Dual-Purpose Wheat

Nutritious Fodder for Livestock, Grain for Humans and Additional Income for Farmers

ICAR- Indian Institute of Wheat and Barley Research (ICAR-IIWBR) International Maize and Wheat Improvement Center (CIMMYT)
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Contents

1. Introduction
2. What is dual-purpose wheat?
3. Importance
4. Package of Practices for dual-purpose wheat
   a. Selection of appropriate variety
   b. Time of sowing
   c. Seed Rate and Spacing
   d. Fertilizer application
   e. Irrigation practices
   f. Time of Green Fodder Harvest
   g. Crop management after green fodder cut
   h. Weed management in dual-purpose wheat
   i. Inter or mixed cropping to improve the fodder production
5. Future research needs
   a. Developing suitable varieties
   b. Fine-tuning the nitrogen and irrigation scheduling
   c. Fine-tuning the weed management practices
   d. Diversifying the use of green wheatgrass
   e. Identifying the suitable intercrops for augmenting the fodder production
Introduction

The availability and procurement of green fodder for livestock in India is generally a challenge, especially during December and January. Within India’s northern hilly states of Jammu & Kashmir, Himachal Pradesh and Uttarakhand, a typical farming household has one or two buffaloes and/or cows and a pair of bullocks to cultivate cereals and/or vegetables on small/narrow terraces. Livestock makes a significant contribution to the livelihood of such farm families but securing sufficient fodder for animals is a significant limiting factor. Likewise, in the plains of India, the availability of green fodder during winter months, especially during December-January is limited. As a result of this unmet need, farmers use part of their land to grow green fodder during Rabi season, which leads to a reduction of land under wheat and other crops. A simple technique of using cereal crops like wheat and barley as dual-purpose has recently been evaluated and it has shown promising results: it can provide nutritious green fodder during December-January, at the critical time it is most needed, with little detrimental impact on the eventual grain and straw yields. This new approach can deliver a welcome boost to ensure the production of food grain for people as well as fodder for livestock. Notably, not all varieties perform well as dual-purpose, as recent studies have shown, and therefore identification of appropriate varieties is necessary. Besides, there is also a need to standardize the management protocol including the time of cutting for the dual-purpose wheat.

What is dual-purpose wheat?

The dual-purpose wheat is a crop utilized both for green fodder as well as grain production. During the initial vegetative crop growth period, the crop biomass is harvested for green fodder (Figure 1). Subsequently, it regenerates and continues to grow to provide a reasonable grain yield almost similar to a normal crop. Traditionally, dry wheat straw obtained after harvesting the crop has been in use as cattle feed for a long time, but the use of wheat as a green fodder is not very well known in many countries, including those in South Asia. Despite being a subject of research for a while now, the major focus of the studies has been in the hill region, which has a longer-than-usual winter and wheat-growing period. In plains where the wheat-growing window is only about 150 days, holistic research efforts for dual-purpose wheat—including the identification of suitable genotypes/varieties, its cutting protocols as well as agronomic management—are required to address the issue of the availability of quality green fodder from limited land resources in order to improve farmers’ incomes and livelihoods.
Livestock and green fodder scenario

As per the 19th Livestock Census (2012), the Livestock sector alone contributes nearly 25.6% of the entire value of the output in Agriculture, Fishing and Forestry sectors. The total contribution of the Livestock sector in India’s GDP is nearly 4.11%. The country’s livestock population consisting of cattle, buffalo, sheep, goat, pig, horses and ponies, mules, donkeys, camels, mithun and yak is 512.05 million. Of these, 299.9 million animals are cattle, buffalo, mithun and yak. To sustain this livestock population, about 582 million ton of dry matter is required annually. Generally, green fodder contribution in the ruminant’s ratio varies between 25–40%, depending upon availability. However, it is routinely observed that there is a shortage of green fodder during December-January in the Indo-Gangetic plains and elsewhere. To satisfy this unmet green fodder demand, farmers cultivate berseem on a part of the land. If wheat can successfully be made adaptable for dual-purpose, farmers would be able to utilize the same piece of land for both grain production as well as fodder during the December-January period when the demand for green fodder is high.

Wheat, as a forage (dual-purpose) crop, is useful in many ways. It provides improved nutrition along with income opportunities since wheat green fodder contains about 15–20% crude protein on a dry weight basis. Moreover, animal feeding trials have shown that wheat fodder ranks highly in terms of digestibility, nutritive value and intake point of view. In countries such as the USA, the consumption of dual-purpose wheat is also considered as being capable of providing value to calves between weaning and feedlot entry. Therefore, contract grazing is used as a possible mechanism to add value to a wheat crop.

Package of Practices for dual-purpose wheat

In order to grow dual-purpose wheat, there is a need to identify appropriate cultivars as well as a package of practices concerning the time of sowing, time of fodder-cutting and nitrogen and irrigation scheduling for the crop’s optimum growth as fodder as well as grain. Indeed, all practices are critical for the successful cultivation of dual-purpose wheat, but the time of crop-cutting stage is generally considered the most crucial.

