

Drought Management Before, During, and After the Drought¹

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Farming is full of risks and experienced farmers know that they are gamblers. The purpose of this paper is to outline management strategies that producers can use:

- before a drought to reduce risk exposure to droughts,
- during a drought to minimize the damage caused by the drought, and
- after a drought to speed recovery from a drought.

For our purposes we are going to define drought as the percent of times that forage yield drops a given amount below the average (mean) forage yield on the farm. As most farmers will tell you there is no average year. As one farmer said: “to understand what an average is put one hand in a bucket of ice water and one hand in a bucket of hot water, on average the temperature is fine but it hurts like heck”.

Since farmers are gamblers it is important that they know how to measure their odds. If you play poker you know that there are four aces in the deck of cards. How do we know the odds of “drawing” a dry year. In pasture and hay research we measure forage yield over years at different locations and calculate the mean yield. Yields will be below average 50-percent of the time and above average 50-percent of the time. We can also calculate the standard deviation (SD) of the yield. The SD of a mean yield is a measure of the variation of the yield about the mean from year to year. The practical meaning of the SD is that about 33-percent of the yield observations lie between the mean and 1-SD below the mean and about 33-percent lie between the mean and 1-SD above the mean. For example when the mean hay yield is 3.0 tons/acre and the SD of yield is 0.85 tons/acre; about one year in three the hay yield will be between 2.15 and 3.0 tons/acre and about one year in three the hay yield will be between 3.0 and 3.85 tons/acre. The rest of the time hay yields will be above or below this 1-SD band. About one-sixth of the time yields are less than 2.15 tons/acre (1-SD below mean) and about one-sixth of the time yields are greater than 3.85 tons/acre (1-SD above the mean).

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The coefficient of variation (CV) is a way of expressing the SD as the ratio of the SD divided by the mean. This allows us to express the odds of achieving certain yield levels as a fraction (or percentage) of the mean.

For cool-season grasses and legumes growing in the Northeast as mean yield goes up the SD of the yield also goes up (Fig. 1, A). For example, 3 and 5 ton/acre yields have a SD of 0.85 and 1.30 ton/acre respectively. However, mean yield goes up faster than the SD so that the yield CV goes down (Fig. 1, B), the 3 and 5 ton/acre yields have CVs of 0.30 and 0.25 respectively.

Before the drought

Pre-drought planning will help reduce the risk exposure to drought and includes all or part of the following strategies:

- optimize the use of soils and forage species,
- determine the optimum stocking rate,
- develop a marketing plan that will make money when reducing stocking rate,
- develop a hay storage plan, and
- develop a relocation plan for the base herd to an area not affected by drought.

Optimize the use of soils and forage species

Knowing the soils on your farm, what forage species are most adapted to them, and how to manage those forages is similar to knowing the genetics of and how to manage your cattle. Some soils are deep, some soils are shallow. There is little value planting a deep rooted crop like alfalfa on a shallow soil. Likewise if a shallow rooted forage such as bluegrass is grown on a deep soil it will not take advantage of soil water in the lower horizons during a drought. In many parts of the county there are alluvial soils that are deep, well drained and sub irrigated if a deep rooted crops such as alfalfa, chicory, or switchgrass are grown on them. Other soils may be wet and be better adapted to grasses such as reed canarygrass, tall fescue or eastern gamagrass that will produce forage during a dry period on these soils. Soil characteristics that you need to know are; the depth of the soil to bedrock, hardpan, or seasonal water table which will limit the rooting depth of plants growing on the soil. Other factors that affect forage species adaptation to a soil include surface drainage and internal soil drainage within the rooting zone.

Combining several adapted forage species in a mixture in pastures reduces the year to year variability in pasture production (Tracy and Sanderson, 2004). Also, manage the forage stands in all years to maintain healthy, deep rooted plants that will be least affected by dry weather.

