

Package and practices of temperate fodder crops in Jammu and Kashmir valley of the north-western Himalayas

Dilip Kumar Verma¹, Suheel Ahmad², Kanhaiya Lal Meena³ and Gopal Lal Meena⁴

Indian Grassland and Fodder Research Institute, Regional Research Station
Srinagar (Jammu and Kashmir) 190 005

Jammu and Kashmir is ideally suited for sheep and goat rearing owing to its agro-climatic conditions and rich alpine pastures. The Gujjars and Bakerwals adopted the sheep and goat rearing as their primary occupation from times immemorial and prefer to migrate in search of pastures to feed their livestock. It played an important role in the economic and ecosystem stability, food and household security contribute in employment generation. Although, it occupied only 52% of State arable land with predominance of 74% rainfed but contributed 70.7% to its total food production.

Key words: Crops, Fodder, North-Western Himalayas, Package and Practices



Fig. 1. Approach map leading to IGfRI, RRS Srinagar, J&K



Fig. 2. Makhan-malai grass rooted slips

THE north-western Himalayas region was characterized under the agro-climatic Zone-I which includes low altitude sub-tropical zonal districts viz., Jammu, Kathua and Riasi; mid-to high-altitude intermediate zonal districts viz., Doda, Rajouri and Poonch; mid-to high-altitude temperate zonal districts viz., Anantnag, Baramulla, Kupwara, Pulwama, Budgam and

Srinagar; cold arid zonal districts viz., Leh and Kargil with high relative humidity and wide variation in temperature and soil structure. The meteorological data showed that lowest in temperature was observed in January, whereas highest during August. The lowest rainfall was observed in November, whereas highest was in March. Thus the conducive crop growing period

commences from April to October. This Regional Research Station of IGfRI, Srinagar, Jammu and Kashmir, was continuously engaged as frontier window for research and technology dissemination activities of Indian Council of Agricultural Research, New Delhi to the farmers of the north-western Himalayas (Figs. 1-2).

Fodder yields of maize, oat, tall

Table 1. Fodder yield of different temperate fodder crops at IGFR RRS Srinagar, J&K between 2013-2014, 2014-2015 and 2015-2016

Fodder crops	Cultivars/ Accessions No.	Fresh fodder yield (q/ha)
<i>Traditional fodder crops</i>		
Maize (<i>Zea mays</i> L)**	Local maize	45-55 1 cutting/year
Oat (<i>Avena sativa</i> L)*	JHO-2000-4, JHO-851, Sabzar, JHO-99-2, SKO-20, JHO-822, SK-90 and SKO-167	35-451 cutting/year
<i>Temperate fodder grasses</i>		
Tall fescue (<i>Festuca arundinaceo</i>)	IGFRIRS- <i>Festuca</i> -10 (IC-0615888) IGFRIRS- <i>Festuca</i> -15 (IC-0615893) IGFRIRS- <i>Festuca</i> -16 (IC-0615894)	30-50 2 to 3 cuttings/year
Orchard grass (<i>Dactylis glomerata</i>)	IGFRIRS- <i>Dactylis</i> -11 (IC-0615914) IGFRIRS- <i>Dactylis</i> -05 (IC-0615908) IGFRIRS- <i>Dactylis</i> -09 (IC-0615912)	40-45 2 to 3 cuttings/year
Harding grass (<i>Phalaris aquatica</i>)	IGFRIRS- <i>Phalaris</i> -11 IGFRIRS- <i>Phalaris</i> -01 IGFRIRS- <i>Phalaris</i> -05	40-45 2 to 3 cuttings/year
Prairie grass (<i>Bromus unioloides</i>)	IGFRIRS- <i>Bromus</i> -05 (IC-0615934) IGFRIRS- <i>Bromus</i> -01 (IC-0615930) IGFRIRS- <i>Bromus</i> -11 (IC-0615940)	45-50 2 to 3 cuttings/year
Timothy (<i>Phleum pratense</i>)	IGFRIRS- <i>Phleum</i> -21 (IC-0615759) IGFRIRS- <i>Phleum</i> -11 (IC-0615749) IGFRIRS- <i>Phleum</i> -01 (IC-0615738)	50-55 3 to 4 cuttings/year
Makhan-malai grass (<i>Lolium perenne</i>)	IGFRIRS- <i>Lolium</i> -37 (IC-0615871) IGFRIRS- <i>Lolium</i> -21 (IC-0615855) IGFRIRS- <i>Lolium</i> -11 (IC-0615845)	48-50 3 to 4 cuttings/year
<i>Temperate fodder legumes</i>		
White clover (<i>Trifolium repens</i>)	IGFRIRS- <i>Tr</i> -23 (IC-0615818) IGFRIRS- <i>Tr</i> -09 (IC-0615804) IGFRIRS- <i>Tr</i> -14 (IC-0615809)	30-35 2 to 3 cuttings/year
Red clover (<i>Trifolium pratense</i>)	IGFRIRS- <i>Tp</i> -13 (IC-0615781) IGFRIRS- <i>Tp</i> -23 (IC-0615791) IGFRIRS- <i>Tp</i> -27 (IC-0615795)	40-60 3 to 4 cuttings/year
Sainfoin (<i>Onobrychis viciifolia</i>)	IGFRIRS- <i>Onobrychis</i> -13 (IC-0615781) IGFRIRS- <i>Onobrychis</i> -16 (IC-0615832) IGFRIRS- <i>Onobrychis</i> -17 (IC-0615795)	60-65 1 to 2 cuttings/year

