USDA-ARS

# Triticale for Dairy Forage Systems

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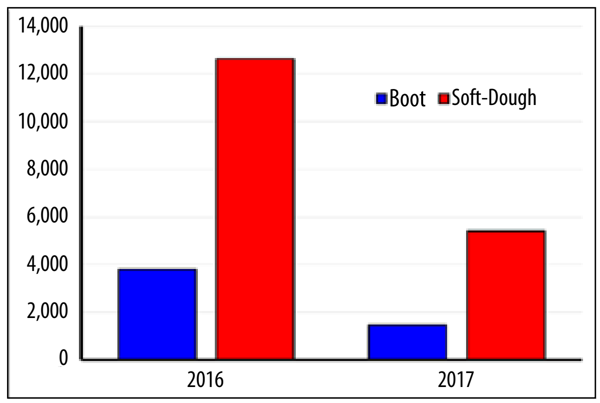
Triticale forages have become increasingly important components of dairy-cropping systems. In part, this trend has occurred in response to environmental pressures, specifically a desire to capture nitrogen and other nutrients from land-applied manure, and/or to improve stewardship of the land by providing winter ground cover. In most cropping systems, triticale functions as a winter-annual forage that includes fall establishment after the removal of corn silage or soybeans, followed by a harvest of silage the following spring or early summer. The most appropriate harvest timing for triticale forages can be heavily influenced by several factors. Historically, there are two often-recommended growth stages for the harvest of cereal-grain forages, which are the boot and soft-dough stages of growth. Typically, a soft-dough harvest often maximizes dry matter (DM) yield; however, triticale forages will not reach this stage of growth throughout central Wisconsin until about July 1, which effectively precludes a subsequent double-crop of corn or soybeans because of the short growing season. In contrast, a boot-stage harvest has inherent yield limitations, but occurs about Memorial Day, yields dairy-quality forage, and also permits a subsequent double-cropping strategy. Recent research conducted by USDA-ARS and University of Wisconsin scientists during 2016-2017 at the Marshfield Agricultural Research Station has evaluated the effects of growth stage on the yield, quality, and digestibility of triticale forages.

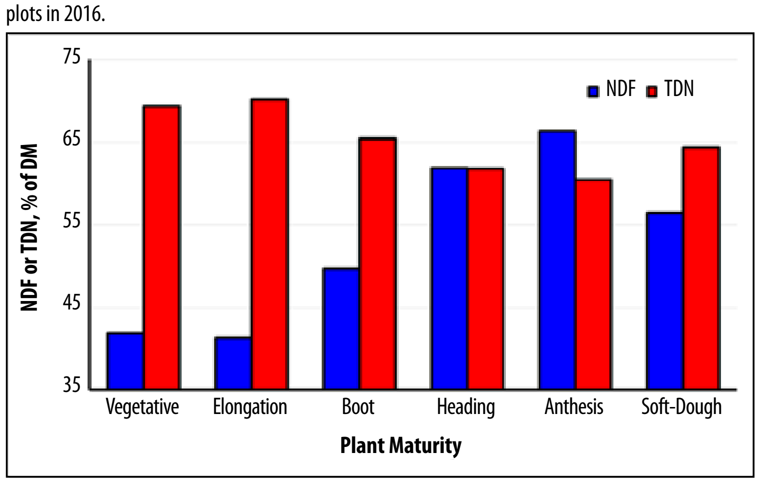
**DM Yield.** Unfortunately, the management decision to harvest triticale at boot stage includes a sharp yield penalty compared to a later harvest at the soft-dough stage of growth (Figure 1). Yields for the two growing seasons (2016 and 2017) differed sharply, primarily due to flooding that occurred during April, May, and June of 2017. Despite the flooding, the relationship between boot and soft-dough harvest management was similar across years; DM yields at boot stage were 30.1% and 26.9% of those at soft-dough for 2016 and 2017, respectively.

**Figure 1.** Yields of DM harvested at boot or the soft-dough stages of growth from replicated triticale plots.




**Fiber and Energy.** In 2016, structural plant fiber (expressed as Neutral Detergent Fiber (NDF)) for triticale forages increased with a typical maturation response through the anthesis (flowering) stage of growth (Figure 2). However, unlike many perennial forages, NDF declined sharply thereafter as plants partitioned nonstructural carbohydrate into the filling seed head. In 2016, this dilution effect resulted in a 9.8-percentage unit reduction in NDF between the anthesis (66.3%) and soft-dough (56.5%) stages of growth. Dilution via grain fill also affects energy density – expressed as Total Digestible Nutrients (TDN). At the vegetative and stem-elongation stages of growth, TDN concentrations ranged from 69-70%, which are comparable to corn silage, but then declined in an inverse relationship with NDF through anthesis (60.4%). The process of grain fill then improved TDN at soft-dough (64.4%), which was nearly equivalent to that observed at boot stage (65.4%). Emphasis needs to be placed on two key points: dilution of NDF concentrations by grain fill occurs for all cereal-grain forages; and this response varies with species, cultivar, growing conditions, etc. An example of this variability occurred the following year (2017); dilution by grain fill reduced NDF by only 1.6-percentage units (61.1% vs. 59.5%) between the anthesis and soft-dough stages of growth in forages harvested from similarly managed plots.