Determine the optimum stocking rate

Experienced grazers understand that stocking rate affects animal performance per head and per acre. At very low stocking rates gain per head is high since there is plenty of forage per animal and forage intake can be high. However, gain per acre will be low since there are few head of livestock per acre. As stocking rate is increased gain per acre will increase. However, at some point forage intake will decrease as the forage produced on the pasture is spread over more animals and there is competition for the best grazing. Gain per acre will continue to increase because adding more animals per acre at a high rate of gain has more impact on gain per acre than the slightly lower feed intake has on reducing gain per head.

However, as stocking rate continues to be increased gain per head goes down even more, gain per acre increased to a maximum, and then decreases as gain per head is greatly depressed as reduced forage mass limits forage intake per head and the forage stand becomes overgrazed. If this continues animal health will be impacted and the forage stand may be severely damaged.

This relationship was modeled for stocker cattle grazing on an orchardgrass forage system where excess spring growth was harvested from selected paddocks and sold as hay (Rayburn 2003). Seasonal gain of 700 pound medium frame steers was predicted using the 1984 NRC Nutrient Requirements of Beef Cattle and expected pasture intake based on stocking rate. Cattle were custom grazed at \$0.25/lb gain to eliminate the marketing risk of buying and selling cattle. Mean annual yield (4.8 tons/acre) was varied at random based on the yield SD (1.22 tons/acre) for each run of the model. The model was run 500 times; gain per head, gain per acre and net income to land, labor, and management were calculated for each run; then the mean and 15- and 85-percentile probability levels were calculated for each measure (Fig. 3 A and B).

Models are not perfect but do point out principles. Differences in forage production from year to year had little effect on gain per head and gain per acre at low stocking rates. As stocking rate increase above 1.5 head per acre in this scenario, the effect of differences in annual forage production started to be seen in greater variation in animal performance (spread between the 15- and 85-percentile lines). Mean net income was highest at 3 head/acre but the highest net income with least variation in income occurred at 2 head/acre. At 3 head/acre the average net income was about \$120/acre, ranging from \$80-\$160/acre. At 2 head/acre the average net income was about \$110, ranging from \$100-\$120/acre. The optimum economic stocking rate is partly a function of how much risk the producer is willing to take. If an income of over \$90/acre is required then stocking 3 head/acre results in years where income will fall below that needed while stocking at 2 head/acre results in less income on average but fewer years when income falls below \$90/acre.

This model does support an old Texan saying that stocking at 85% of the biological optimum will take care of drought 85% of time.

Develop a marketing plan that will make money when reducing stocking rate

Some droughts get so severe that selling cattle is the only practical means of reducing the stocking rate to put livestock forage demand in balance with forage supply. It is important to remember that the animals you are selling are your capital investment and need to generate a good income and not be sold at a loss. How you organize the sale of cattle will depend on if you are running a cow-calf operation, stocker cattle, finishing animals on pasture or some combination of the above animal classes. In any case to make money when marketing cattle to reduce the stocking rate you have to:

1. have good cattle that others want to buy and
2. sell the cattle at a time and location where the market is not depressed.

When you accomplish these two goals you can make money on the transaction. Also, mentally divide the herd into animals that will be sold in the early stages of a drought, those for sale when the drought is hard, and the base herd (for a cow-calf operation) that you do not want to sell.

Develop a hay storage plan

Grazing is the low cost option for feeding livestock, but in some areas making or buying hay is required for wintering cattle. When hay making is part of the normal management practice it is an option for drought management. Storing hay for drought requires a hay barn or hay stacked on deep gravel pads and covered with good tarps that will provide adequate protection from weather damage. Also, the hay needs to be rotated, that means feed the oldest hay first each year and hold over hay from this year for use next year if the yield was above average. Haying and hay storage are expensive options and during a drought hay is valuable and you may make more money by selling the hay than feeding it to your own animals.