*Intra-varietal trials of oat was being conducted during at IGFR, RRS Srinagar, Jammu and Kashmir

**In addition to fodder a cash crop harvest of baby corn was ascertained after 45-50 days of seeding as exploratory trial.

fescue, orchard grass, harding grass, prairie grass, timothy, *makhan-malai* grass, white clover, red clover and sainfoin (Table 1) were severely affected by abiotic and biotic stresses different than other agro-climatic regions. The stresses prevalent in western Himalayan hills were inherently low fertile soils and sloppy land, aluminium (Al) toxicity, phosphorous (P) deficiency, erratic snowfall as well as rainfall, sudden fluctuations in day and night temperature, varying population density and prevalence of diseases and insect pests, hence fodder varieties from other agro-climate rarely succeed in the north-western Himalayas.

Tall fescue

Tall fescue (*Festuca arundinacea*) is

green, lush, and growing well on a sloped hillside during drought. It dominates grasslands. It is vigorous, widely adaptable, able to withstand poor soil conditions, resistant to pests and drought. It is used primarily in pastures and low maintenance situations. Fescues are perennial grass adapted to an altitude above 1,500 m and is suitable for grazing and hay. It has dark green leaves, medium thick round stem, deep fibrous root system, long open panicle and bold seed. Plant height is 1.5 to 2 m. It is resistant to lodging, cold and frost. It is very nutritive and palatable grass containing 12 to 14% crude protein on dry matter basis.

Varieties: IGFRIRS-*Festuca*-14 (IC-0615892), IGFRIRS-*Festuca*-10 (IC-0615888), IGFRIRS-*Festuca*-15

(IC-0615893), IGFRIRS-*Festuca*-16 (IC-0615894) and common fescue (non-descript) grass should be grown.

Sowing time: March-April, after melting of snow. Rooted slips can be transplanted during monsoon in rows 40 cm apart.

Seed rate: The seed rate is between 12 and 16 kg/ha, or about 1,00,000 rooted slips/ha are required.

Manuring: Basal dose of 40 kg/ha N and 40 kg P₂O₅ was followed by top dressing of 20 kg N/ha.

Other practices: Usually not irrigated. One to two irrigations may be given in summer, if available.

Orchard grass/Cocks foot/ Canary grass

The orchard grass (*Dactylis glomerata*) is also known as cocksfoot. This is tussock-forming perennial, erect, 50 to 150 cm with strongly flattened vegetative shoots. Grayish-green to green foliage, leaves usually flat. It is a strongly tufted, deep-rooted, long-lived perennial. Culms are erect and glabrous. Leaf blades are broad. Leaf sheaths very much flattened, hairless, prominent keel. It is a soft, palatable deep rooted and long-lived perennial suitable for temperate alpine areas.

