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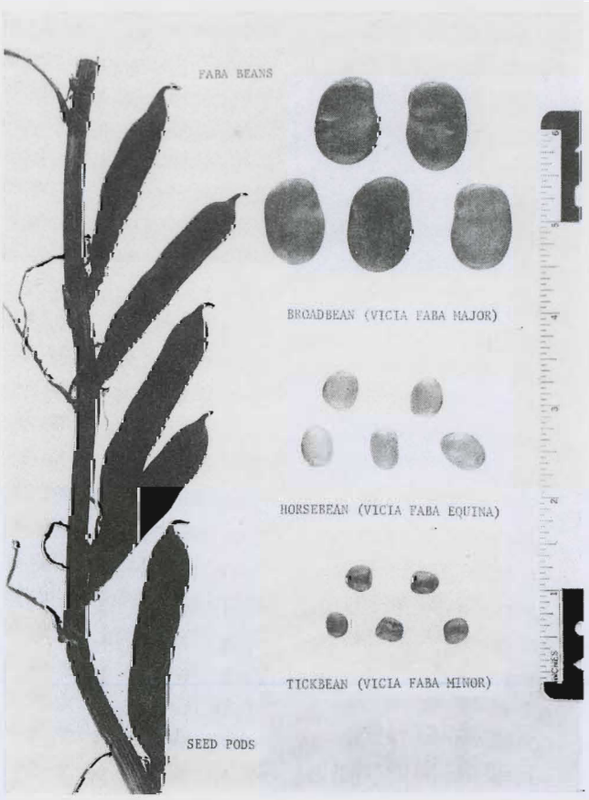
UNIVERSITY OF MINNESOTA

Figure 1. Pods and seed of three types of fababeans.



FABABEANS – A NEW CROP FOR MINNESOTA?

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Vicia faba L. is a large-seeded annual legume species and includes broadbeans, windsorbeans, horsebeans, tickbeans, and pigeonbeans. Fababean or favabean is a common name for the species in the United States. They are called field beans in England and silkworm beans in parts of China. The seeds are high in protein, low in oil, and of potential value for human food and livestock feed. The crop may also be used as a high-protein forage or a high-nitrogen green manure.

Fababeans are a cool-season crop so they should be planted early in the spring. They are ready for forage harvest about mid-July or for seed harvest in August.

The crop appears best adapted to silt loam soils of high fertility and fair to good drainage.

TYPES AND VARIETIES

Over sixty collections or varieties have been tested since 1960. Most came from North Africa and southwestern Asia. A few named and fairly uniform varieties came from England, Holland, Belgium, and Sweden.

Both fall-and spring-sown types were tested, but the fall-sown were not winter-hardy. In contrast to winter wheat, fall-sown types planted in the spring produced seed. However, harvest was about two weeks later than with comparable spring-sown types, and the fall-sown types did not die but started regrowth after harvest.

Fababeans can be classified into three types based on seed size and shape (figure 1).

Broadbean or windsorbean *(Vicia faba* var. *major)* seed is large (sometimes over 0.8 grams per seed) and flat. The seed is difficult to plant and harvest without excessive loss when using farm machinery.

Horsebean *(Vicia faba* var. *equina)* seed is medium size (often 0.4 to 0.5 grams per seed). It is less flat than broadbean seed and has an irregular, oval shape.

Tickbean or pigeonbean *(Vicia faba* var. *minor)* seed is small (often 0.2 to 0.3 grams per seed) and round to oval shaped. Collections tested produced lower yields than some horsebeans.

None of these types are readily available in the United States although a few seed companies sell broadbeans as a garden vegetable. To make seed available for trial plantings, the Minnesota Agricultural Experiment Station gave the Minnesota Crop Improvement Association a small quantity of a small-seeded horsebean for distribution. This horsebean is fairly uniform and relatively good in seed and forage production. Performance of this cream-colored horsebean at the agricultural experiment station at Rosemount is shown in table 1.

USES

Like field beans and peas, fababeans are a high protein crop and their uses reflect their nutritive value. Nutritionists recommend a diet of about 15 percent protein for adult humans. Animal scientists suggest about 16 percent protein for weanling pigs, 12 percent for finishing pigs, and 10 to 12 percent for finishing cattle and lambs. Beans grown at Rosemount contained less than 1 percent oil and 26 to 33 percent protein. These analyses suggest that fababeans could be a protein supplement for diets and rations composed of low-protein cereal grains. However, fababean protein is reported low in the amino acid, methionine.