Develop a relocation plan for the base herd to an area not affected by drought

An alternative to selling cattle is to lease pasture land in a part of the country not affected by the drought. This is a viable option since there are graziers who do not want to own cattle but do want to sell grass and management. It will often be less expensive to move cattle and rent pasture and management than to buy hay and truck it into a drought area. However, moving cattle to a different part of the country may mean moving them to a forage type that they have never experienced resulting in grazing behavioral problems and possible nutritional or other health issues. Before moving cattle to a different type of forage it will be of worthwhile reading Fred Provenza's work at the *Behave* web site on the topic of how animals learn what to graze and what not to graze: <http://www.behave.net/products/booklet.html>

During the drought

Pre-drought planning prepares us mentally as well as managerially for the drought while the drought will test our drought management plan. During the drought it is important to accomplish the following management tactics to minimize the droughts effect on profitability, animal health and pasture health:

- inventory forage supply,
- graze plants to target stubble height,
- rest pasture until target grazing height is achieved,
- don't open up the gates,
- improve grazing efficiency,
- wean calves early,
- reduce grazing of cow herd,
- feed hay or grain, and
- implement livestock marketing/relocation plans.

Inventory forage supply

When pastures are growing well it is easy to get lax and not keep a forage budget. However, when you are looking at the possibility of a drought it is important to keep a close eye on the forage supply. Now is the time to break out and dust off the old pasture plate; walk the paddocks weekly, keep a record of forage mass, and estimate the pasture growth rate. These two measures will enable you to see how the drought is progressing and when you will need to implement your planned drought management tactics.

Graze plants to target stubble height

At all times, before or during a drought it is important to graze pastures to the proper stubble height and allow plants to rest until they reach the proper grazing height in order to maintain plant health and pasture diversity. During the drought this is still important so that the health and diversity of the pasture is not adversely impacted by the drought. The rain will return and we want a healthy pasture that will take off growing rapidly when it does, to provide forage for our livestock.

Rest pasture until target grazing height is achieved

At all times, before or during a drought it is important to graze pastures to the proper stubble height and allow plants to rest until they reach the proper grazing height in order to maintain plant health and pasture diversity. During the drought this is still important so that the health and diversity of the pasture is not adversely impacted by the drought. The rain will return and we want a healthy pasture that will take off growing rapidly when it does, to provide forage for our livestock. Yes, I am repeating myself.

Don't open up the gates

One of the worst errors to make during a drought is to open up all the gates and let the livestock graze where ever and what ever they want to. During drought plants will be photosynthesizing, even if they are not growing, as long as they have live leaves to intercept the sunshine. Since the plant is not growing, because there is no moisture for growth, the carbohydrates produce by photosynthesis will increase in the plants leaves and storage organs. When the rain returns the plants will exhibit rapid (in a sense compensatory) growth because they have an above average carbohydrate status in the stubble or root reserves. Grazing the pastures into the ground prevents this. So don't open up the gates.

Improve grazing efficiency

At the early signs of drought it can pay to improve grazing efficiency by subdividing large paddocks to improve forage utilization and increase the rest interval. There may be forage available for grazing that would not normally be grazed such as pond dikes (fence off the water so the pond is not damaged), ditch and creek banks, aftermath hay that is too short to hay but rested adequately for grazing, crop residue from corn or small grains (ensure that there are no herbicide or insecticide restrictions on their use), or farm road sides that are normally mowed.

Wean calves early

For the cow-calf producer, early weaning of calves is an important drought management practice. Keeping calves on cows late in lactation, on a drought stressed pasture, does not help the calf and hurts the cows and the pasture. By weaning the calf early, the calf can be sold or put on hay and supplement to maintain a profitable rate of calf gain and then sold when ready to reduce the stocking rate on the farm. By drying off the cow, the cow has a lower energy requirement and can maintain body condition on less feed or lower quality feed.

Reduce grazing of cow herd

By drying off the cow the forage demand of the cow herd will be reduced. The grazing of the cow herd can also be restricted by limiting the time spent grazing, keeping them in an abuse area when not grazing. When restricting the feeding of cows during a drought it is important to monitor body condition and not let it drop to a level that will be costly to rebuild or costly in terms of reduced health or calf crop. When finishing animals on pasture, give them first choice on the best pasture and after moving them to a new paddock let the dry cows clean up after them.

