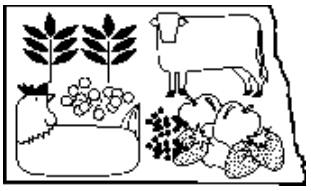

Lupin

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Lupin has been cultivated for at least 2,000 years, and probably was first raised in Egypt, or at least in the general Mediterranean region. The lupin plant, like other grain legumes (beans, peas, lentils), fixes atmospheric nitrogen and produces seed high in protein. Of the more than 300 species of the genus *Lupinus*, only five are cultivated. Many lupins have high levels of alkaloids (bitter tasting compounds) that make the seed unpalatable and sometimes toxic. Historically, lupin alkaloids have been removed from the seed by soaking. But German plant breeders in the 1920s produced the first selections of alkaloid-free or "sweet" lupin, which can be directly consumed by humans or livestock.

Lupins are grown as both a forage and grain legume in the USSR, Poland, Germany, South Africa, and the Mediterranean, and as a cash crop in Australia where they are exported to the European and East Asian feed markets.

Adaptation

Lupins are best adapted to regions with sandy or sandy loam soils and cool temperatures.

Spring-grown white lupins require 100 to 140 days to mature. They are quite tolerant of frosts and can withstand temperatures approaching 16 degrees Fahrenheit in the seedling stage. High temperatures can reduce growth, increase flower or pod abortion, and reduce yield. They are not particularly drought tolerant although they have tolerated water stress much better than dry beans or soybeans, and will respond to irrigation. Long, cool springs with sufficient moisture are generally beneficial for lupin followed by dry fall conditions to ensure uniform maturity.

Seedbed Preparation

A uniform, firm seedbed will maximize emergence. The seedbed should be level and free of depressions to permit uniform depth of seeding. An ideal seedbed is one that permits good soil/seed contact and is free of trash to ensure uniform seed placement. Lupins have been grown successfully with ridge tillage, but the wider rows tend to reduce yields.

Varieties

There are both winter and spring types. However, only spring type cultivars have been developed for North Dakota. White lupin (*L. albus L.*), yellow lupin (*L. luteus*), and blue or narrow-leafed lupin (*L. angustifolius*) are the types most experimented with in North Dakota variety trials.

Seeding Date

Since lupins are sensitive to heat and water stress during flowering and pod fill, lupin planting, like small grain planting, should occur as early in the spring as possible. According to results from five years of Minnesota field trials, planting in mid-April results in maximum grain yields and biomass production. Seed yields were consistently reduced with plantings after late April. Early planting encourages flowering and branch growth before the excessive summer heat. However, planting too early (early April), when cold temperatures can affect the seed or seedling, may reduce plant growth by decreasing node number, plant height, and days to maturity. This reduces yields.

Seeding Depth and Row Spacing

Depth of seeding is critical in obtaining a successful stand. Since lupin seeds are large, they require high amounts of moisture for imbibition; a depth of 1 to 2 inches is recommended.

Lupins can be planted as a solid-seeded crop using a grain drill or in rows with a row crop planter. Yield increases between 37 to 110 percent have been achieved in Minnesota by narrowing row spacing from 30 inches to 6 inches. Lupin planted in narrow rows has also been reported to mature earlier. But since lupin can be susceptible to weed infestations, some growers may need to use row spacings of 18 inches to 22 inches, to allow for cultivation.

Seeding Rate

Lupin can be planted in narrow rows (6- to 8-inch) or wide rows (30-inch) at a rate of 4 plants per square foot (175,000 seeds per acre or 120 pounds per acre). Slightly higher yields or improved plant population results from higher seeding rates, but high seed costs encourage lower seeding rates. White lupin has large seed: planting equipment must be able to handle the seed without damaging it.

Growth Characteristics

Lupin differs from other grain legumes in its growth habit. Emergence is epigeal (cotyledons emerge above ground before development of true leaves), and early seedling growth is slower than later vegetative stages. Maximum vegetative growth rate occurs during flowering. Environmental conditions influence the process of flowering and setting of pods.

Inoculation

Yield increases of approximately 60 percent have occurred in Minnesota due to inoculation of lupin seed with Rhizobium lupini, the appropriate nitrogen-fixing bacteria for lupin on fields not previously planted to lupin. Since inoculant is inexpensive, lupin seed should be treated to ensure good nitrogen availability.