Varieties: IGFRIRS-*Dactylis*-11 (IC-0615914), IGFRIRS-*Dactylis*-05 (IC-0615908), IGFRIRS-*Dactylis*-09 (IC-0615912) and common orchard grass should be grown.

Sowing time: It is March-April or September-October, when propagated from rooted slips, the best time is early monsoon period.

Seed rate: The 9-11 kg/ha or about 1,00,000/ha rooted slips are required.

Manuring : Basal dose of 40 kg N and 40 kg/ha P₂O₅ followed by top dressing of 20 kg N/ha.

Other practices: The 2-3 irrigations should be given.

Harding grass/ Australian Phalaris/ Bulbous canary grass/ Toowoomba canary grass

Phalaris is also known as white crested, referring to the appearance of the seed head. It is palatable to animals, high nutrient hay or silage. It should preferably be cut before reaching the heading stage. It is a perennial grass. The production of

dormant buds and the deep root systems provides its summer survival. Dormant buds formed at the internodes are the bases of reproductive tillers. The buds remain dormant over the summer, becoming active in favourable conditions to form new tillers. Its duration is perennial which means it will grow year after year.

Varieties: IGFRIRS-*Phalaris*-29, IGFRIRS-*Phalaris*-11, IGFRIRS-*Phalaris*-01, and IGFRIRS-*Phalaris*-05 are common varieties.

Harding grass (non-descript) should be grown.

Sowing time: It is March-April, after melting of snow. Rooted-slips can be transplanted in monsoon in rows 40 cm apart.

Seed rate: About 1,00,000/ha rooted slips are required.

Manuring: Basal dose of 40 kg/ha N and 40 kg/ha P_2O_5 was followed by top dressing of 20 kg N/ha.

Other practices: Usually not irrigated. One to two irrigations may be given in summer, if available.

Prairie grass

Prairie grass/ Rescue grass/Preibe's prairie grass (*Bromus unioloides*) is a pasture species because it is a highly palatable feed and has the ability to grow in cooler times of the year. It is soft, palatable deep rooted and long-lived perennial suitable for temperate alpine areas. It is an invasive annual, are better adapted to low rainfall, high summer temperatures, and severe winters. It performs well on fertile soils under favourable growing conditions. It will not persist under dry conditions. It has winter annual life-cycle that differs from that of the perennial native grasses. Seeds germinate in early winter so that established plants grow rapidly in early spring when moisture is most available. It is a soft, palatable deep rooted and long-lived perennial suitable for temperate alpine areas.

Varieties: IGFRIRS-*Bromus*-27 (IC-0615956), IGFRIRS-*Bromus*-05 (IC-0615934), IGFRIRS-*Bromus*-01 (IC-0615930), IGFRIRS-*Bromus*-11 (IC-0615940) and common prairie grass should be grown.

Sowing time: It is March-April or September-October, when

propagated from rooted slips, the best time is early monsoon.

Seed rate: The seed rate 9-10 kg/ha or about 1,00,000 rooted slips/ha are required.

Manuring : Basal dose of 40 kg N and 40 kg P_2O_5 followed by top dressing of 20 kg N/ha.

Other practices: The 2-3 irrigations should be given.

Timothy/Meadow cat's-tail

The timothy is also known as meadow cat tail grass. It is a major source of hay and cattle fodder. Because of its value as a pasture species it was introduced into the temperate parts. It prefers higher rain fall, and is commonly used for pastures and hay production. This grass is palatable at all stages of growth for cooler and higher altitudes. It is suitable for hay as well as for grazing.

Variety: IGFRIRS-*Phleum*-23 (IC-0615761), IGFRIRS-*Phleum*-21 (IC-0615759), IGFRIRS-*Phleum*-11 (IC-0615749), and IGFRIRS-*Phleum*-01 (IC-0615738).

Sowing time: It is March-April or September-October, rooted slips can be transferred during monsoon rows 40 cm apart.

Seed rate: The seed rate 8-12 kg/ha or rooted slips about 1,00,000 rooted-slips/ha are required.