Feed hay or grain

When the pasture and aftermath hay fields have been grazed to the target stubble height and none have grown to the target grazing height and we have kept the rule of *Don't open up the gates* we may have to feed hay or grain in an abuse area to maintain cow body condition or growth of young stock. Feeds such as homegrown hay or purchased hay and supplemental grain should be feed in a hay meadow or pasture that will benefit from the added nutrients provided by these feeds. Another option is to cross fence the pastures and start feeding the hay or grain on pasture, to extend the grazing and spread the nutrients over more acres. By feeding hay in August, when pastures are not growing due to a drought but are healthy and fixing carbohydrates, we set up a situation where there will be rapid pasture growth when fall rains return to moisten the soil.

Implement livestock marketing/relocation plans

The livestock marketing/relocation plans should have different set points for different drought intensities. The first stage of the marketing plan should be implemented in the early stages of the drought. Animals marketed in stage one are those that are sold in the normal course of business (calve, yearling etc.) and animals that can be sold without a negative impact on the herd (older cows). The second set of animals that assigned for sale are cows at the lower end of the herd based on age, performance, temperament, and conformation. This leaves the top end of the herd that might be relocated outside of the drought area instead of being sold. In most cases in the Northeast droughts do not get this severe. When selling the first two groups of cattle the quality of the herd remaining after a drought is greatly increased due to the strict culling enforced by the drought management.

After the drought

The sound of a soft soaking rain is one of the most beautiful sounds, especially after a drought. It also marks the time when we should get to work on repairing damage caused by the drought. When soil moisture marks the end of the drought we need to accomplish the following management to help get the operation back on course:

- rest pastures until the target grazing height is achieved
- graze pastures to target stubble height
- use N fertilizer to increase production
- reseed legumes and grasses as needed
- use annual forages during pasture renovation

Rest pastures until the target grazing height is achieved

Did I mention that, before or during a drought it is important to graze pastures to the proper stubble height and allow plants to rest until they reach the proper grazing height in order to maintain plant health and pasture diversity? After the drought this is still important. Since we did not open the gates, the plants' growth rate has jumped and those stored carbohydrates are being rushed to make new leaves. It is tempting to get the cattle back out on grass. However, to do so in the early stage of growth will really damage the plant by reducing leaf area after the carbohydrates have been used up to start leaf growth, resulting in slow plant growth after defoliation (about one half the normal growth rate). By waiting a few more weeks the plants will have grown to their full target height, restored their reserve carbohydrates, and be ready for grazing and good growth after grazing.

Graze pastures to target stubble height

By this time you probably get the idea that optimum grazing height and stubble height are important (or that the guy writing this is a nut or all of the above).

Use N fertilizer to increase production

Feeding home grown hay during a drought puts a dent in the winter feed supply. Therefore, in dry years it is even more important to extend the grazing season into the winter and to have early spring pasture to reduce the need for hay feeding. The use of nitrogen fertilizer on grass stands such as tall fescue can do this for us. Nitrogen should be used on healthy grass stands that are low in legume content. This will provide the best response to the nitrogen and provide grazing past the hard freezes of early winter that kills legumes and reduces their available forage later in the winter. Nitrogen fertilized south facing slopes will also provide the earliest spring grazing. When these areas are used for winter grazing, do not graze them too short, which could prevent the stand getting an early and rapid growth in the spring. These sites may benefit from another application of nitrogen in early spring to get early yield. In these situations feed a mineral supplement containing magnesium since the risk of grass tetany increases when grazing early spring pasture that has been fertilized with nitrogen. If the soil is low in phosphorus add phosphate to the fertilizer since it will help the plants take up magnesium and increase animal utilization of magnesium reducing the risk of grass tetany.

Reseed legumes and grasses as needed

Where pasture or hay fields have been thinned by the drought they can be thickened back up by the use of fall nitrogen and proper grazing or by the seeding of grasses and legumes into the stand. When nitrogen prices are high it is probably best to use nitrogen only on the better grass stands in order to get the best yield from the nitrogen purchased. Then reseed the thin stands since there will be less competition to the new seedling in these thin stands. No-till seeding is a good option since it causes less soil disturbance and less soil moisture loss than plowing and disking.