**Figure 2.** Concentrations of fiber (NDF) and energy (TDN) for triticale forages harvested from replicated plots in 2016.

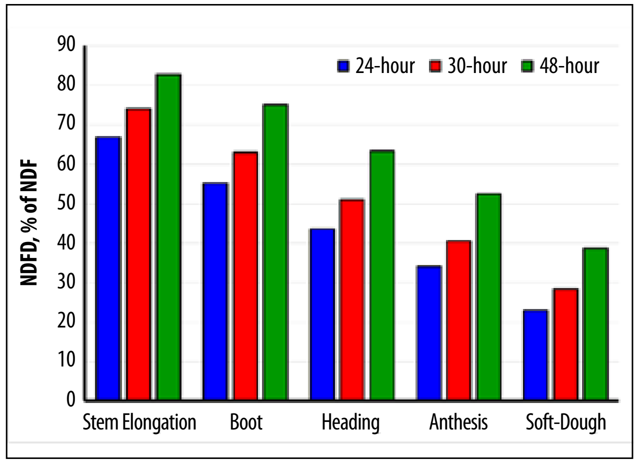


Another aspect of management to be considered is the livestock class targeted to consume these forages. Given the reduced yields associated with early harvests, it is unlikely a livestock producer would find it practical or cost-effective to harvest triticale while plants were vegetative (all leaf) or beginning stem elongation. As such, a boot-stage harvest is most suitable for lactating cows, and also likely will meet the energy requirements of pre-bred heifers; however, the energy density of triticale forages at anthesis is better suited for pregnant dairy heifers having lower daily energy requirements. It also should be noted that the crude protein concentration in triticale forages is affected by nitrogen fertilization rates and declines steadily throughout maturation; with a modest fertilization scheme, farmers can expect crude protein concentrations of 12-15% at boot stage, ~10% at anthesis, but only ~6% at the soft-dough stage of growth.

**Digestibility of NDF.** For most forage plants, a typical and well-understood observation is the digestibility of NDF declines with plant maturity and/or age. For triticale forages, 24-, 30-, and 48-hour in-vitro digestions of NDF (NDFD) in buffered rumen fluid illustrated a couple of important points (Figure 3):

- Concentrations of NDFD (% of NDF), regardless of incubation time, decline in a typical pattern with advancing plant maturity. For NDFD, this response is *not* affected by the physiological process of grain fill; however, grain fill *would* affect digestibility of DM in much the same way it affects estimates of energy density (TDN).
- While the energy content of triticale forages is improved by grain fill at the soft-dough stage of growth, NDFD concentrations at that same growth stage are poor. Nutritional benefits with respect to energy content and/or DM digestibility derived by delaying harvest to take advantage of grain fill are associated entirely with the grain component, and not with the leaf and stem structure supporting the seed head.
- Digestibility is influenced positively by residence time in the rumen. The 24- and 30-hour estimates of NDFD are meant to simulate the shorter ruminal residence times commonly observed in high-producing lactating cows. The 48-hour incubation is more appropriate for dairy-heifer or beef-cattle applications, in which voluntary intakes are lower. For these forages, NDFD increases with incubation time, regardless of the plant growth stage at harvest. In addition, the differences in NDFD across incubation times remained similar for all growth stages.

**Figure 3.** In-vitro digestibility of NDF (NDFD) after 24-, 30-, and 48-hour incubations for triticale forages harvested at five growth stages in 2016.




**Conclusions.** The nutritional characteristics of triticale forages are heavily influenced by two competing processes. These include the normal maturation effects reducing the quality of most forages juxtaposed against the physiological process of grain fill. Energy content and DM digestibility are improved by grain fill, but NDFD is not. Furthermore, a fairly severe yield reduction (~70-75%) can be expected by an early harvest at boot stage compared to soft-dough. While these considerations are largely predictable, an informed harvest-management decision for lactating cows may still favor an early harvest because of superior nutritional characteristics, a need to plant double-cropped corn expeditiously, or both.