Fertilizer

Under most circumstances lupin does not need to be fertilized. Nitrogen fertilizers are not recommended for lupin because of the recommendation that lupin be inoculated at planting. Lupins are highly efficient phosphorus (P) feeders. Lupins have the ability to use existing P in soil that most crops can't use.

Weed Control

Lupin is a poor competitor with weeds; it is slow to develop a canopy. Therefore, effective weed control is essential for success with this crop. Poor lupin performance in Minnesota and Wisconsin often has been linked to poor weed control. A specific problem at many sites is late germinating annual broadleaves, such as lambsquarters, pigweed and ragweed. Fields with large populations of these weeds should be avoided.

Fields should be free of perennial weeds such as quackgrass, milkweed, bindweed and Canada thistle. Also, avoid fields with atrazine residues or excessive levels of annual weed seed buildup in the soil. Planting lupin early will give it a head start on many weeds.

Dual, Prowl and Poast have been approved for use on lupin. Using other non-labeled chemicals is a violation of federal law. When lupin is planted in narrow rows (7 to 10 inches apart), row cultivation is not feasible. However, a rotary hoe is safe and effective on many annual weeds if performed at the right time. When weed problems exist in a field, lupin planted in wider rows allows room for cultivation.

Diseases

All varieties of lupins are susceptible to root rots caused by *rhizoctonia* and *fusarium* fungi. These diseases are associated with reductions in yield throughout the region, especially on heavier, poorly drained soils. *Phytophthora, pythium, ascochyta* and *botrytis* stem canker also have been disease problems under certain conditions. Resistant varieties are the only protection against these diseases. Genetic resistance is not yet available, so a way to offset the problem is to avoid sites with excessive soil moisture and higher pH.

Insects

Corn seed maggot has been reported to reduce lupin stands by more than 50 percent in New York, but this insect's damage in North Dakota is still unknown. High organic matter and fresh manure application, which attract adult insects, could contribute to the problem. Chemical seed treatments deter some maggots. Potato leaf hopper and tarnished plant bug (lygus bug) have been detected in lupin fields in Minnesota, but yield impacts are unknown.

Harvesting

Lupin planted in April generally will be ready for harvest during August or September. Lupin is most commonly resistant to lodging and shattering. Lupins can be direct combined or swathed (depending on weed populations). Lupins can be direct combined when the seed moisture reaches 12 to 15 percent, but shattering potential increases at moisture less than 14 percent. Lupin can be direct combine harvested with the same equipment that is used for soybeans or small grains. Swathing lets the weeds dry, allowing easier thrashing, decreasing discoloration of seeds, and resulting in cleaner grain.

Yields

Sweet white lupin yields at the Carrington Experiment Station variety trials averaged 30 bushels per acre (1989-1992). However, a more realistic yield goal for North Dakota producers should perhaps be 24 bushels per acre.

Storage

Lupin can be stored directly from the field if the grain moisture content is 15 percent or less. If the lupin seed is to be stored for longer periods of time, the moisture content should be below 12 percent. Lupin either can be dried by natural air or low temperature drying. To prevent spoilage from moisture migration, the grain should be aerated.

Extra care should be taken when storing seed to be used for planting the following season. Lupin seed is vulnerable to mechanical damage, as are soybeans or dry edible beans.

Uses

Lupin seed can be fed directly to poultry and livestock either whole, cracked or ground.

Dairy - The current recommendation is that lupin can replace up to 65 percent of the soybean meal (10 percent of the total mix) in a dairy cow diet. Calves fed ground lupin respond as well as if they were being fed soybean meal.

Beef - All studies indicate that lupins are a satisfactory protein supplement for beef cattle in either whole or ground form.

Lambs - According to ration trials, whole lupin seed can replace 100 percent of the soybean meal in lamb diets.

Swine - Lupin can replace up to 20 percent of the total diet of swine weighing more than 120 pounds, with no decrease in production. Diets of swine and poultry which are fed lupin need to be supplemented with methionine.

Poultry - Turkey rations containing up to 20 percent (dry basis) lupin in the diet compare with soybean meal diets.

Lupin can be substituted for cereal grains in many human food products. An important attribute of the lupin substitution is the increased nutritional quality of the product: it is higher in protein and carotene. Lupin hulls and flour are incorporated into pasta and breads for human consumption. Additional potential uses of lupins are in crunchy cereals and snacks, baby formula, soups and salads.