Use annual forages during pasture renovation

Some pastures may be so damaged or weedy that they need complete renovation. On these sites use summer or winter annuals to provide high quality forage as well as a means of cleaning up weeds and providing a good seed bed for the establishment of a new pasture or hay field. When choosing an area for feeding during a drought this option should be kept in mind.

Conclusion

Droughts happen, about half the time, the only question is how bad. There are many management options for reducing drought risk to a pasture system. Confinement operations are also at risk to drought. The difference is that pasture systems feel the effects in real time while confinement systems feel the effects about six months later.

To make it through a bad drought; with the least damage financially, emotionally, and to the animals and pasture; requires a drought management plan. Then when the drought hits, damage will be minimized by the thoughtful implementation of the drought management plan along with continual good forage and livestock management. It is the planning and management of the plan that will reduce the risk and cost associated with a drought.

References:

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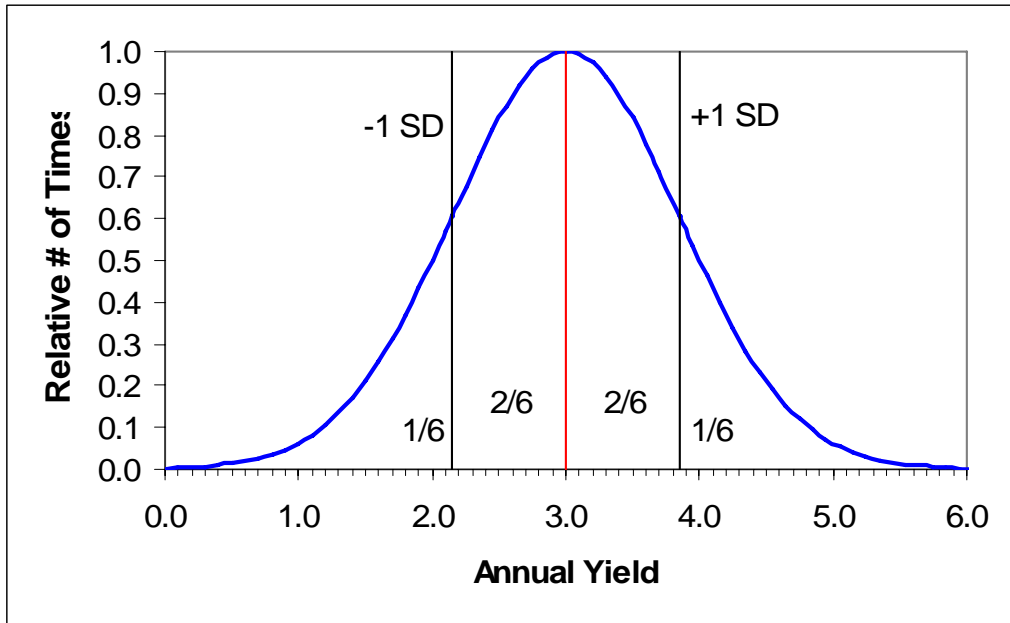
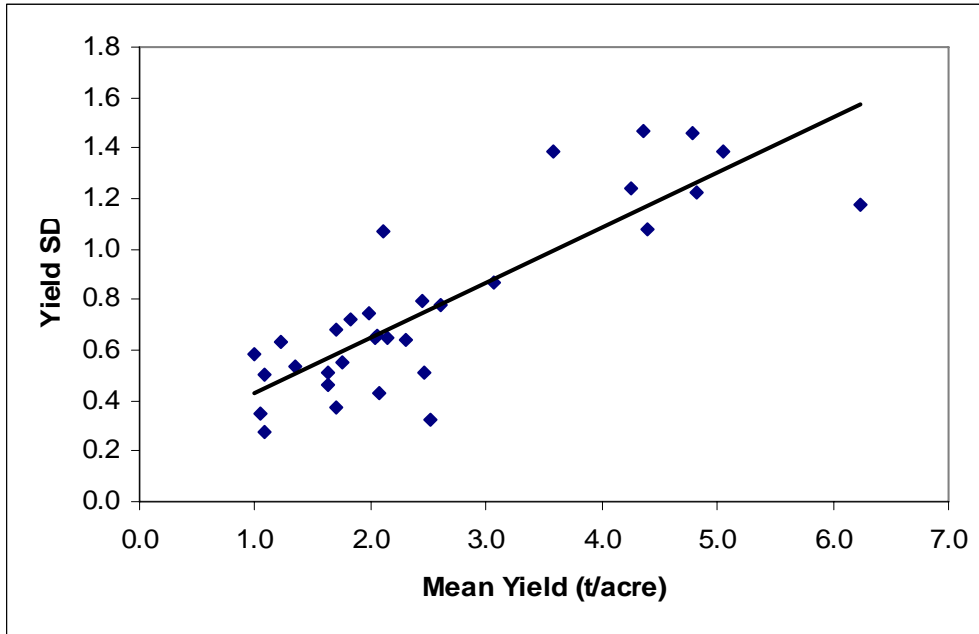