Cultivar choices

All genotypes are not expected to perform well under dual-purpose, since the suitable variety should have the capability of early bulking as well as good regeneration after crop-cut. In current varieties, although the grain yield reduces by 10 to 20 per cent (Figure 2), it is still more profitable because of the high price which green fodder fetches during December-January. It has been observed that there are variations among varieties when grown for dual-purpose. Some of the genotypes like 32nd SAWSN75, which produce high biomass, tend to lodge under uncut conditions leading to lower yield when compared to dual-purpose variety with crop cut at 50–55 days after seeding. For this particular genotype, the green fodder production of about 12 t/ha has been recorded along with the grain.

Figure 2. Performance of wheat genotypes for dual-purpose
yield gain of about 3–5 per cent (Figure 2). Other genotypes which produced about 9–10 t/ha and did not lodge, experienced grain yield reduction from about 10 to more than 35 per cent. These results indicate that among the genotypes evaluated, the recently released high yielding varieties HD 2967 and DPW 621-50, as well as the older variety PBW 343, gave about 9 t/ha green fodder with grain yield reduction of only 10–20%. Therefore, the selection of an appropriate variety is significant for the successful cultivation of dual-purpose wheat.

**Time of sowing**

For dual-purpose wheat, early sowing is necessary to account for the time required for regeneration, faster crop growth and biomass development. Hence, sowing during the second fortnight of October may be more suitable for optimum green fodder as well as wheat grain production in north western India. This practice might even be more appropriate since the shortage of green fodder is generally observed during the months of December and January. If green fodder is made available from the beginning of December itself, farmers will greatly benefit from the improved production of milch animals.

**Seed Rate and Spacing**

The dual-purpose crop may be grown using a seed rate of at least 125 kg/ha at the row-to-row spacing of 17–20 cm which will help in early ground cover. This will lead to increased initial biomass production and green fodder yield. It will also help with the compensation of regeneration after green fodder harvest.

**Nutrient Management**

The fertilizer requirement for wheat crop in northwestern plains is 150 kg nitrogen, 60 kg phosphorus and 40 kg potash per hectare along with micronutrients, if the soil is deficient. Application of the fertilizer should be ½ nitrogen and full phosphorus and potash at the time of sowing, with the remaining ½ nitrogen to be used at Crown Root Initiation (CRI). The nitrogen must be top dressed just before irrigation. Since the crop is harvested as green fodder in dual-purpose wheat, an additional application of at least 25% nitrogen per hectare is required (Figure 3).

The initial studies in northwestern plains were conducted at the ICAR-Indian Institute of Wheat and Barley Research (IIWBR), Karnal and other institutions using the varieties released for dual-purpose for northern hills zone (VL 616 and VL 829) as well as the ruling variety (PBW 343) already being cultivated in northern plains. The results showed that the fodder yield was almost similar for all the three varieties but the grain yield was much higher for PBW 343 as compared to VL 616 and VL 829 under both cut as well as uncut condition (Figure 4). In the BMZ Phase-I, other promising genotypes such as HD 2967 and DPW621-50 for dual-purpose wheat were also identified.
Water management

The irrigation practices for the dual-purpose crop, in general, are almost similar to the normal wheat crop grown for grain production. The first irrigation must be applied at CRI around 20 days after seeding. However, the second and third irrigations must follow a careful schedule. Depending upon the climatic conditions and soil type, the second irrigation needs to be applied between 40–45 days after seeding so that the entry in the field is possible between 50–55 days after seeding for harvesting the crop for green fodder. The third irrigation is extremely significant—it needs to be applied between 5–7 days after crop cut, depending upon the soil type, for better crop regeneration. The subsequent irrigations are to be applied as per the standard practice for growing wheat.

Fodder cutting management

Time of Green Fodder Harvest

The time of green fodder harvest is critical for best production of green fodder as well as grain yield. In the northwestern plains, 50–55 days after seeding is considered to be the optimum time for crop cut; however, in northern hills, crop cut may be delayed by up to 75 days. It has been observed that harvesting before 50 days after seeding does not lead to a good harvest. On the other hand, delaying crop cut beyond 55 days leads to poor regeneration of the wheat crop. Location-specific fine-tuning may be required before a farmer adopts dual-purpose wheat. It is possible to harvest the green fodder manually, but it is time-consuming. Farmers may also use fodder harvesters (Figure 5) to save time and drudgery and increase efficiency.

Crop management after green fodder cut

Green fodder harvesting from the crop leads to a loss of green biomass which is responsible for photosynthesis. Hence, to restore the green crop surface, the first step is the recovery of the tillers and leaves of the plants. In the harvested green fodder mass, nearly 30–40 kg/ha nitrogen is harvested from the crop which needs to be replenished. To facilitate this, an additional

Figure 5. Mechanized harvesting of wheat for Green Fodder

Figure 6. Regeneration of Wheat after cutting (57 DAS) for Green Fodder
A dose of 25% nitrogen (37.5 kg N/ha) must be applied between 5–7 days after harvesting, along with irrigation. The nitrogen must be applied just before irrigation for increased nitrogen use efficiency.