Manuring: Basal dose of 40 kg N and 40 kg P_2O_5 followed by top dressing of 20 kg N/ha.

Other practices: If irrigation facilities are available, 2-3 irrigations may be given as and when needed.

Makhan-malai grass

Makhan-malai grass/Perennial ryegrass/English rye grass/Crested rye grass (*Lolium perenne*) or perennial ryegrass is a valuable pasture grasses for temperate regions. It is an important turf and forage crop. It is highly digestible and tolerates high grazing pressures. It has traits for turf usage viz., quick seedling development, high traffic tolerance and minimal maintenance requirement. Tussock-forming perennial up to 60 cm in height with a fibrous root system, dark-green foliage, leaf blades are hairless, flat, upper surface evenly ribbed, lower

surface smooth and shiny. It is compatible with most pasture legumes and with other temperate perennial grasses. It is also used as an indicator of non-species rich grassland. Highly nutritious and palatable perennial grass with good management can be very productive in suitable environments, excellent seedling vigour, high temperatures constrain summer growth, low drought tolerance, so best suited to fertile soils (>600 mm), requires rotational grazing for persistence, high yields and to maintain nutritional quality.

Varieties: IGFRIRS-*Lolium*-38 (IC-0615872), IGFRIRS-*Lolium*-37 (IC-0615871), IGFRIRS-*Lolium*-21 (IC-0615855), IGFRIRS-*Lolium*-11 (IC-0615845) and common *makhan-malai* grass should be grown.

Sowing time: It is March-April or September-October, when propagated from rooted slips, the best time is early monsoon period.

Seed rate: The seed rate 8-9 kg/ha or about 90,000 root-slips/ha are required.

Manuring : Basal dose of 40 kg N and 40 kg P_2O_5 followed by top dressing of 20 kg N/ha.

Other practices: The 2-3 irrigations should be given.

White clover

White clover/ Ladino clover (*Trifolium repens*) is commonly sown in the low-to-medium rainfall region. It is the most widely used perennial legume species in grazing systems across low to medium rainfall (500-750 mm) region. It is at its natural limit of climatic adaptation, performing best in areas receiving more than 700 mm mean annual rainfall. It needs plenty of water. Some cultivars are tougher than others. It is gathered during the full moon night by young girls in search of a token of perfect happiness. It is most important pasture legume in many parts of the temperate zones. Best adapted to well-drained silt loam and clay soils of pH 6 to 7. Prostrate growth habit develops stolons or runners from buds on the primary stem. Plants spread by these stolons, which develop roots at the nodes. Presently a bloat hazard when it

represents a high percentage of the pasture. The danger can be minimized by maintaining proper mixture with grass. It is of two types., viz., giant type: giant in height and leaf size. Ladino is a giant type of white clover. It is one of the three-leafleted clover species that occasionally produces a leaf with four (or more) leaflets, i.e., a 'four-leafed clover'. It is an excellent pasture for cooler regions mainly used for grazing purpose and is known to be the best nitrogen-fixing legume. On an average, it yields 400 q/ha green fodder/ha.

Varieties : IGFRIRS-*Tr*-23 (IC-0615818), IGFRIRS-*Tr*-09 (IC-0615804), IGFRIRS-*Tr*-14 (IC-0615809), Palampur composite and Ladino are common varieties.

Sowing time : It is April-May, after melting snow.

Seed rate : The seed rate is 3-5 kg/ha.

Other practices: The 2-4 irrigations in summer, if available. First cutting is ready in about 90 days. In subsequent years, 3-4 cuttings can be obtained.

Red clover

Red clover (*Trifolium pratense*) is used as forage, are the most widely used perennial legume species in grazing systems across low-to-medium rainfall (500-750 mm) region. In this environment all of these species have adaptational deficiencies limiting their persistence. It has a low tolerance to moisture stress and will not survive long, dry summers.