Figure 1. In the Northeast when mean forage yield is 3 tons/acre the standard deviation (SD) of yield is about 0.85 tons/acre. Fifty percent of the time yields are below the mean and about fifty percent of the time yields are above the mean. About one third ($2/6$) of the time yields are above or below the mean by as much as one SD. About one-sixth of the time yields are less than 1 SD below the mean and about one-sixth of the time yields are greater than 1 SD above the mean.

A



B

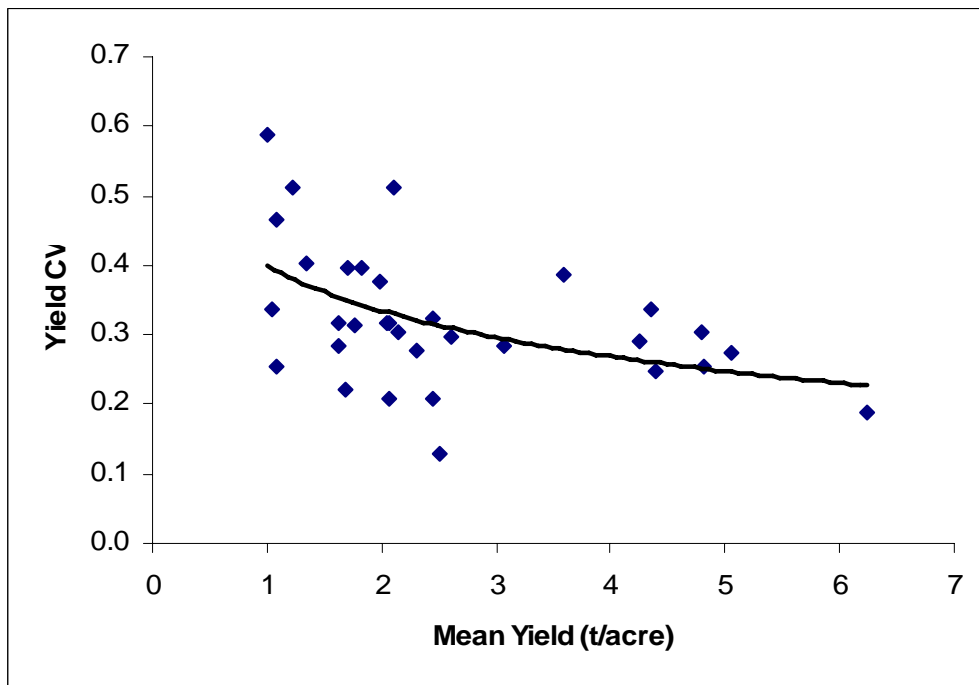
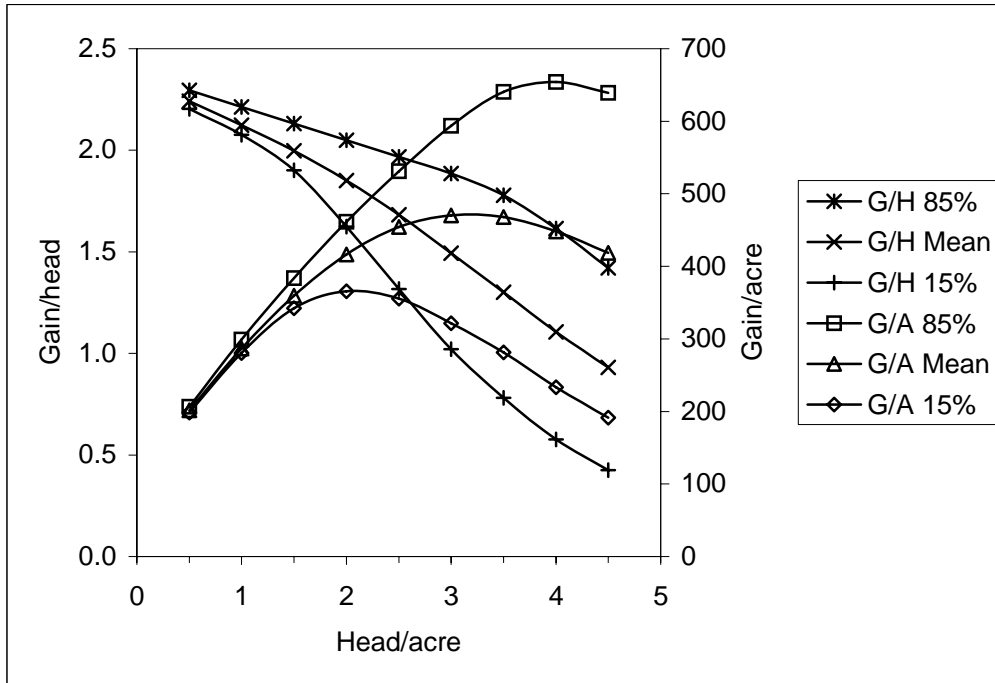