**Weed management in dual-purpose wheat**

For weed control in dual-purpose wheat, pre-emergence pendimethalin @ 1250–1500 g/ha at 0–2 DAS is useful (Figure 6). The post-seeding herbicides which are recommended for the normal wheat crop at 35–40 DAS may be withheld as the fodder is to be cut for animal use; some of the herbicide may have residue in green fodder because of the smaller time interval between the herbicide application and fodder harvest and usage. The better option might be the application of the herbicides after about 10 days of the fodder cut depending on the weed flora infestation. Some of the herbicide combinations for diverse weed flora control are sulfosulfuron+metsulfuron 25+4 or its ready mixture 30+2 g/ha or application of clodinafop 60 g/ha or pinoxaden 50 g/ha or metsulfuron 4 g/ha. Also, the weeds, in particular the broadleaf weeds which have a poor regeneration capacity after crop-cut, will be generally suppressed in this system. Depending upon the regeneration capacity of weeds, a shift in weed flora may occur—accordingly, the herbicides may be applied.

**Inter or mixed cropping to improve the fodder production**

The study conducted in India (Modipuram) indicates that mixed cropping of berseem with wheat can improve the green fodder production as well as the economics of the total production system (Table 1). When the wheat crop was harvested for green fodder, about 40% improvement in net returns was observed as compared to the uncut sole wheat. A further improvement in returns of about 5% was noticed when berseem was used as a mixed crop with wheat. The inclusion of berseem as a mixed crop with wheat improved the fodder yield by 22.5%, which also leads to increased profit margins for the farmers.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Green Fodder yield (kg/ha)</th>
<th>Grain Yield (kg/ha)</th>
<th>Straw Yield (kg/ha)</th>
<th>Wheat Equivalent Yield</th>
<th>Total cost of production (USD/ha)</th>
<th>Gross returns (USD/ha)</th>
<th>Net returns (USD/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat + Berseem, With cut fb 2,4-D</td>
<td>15025</td>
<td>4539</td>
<td>6752</td>
<td>6465</td>
<td>1262</td>
<td>2005</td>
<td>743</td>
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<tr>
<td>Wheat + Berseem, With cut</td>
<td>15025</td>
<td>4528</td>
<td>6183</td>
<td>6454</td>
<td>1244</td>
<td>1973</td>
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<tr>
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<td>4819</td>
<td>7206</td>
<td>4819</td>
<td>1177</td>
<td>1593</td>
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<tr>
<td>Wheat + Berseem, Uncut</td>
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<td>4764</td>
<td>7583</td>
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<td>1160</td>
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<tr>
<td>Sole Wheat With cut</td>
<td>12267</td>
<td>4639</td>
<td>6250</td>
<td>6212</td>
<td>1199</td>
<td>1911</td>
<td>712</td>
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<tr>
<td>Sole Wheat (Control)</td>
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<td>4917</td>
<td>7275</td>
<td>4917</td>
<td>1115</td>
<td>1622</td>
<td>507</td>
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</table>
Future research needs

**Developing suitable varieties:** The present-day high yielding varieties provide 9–12 t/ha green fodder but the grain yield reduction is significant, varying from 10 to 20 per cent and at times even more. To facilitate the adoption of dual-purpose wheat at a large scale by farmers, there is a need to develop varieties which can give higher green fodder along with a smaller or no reduction in grain yield. Efforts have been made under the BMZ project to identify new genotypes for dual-purpose wheat (for example, HD 2967 and DPW621-50) which may serve as potential varieties in the future.

**Fine-tuning the nitrogen and irrigation scheduling:** There is a need for further studies on the role of nitrogen rate and nitrogen and irrigation scheduling interactions for an efficient dual-purpose wheat production system. These studies must take cognizance of varying soil types and agro-ecologies.

**Fine-tuning the weed management practices:** It is also important to standardize the weed management strategies for dual-purpose wheat production system.

**Diversifying the use of green wheatgrass:** In addition to green fodder for animal consumption, wheatgrass can also be utilized for human consumption in the form of wheatgrass juice which has been reported to have immense medicinal value.

**Identifying suitable intercrops for augmenting fodder production:** Systematic research is also required to identify suitable intercrops along with appropriate management practices. In addition to berseem, other compatible crops such as mustard could be tested.

- Development of low cost and women-friendly green fodder harvesting tools for the smallholder farmers is important. The tools should allow farmers to efficiently and precisely harvest the green fodder while reducing drudgery.
- Studies for integrating dual-purpose wheat in smallholder integrated farming systems for better crop-livestock interactions are required.