers to utilize this precious source of plant protein which needs to be changed.

9. Conclusions

The exceptional resistance to drought, higher biomass production under unfavorable pedo-climatic conditions, rapid regeneration capacity, and acceptable nutritional quality at all phonological stages suggests that there are opportunities to utilize weeds as forage for all types of ruminants. Weeds availability throughout the year warrants their potential to fulfill essential dietary needs of animals and favors their inclusion as supplementary forage especially during extreme weather conditions. However, controlled field investigations for determining the appropriate growth timings, nutritional quality, anti-nutritional factors and biomass production potential of different native weeds must be done in rangelands while maintaining a balanced and healthy rangeland ecosystem.

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