Human food. The seed can be baked after it is softened by soaking in water. The seed coats require more chewing than those of the commonly-baked bean varieties in the United States. Broadbean seed is large so the seed coats are often removed by hand before eating. Skinned beans are cooked, salted, and used for sandwich filling in North Africa.

Immature bean pods are picked and shelled, and the beans eaten like fresh garden peas. The pods are picked when about half full before the seed coats toughen.

Livestock feed. English farmers use the seed for pigs, sheep, and cattle. The seed is ground for pigs and cracked or coarsely ground for cattle. A mixture

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of two parts cereal grain to one part beans is often used for cattle. Swine rations may contain 10 to 20 percent beans supplemented with animal protein.

Research on horsebeans is expanding in Scandinavia with the object of using horsebeans supplemented with methionine instead of imported soybean meal.

In forage crop trials from 1962-64 at Rosemount, horsebeans sown at 180 pounds per acre yielded 4,376 pounds per acre dry forage containing 10.5 percent protein. A mixture of 60 pounds horsebeans plus 64 pounds oats yielded 5,613 pounds dry forage containing 10.1 percent protein. The horsebean-oat mixture also gave better weed control at a lower seed cost per acre than horsebeans alone.

Comparisons of the horsebean + oat mixture with oats alone in trials at Rosemount and Duluth, and in single plot observations at Waseca, Lamberton, Crookston, and Grand Rapids indicate that the mixture produces a forage of higher protein content and higher protein yield per acre. (table 2).

Previous research has shown a similar advantage for a mixture of peas + oats over oats alone. The pea + oat mixture may be expected to give higher yields of protein than horsebeans + oats on sandy and nitrogen deficient soils; but on fertile soils where peas + oats lodge badly, horsebeans + oats have the advantage.

Like pea + oat mixtures, the horsebean + oat mixture can be combine-harvested for seed provided the varieties mature about the same time. The presently available horsebean variety is too late for optimum seed yields of the mixture. Oat varieties used in the Rosemount trials were Garry and Lodi. Although Lodi is the best maturity match with horsebean, Garry gave better results because it was less competitive with the horsebean.

Pigeon and poultry feed. Tickbeans are used for pigeon and poultry feed in parts of Europe and the Middle East, whereas field peas are used for pigeon feed in the United States.

Green manure and soil improvement. Since fababeans are legumes they can be expected to add nitrogen to the soil if inoculated and used for green manure. A mixture of horsebeans + hairy vetch provides a full season green manure crop. Hairy vetch continues growth until freezing similar to alfalfa in the commonly used oat + alfalfa mixture. Data from Rosemount reported in table 3 show that corn following either horsebeans + vetch or oats + alfalfa green manure mixtures yielded more than corn following oat green manure.

Horsebeans as companion crops to establish perennial legumes and grasses were compared with oats for 4 years at Rosemount. Horsebeans were better than oats for establishing timothy or bromegrass and inferior to oats for establishing alfalfa or red clover. Oats gave much better weed control than did horsebeans.

Cash crop. There may be no commercial market for the crop. Farmers or local feed dealers may be the only prospective buyers.

GROWING THE CROP

Seed and Pollination. About two-thirds of the pods are self-pollinated and one-third cross-pollinated although one study showed spring beans were about 50 percent cross-pollinated. Therefore, isolation from other varieties of fababeans is needed to maintain pure seed of a variety. Although isolation standards for certified seed production have not been established, 40 to 80 rods appear minimum based on standards established for crops with similar pollination characteristics.

Good seed germinates well and the seedlings are sturdy, so fungicide seed treatment may not always be necessary. Nevertheless chloranil (Spergon), a fungicide seed treatment recommended for peas, was used in all experiments. Seed used for cultural practice trials was also inoculated with the same commercial inoculants used for peas and vetch.

Planting Time. Fababeans are injured by hot, dry weather so they should be planted as early as possible in the spring. There is little danger of freezing loss. Although injured by 26°F. in 1968, horsebeans showed less injury than barley.