Short-lived perennial best suited for hay, silage or pasture. Stand life limited to 2 or 3 years, best suited for short crop rotations and pastures. Fertile, well-drained soils of high moisture-holding capacity are best for red clover. Loams, silt loams, and even fairly heavy-textured soils are preferred to light sandy or gravelly soils. Easiest legume to establish in closely grazed, thus ideally suited for pasture renovation. Rotational rather than continuous grazing will result in longer life of the stand. Very palatable to all classes of livestock. It is used as a fodder crop rather than for permanent pasture. Needs careful

grazing management to avoid plant death prefers well drained, fertile soils. It is an excellent pasture for cooler regions mainly used for grazing purpose and is known to be the best nitrogen-fixing legume.

Varieties: IGFRIRS-*Tp*-13 (IC-0615781), IGFRIRS-*Tp*-23 (IC-0615791), IGFRIRS-*Tp*-27 (IC-0615795) and composite.

Sowing time: It is April-May, after melting snow.

Seed rate: The seed rate is 3-4.5 kg/ha.

Other practices: The 2-4 irrigations in summer, if available. First cutting is ready in 90 days. In subsequent years, 3-4 cuttings can be obtained.

Sainfoin or holy hay

The *Onobrychis vicifolia* known as sainfoin or hely hay, tolerates drought, cold and low nutrient status. It was being grown to maintain soil fertility. Farmers consider it as the 'best cog in the farming wheel' for sustainable farming, improving soil fertility of poor soils.

Varieties: IGFRIRS-*Onobrychis*-17 (IC-0615795), IGFRIRS-*Onobrychis*-13 (IC-0615781), IGFRIRS-*Onobrychis*-16 (IC-0615832) and composite.

Sowing time : April-May, after melting snow.

Seed rate : The seed rate is 11-12 kg/ha.

Other practices: The 2-4 irrigations in summer, if available. First cutting is ready in 90 days. In subsequent years, 3-4 cuttings can be obtained.

Agronomic management of micro-nutrients

Modern crop production technology and the spiralling frequency with which micronutrients are involved in fertility problems emphasize the necessity for a

dynamic management of micro-nutrients in fodder crop production. Multiple cropping with high-yielding varieties and intensive cropping in space and time dimension without proper nutrient replenishment had led to the deficiency of micronutrient. Obviously, they have now become one of the major constraints in getting higher fodder yield. An array of agronomic management practices may be followed to safeguard the soil and plant health to overcome micro-nutrient disorders.

Sowing time

The best cultural micronutrient management practice is by adjusting the sowing time of crops. Some of the micronutrient availability/deficiency are weather related.

Zinc deficiency is commonly noticed during cool wet part of the year. Still, low night temperature of 15°C encourages the deficiency. Similarly iron deficiency is common in cool rainy weather. Whereas boron (B) is deficient during dry and warm period.

Crops that are sensitive to these elements can be sown in such a way that the sowing season should not coincide in these conditions when the crop's requirement of these elements is high. This is a 'no cost technology' to fight against micronutrient disorders.

Soil breeding

It refers to mixing of two kinds of soils to exchange their inherent properties, i.e. addition of coarse textured soil with fine textures soil and *vice versa* to modify the bulk density and other physical properties of the soils. Boron (B), Manganese (Mn) and Copper (Cu) are such of these micronutrients which tend to be deficient in coarse textured sandy

Table 2. Micronutrient content of organic manures (ppm)

Particulars	Cu	Mn	Zn	Fe	B	Mo
Farmyard manure	10	200	43-247	NA	17.4	0.13
Compost	300-600	12.4	9	NA	5.8	0.1
Vermicompost	5.83	11	12.65	21.6	NA	NA
Poultry manure	60.5	75	13	300.8	NA	NA
Biogas slurry	47.4	55.3	8.7	NA	180.2	NA
Press mud-cake	120	288	230	560	NA	NA

NA: Not available

Table 3. Micronutrient content of certain fertilizers (ppm)

Fertilizers	Cu	Mn	Zn	B	Mo
Ammonium sulphate	0.5	70	0.33	6	0.1
Triple superphosphate	2-12	170-245	53-100	529	0.2
Potassium sulphate	5.6-10.4	2.2-13	2	4	0.2
Calcium ammonium nitrate	18	12.5	8.55	-	-
Rock phosphate	5.6-9.5	130-320	24-137	19	5.6

soils and they can be managed to certain extent by the addition of fine textured clay soils.