Markets

Lupin can be fed to poultry and livestock. The United States has a developing specialty human food market -- lupin flour, lupin pasta, and hulls for dietary fiber. Voyageur Trading Company, whose headquarters are in Minneapolis, Minnesota, has been processing "Lupini Pasta" for approximately 5 years. The pasta is distributed to 22 states, with a volume of 42,000 pounds per year.

Seed quality standards, such as protein and oil percent, are currently being established for many commercial products.

Other markets include commercial and seed production contracts with seed companies. Replanting seed is an option if seed quality is high.

Lupin has substituted for soybean in the cooler climates of Minnesota. The costs of lupin and soybean are similar, except for seed and fertilizer costs. Lupin seed has been calculated to be approximately 3.5 times more expensive than soybean seed. However, since lupin has not shown a response to fertilizer (P and K), no fertilizer is budgeted for lupin. Soybean receives P and K, an expense of approximately $12 per acre. The major difference between the two crops is the higher soybean price and higher lupin seed costs.

Economics of Production

A rule of thumb sets lupin returns at 75 percent of the soybean meal price. A ten-year average (1980 to 1990) soybean meal price of $180 per ton at Decatur, Illinois, was used in the budget (below) to determine a lupin price of $4.09 per bushel.

In 1992, 137 acres of lupin were reported in North Dakota -- 43 acres in Burke county, 82 acres in Divide county and 12 acres in Slope county.

United States Production

Production of lupins in the United States has varied between 5,000 to 10,000 acres. Lupins are produced in Minnesota, Wisconsin, Michigan, Maine, California and Oregon, and in Ontario, Canada.

United States Exports

Lupin export information is not available, but lupin researchers report that small commercial quantities are exported. The major export markets are Europe, Asia and, to a lesser extent, the Middle East. Limitations exist in marketing lupins due to domestic cereal price cuts from implementing agriculture reforms by the European Community, the disintegration of the Soviet Union and the prospect of increased oilseed production in the former Eastern Bloc satellite nations. An additional limitation in Asia is the substitution of cheap soybean meal. The Asian livestock industry is dominated by the poultry sector, the least efficient users of lupins in the livestock industry. This means that short-term prospects for the expansion of markets in Asia are minimal.

Though shipped to only two export destinations ten years ago, lupins now have been shipped in commercial quantities to almost twenty countries throughout the world. A market was established in South Africa in 1991, and lupins were shipped to Southeastern Spain in 1992.

In Asia, the immediate outlook is for little change from 1992. This region collectively is expected to consume around 200,000 tons, or approximately one-third of the Western Australia lupin available for export in 1992.

Estimated 1993 Economic and Cash Flow Budgets for North Dakota

	Economic Cost/Acre (24 bu x $4.09)	Cash Cost/Acre
Market Income	98.16	98.16
Direct (Variable) Costs		
Seed	31.20	31.20
Herbicides	6.72	6.72
Inoculant	1.60	1.60
Fuel & Lubrication	7.43	7.43
Repairs	9.88	9.88
Miscellaneous	1.00	1.00
Operating Interest	2.75	2.75
Sum of Listed Direct Costs	60.58	60.58
Indirect (Fixed) Costs		
Misc. Overhead	4.51	2.27
Machinery Depreciation	18.18	xxxx
Machinery Investment	9.48	19.60
Land Taxes	3.29	3.29
Land Investment	25.08	9.70
Sum of Listed Indirect Costs	60.53	34.86
Sum of All Listed Costs	121.11	95.44
Return to Labor and Management	(22.95)	xxxx
Net Cash Flow	xxxxx	2.72
LISTED COSTS PER UNIT (bu):		
Direct Costs	2.52	2.52
Indirect Costs	2.52	1.45
Total Costs	5.05	3.98

The economic budget is generated by charging market rates for all resources needed for production. It helps answer the question "Is this enterprise profitable?" The bottom line represents a return to labor and management.

The cash flow budget is an estimate of the out-of-pocket cash needed to run the enterprise, including not only direct costs but indirect cash costs such as principle and interest payments, insurance and taxes. It helps answer the ques-tion "Can I make meet my cash obligations if I go into this enterprise?" Total cash expenses are subtracted from total cash receipts to calculate the net cash which is available for family living and other needs.

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