Plantings after normal small grain sowing time are too late. A trial planted May 3, 1961, produced 1,470 pounds per acre are compared to the May 23 planting of only 588 pounds per acre. Late May and June plantings have consistently failed to produce seed.

Planting Depth. The hard, dry seed takes longer to absorb water and germinate than does seed of common beans. Deep planting is necessary to get seed below the surface soil that is likely to dry out. Deep planting is more important for horsebeans than for small-seeded tickbeans.

Fababeans do not emerge like soybeans or field beans (figure 2). The seed is composed of a seedcoat(s) surrounding two large cotyledons (seed leaves). The cotyledons are attached to the first node of the very small stem. Between the first node of the stem and the very small root is the hypocotyl. In field beans, the hypocotyl elongates and pulls the cotyledons above ground, thus exposing them and the base of the stem to the weather. In fababeans, the hypocotyl does not elongate so the cotyledons remain below ground in the seed. The first internode elongates pushing or pulling the terminal bud to the surface. With very deep planting the second node doesn't reach the surface so the second internode emerges (figure 3).

Data in table 4 show that horsebeans will emerge satisfactorily from a 7-inch depth in silt loam soil.

Recommended depth is at least 3 inches. These depth trials were planted by hand and every seed was covered to exact depth. The high yield of the 1-inch depth would not be expected from grain drill planting where much of the seed might be left uncovered or in dry surface soil.

Rate of Sowing, Row Width, and Seedbed Preparation. Fababeans can be grown as a cultivated row crop or as a non-cultivated narrow row crop like small grain. High rates of sowing and narrow rows tend to produce higher yields than low rates, but seed cost is a major expense of production. In a 1960 trial sown at 120 pounds per acre, plots with 12-inch rows produced 3,432 pounds per acre compared to 2,100 pounds for 36-inch rows. In 1961, sowing rates of 300-, 150-, and 90 pounds per acre in row widths of 12-, 24-, and 36 inches, respectively, produced 2,230-, 2,208-, and 1,470 pounds per acre.

The ability of the crop to emerge from 5- to 7-inch depths makes "plow-under planting" feasible. Seed is broadcast on the surface and plowed under with a moldboard plow. The objectives are to plant the seed deep, reduce field operations, reduce soil compaction, and improve weed control. The rough, loose soil surface retards weed seed germination. The deep planting allows disking, dragging, or herbicide applications before crop emergence with less risk of crop injury. "Plow-sole planting," a variant of plow-under planting, permits seeding in rows for cultivation. Seed is planted in the bottom of the open plow furrow and then covered by the next furrow slice.

Data comparing plow-under planting with the conventional procedure of moldboard plowing-disking-dragging-grain drilling in combine-harvested plots are shown in table 5.

More research is needed on planting methods, rates, and spacings but present recommendations are for conventional seedbed preparation and grain drill sowing in rows 6- to 7 inches apart at a rate of 180 pounds per acre based on a seed weight of 40 grams per 100 seed. Or, if row cultivation is desired, rows should be as close together as the tractor tires and cultivator permit. Rate should be increased for larger seed and decreased for smaller seed. Grain drill gates should be in lower slots for fababeans than for small grain to allow seed to pass through without breakage. Because no herbicide is approved for fababeans, the crop should be planted on clean land unless handweeding is planned. At present the crop may not be of sufficient value to warrant handweeding.

HARVESTING SEED

Fababeans can be harvested by windrowing and combining or by direct combining of the standing crop. Windrowing is usually necessary because of weeds. The crop should be windrowed when the leaves have dropped off, pods are black, and most seed can be easily detached at the hilum (seed scar).

Lodging, shattering, and height of lowest pod are harvest problems with many crops. Fababeans are not as lodging resistant as soybeans but they usually remain upright in contrast to the prostrate growth of common field beans. Fababean pods often turn black and dry much sooner than their green stems so the crop should be harvested if shattering starts. Research indicates that only 15 to 35 percent of the flowers set pods. If insufficient pollinating insects are

Figure 2. Field beans emerge by hypocotyl elongation; fababeans emerge by first internode elongation so the cotyledons and lower part of the stem remain below ground.