Figure 2. The relationship of mean yield and yield standard deviation (SD) (A) and mean yield and yield coefficient of variation (CV) ($CV=SD/average$) (B) for cool-season grasses and legumes grown in the Northeast.

A



B

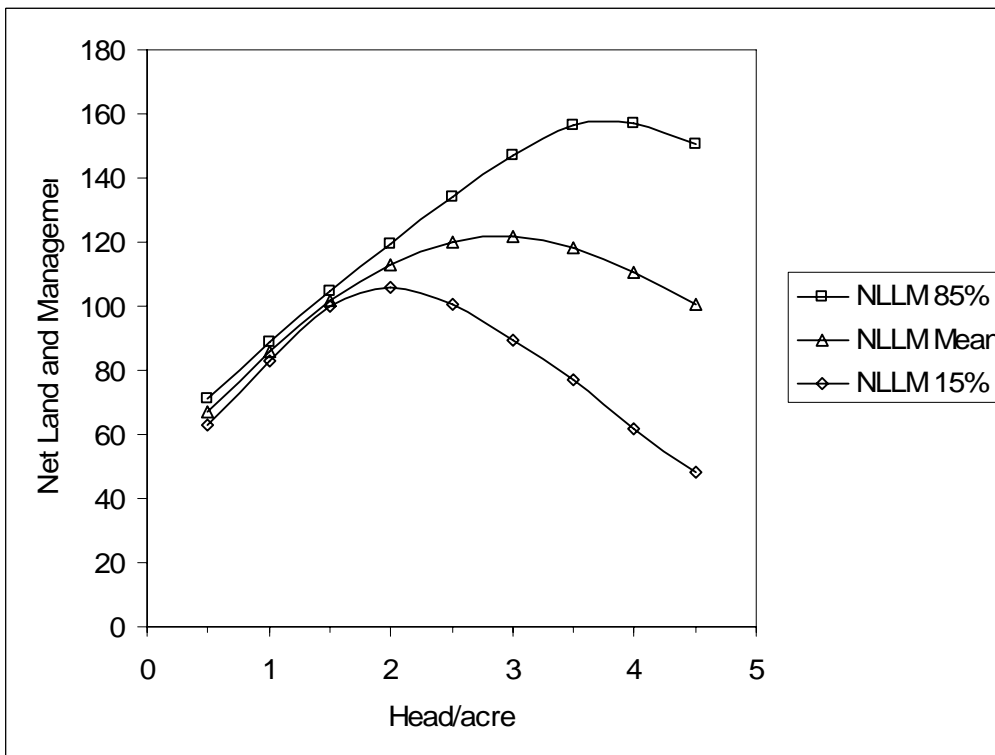


Figure 3. Stocking rate effect on mean and 15% and 85% probability level of gain per head (G/H), gain per acre (G/A) (A), and net income to land, labor, and management (NLLM) (B) for a contract stocker orchardgrass pasture-hay system growing on deep soils in the Northeast.

Table 1. Cool-season forage species characteristics, management, and ecological adaptation.

| Forage species | Growing point | Aftermath reproductive growth | Establishment vigor | Plant type | Management adaptation | | | Optimum soil pH | Tolerance to poor drainage | Tolerance to flooding | Tolerance to drought |
|---------------------|---------------|-------------------------------|---------------------|------------|-----------------------|------------|------------|-----------------|----------------------------|-----------------------|----------------------|
| | | | | | Hay | Grazing | | | | | |
| | | | | | | Rotational | Continuous | | | | |
| Legumes | | | | | | | | | | | |
| Alfalfa | Elevated | Yes | Medium | Bunch | E | E | P | 6.5-7.0 | P | P | E |
| Alsike clover | Elevated | Yes | Medium | Bunch | P | G | P | 5.8-6.5 | E | P | P |