Fertilization with organic manures

Application of cowdung, sheep manure etc. are age old manorial practices of Indian farming. It has slowly become 'obsolete with the use of inorganic fertilizers' (Table 2). Organic manures are potent multi-nutrient fertilizers that upon application improve micronutrient status, beneficial microorganisms and physical properties of the soils also.

Organic manures are cost effective. Their latent energy, if unleashed can bring about revolutionary transformation in the modern agriculture. A significantly higher availability of micronutrient except copper was noticed when vermicompost applied along with chemical fertilizers compared to only chemical fertilizers. Vermicompost acts as a good media for growth and development micronutrients in soils and make them available for plant uptake.

Green manuring and recycling of crop residues

Raising of green manure crops like *dhaincha* and *in situ* incorporation may help to enrich soil micronutrient status. The green manure upon decomposition release macro-nutrients, micronutrients, and growth stimulating substances. Similarly recycled crop residues will enrich soil micronutrient content.

Use of organic and inorganic amendments

The so called problem soils viz., acid soil, alkali soil, saline soil, sodic soil prevents the availability of different micronutrients. Zinc (Zn) deficiency is favoured by calcareousness. Boron deficiency can be noticed in alkaline, humid and over limed soil. Manganese deficiency occurs in acid soils. Iron (Fe) becomes a limiting nutrient in calcareous /over limed soil. Besides, soil related constraints like poor aeration, water-logging also render micronutrient availability. Proper organic or inorganic amendments should be utilized to improve the micronutrient availability of that soil. Acid soils could be amended using lime and saline soils using gypsum. Application of sugarcane press mud is found to tackle problem soils effectively. Press mud-cake can be used as soil conditioner and ameliorant in reclamation acidic and alkaline soils.

Choice of fertilizers

Selection of correct fertilizers assumes paramount importance in fulfilling the nutrient requirement of crops. There is a general belief that continuous use of high analysis fertilizers have led to micronutrient depletion from the soil. Select fertilizer which has variety of nutrients i.e. multinutrient fertilizer (Table 3).

Application of micronutrient mixture

Each crop has certain specific micronutrient requirement (Table 4)

and hence, a common recommendations may not solve the problem fully. So micronutrient mixtures for different crops were prepared. Farmers can be educated to take up micronutrient mixture in addition to the regular NPK fertilization programme. It should be particularly emphasized in micronutrient deficient tracts.

Crop rotation

Monoculture is a curse as it depletes some nutrients for which the crop has high requirement. It leads to serve micronutrient deficiency. To get rid of these problems, crop rotation can be followed with crops having differential micronutrient requirements and the soil may become sustainable.

Foliar feeding of micronutrients

Care should be taken to diagnose the correct nutrients elements deficient and concentration to be used for nullifying the symptoms. This will be the final solution to micronutrient deficiency, if notice in the crop.

SUMMARY

Green forages when dried to about 80-85% dry matter, containing most of its nutrients including cardene, is called hay. The moisture concentration in hay must be less than 15% at storage time. However, crops with thin stems and many leaves are better suited for hay making as they dry faster than those having thick and pithy stems and small leaves. Natural grasses oats, lucerne, are highly suitable for hay making which is used for lean period.

¹Principal Scientist (Genetics and Breeding), Indian Agricultural Research Institute Regional Research Station, Indore (Madhya Pradesh) 452 001, ²Scientist, IGRI Regional Research Station, Old Air Field KD Farm Central Institute of Tropical Horticulture Campus, Rangreth, Srinagar (J & K) 190 007, ³Scientist, IGRI Western Regional Station, Avikanagar, Malpura, Tonk (Rajasthan) 304 501, ⁴Scientist, Indian Grassland and Fodder Research Institute, Gwalior Road, Jhansi (Uttar Pradesh) 284 003. Corresponding authors' e mail: mailmedilipverma@rediffmail.com

Table 4. Micronutrient content of certain fertilizers

Particulars	Nutrient content (percentage by weight)					
	Fe	Mn	Zn	Cu	Mo	V
India	2	2	5	0	0	0.5
Mixture	3.8	2.99	3.15	3.152	0.07	1.25