| Birdsfoot trefoil | Elevated | Yes | Low | Bunch | E | G | G | 6.0-6.5 | E | P | G |
| Lespedeza, Korean | Elevated | Yes | Medium | Bunch | G | G | G | 5.8-6.5 | G | P | G |
| Lespedeza, Sericea | Elevated | Yes | Low | Bunch | P | G | G | 5.8-6.5 | G | P | G |
| Red clover | Elevated | Yes | High | Bunch | G | G | P | 5.8-6.5 | G | P | G |
| White clover | Ground | Yes | Low | Bunch | P | E | G | 5.8-6.5 | E | P | P |
| Grasses | | | | | | | | | | | |
| Bermudagrass | Elevated | Yes | Medium | Sod | G | G | G | 5.8-6.5 | P | P | G |
| Bluegrass, Kentucky | Ground | No | Low | Sod | P | E | E | 5.8-6.5 | G | G | P |
| Bromegrass, Smooth | Elevated | Joints | Medium | Sod | E | G | P | 5.8-6.5 | G | P | E |
| Orchardgrass | Ground | No | Medium | Bunch | E | E | G | 5.8-6.5 | G | P | G |
| Ryegrass, Perennial | Ground | Yes | High | Bunch | G | G | P | 5.8-6.5 | P | P | P |
| Ryegrass, Annual | Ground | Yes | High | Bunch | P | G | P | 5.8-6.5 | P | P | P |
| Reed canarygrass | Elevated | Joints | Low | Sod | E | G | P | 5.8-6.5 | E | E | E |
| Tall Fescue, E+ | Ground | No | Medium | Bunch | G | G | G | 5.6-6.5 | E | E | E |
| Tall Fescue, E- | Ground | No | Medium | Bunch | E | E | P | 5.8-6.5 | E | E | G |
| Timothy | Elevated | Joints | Medium | Bunch | E | G | P | 5.8-6.5 | G | P | P |

E+ = endophyte infected

E- = endophyte free

E - excellent

G - good

P- poor