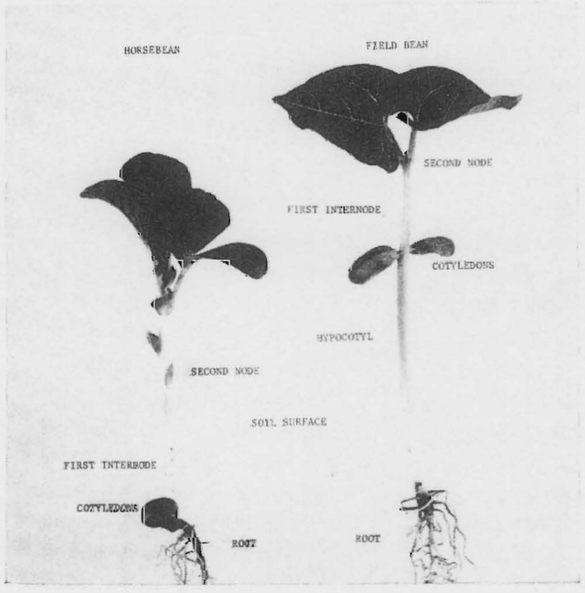
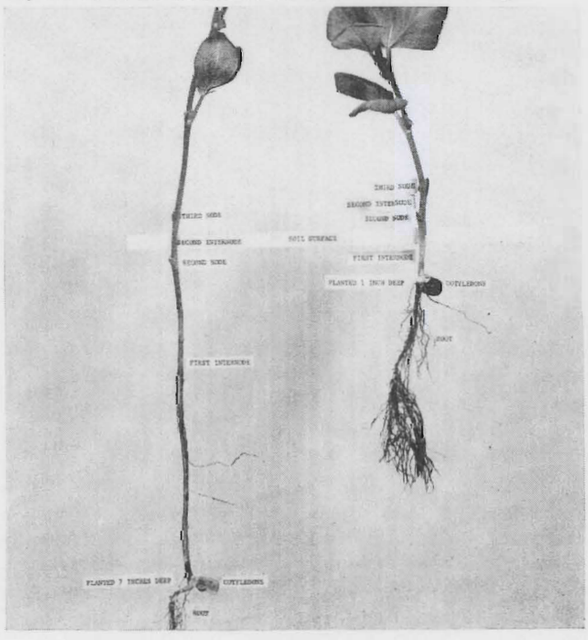


Figure 3. When depth of planting exceeds 5 inches, the second node may not reach the surface so the second internode emerges.



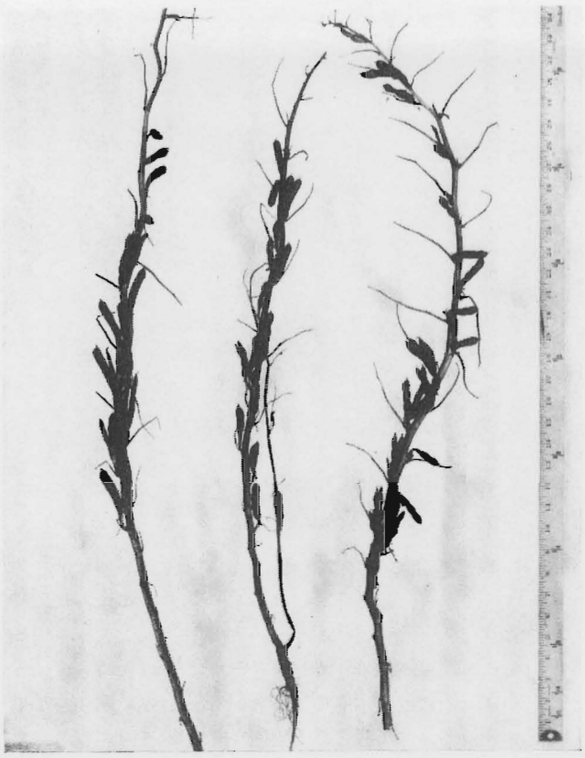


Figure 4. Pod height and arrangement on typical horsebean plants.

present, the pods will be distributed evenly on the stem. With adequate pollination, pod set is greater on the lower part of the stem and very sparse above (figure 4). However the lowest pods are borne high enough to permit direct combining.

Preharvest dessicants were tried at Rosemount and permitted weedy plots to be direct combined. However, no dessicants are approved for fababeans by the USDA so use is confined to experiments.

The large size and heavy weight of horsebean seed (usually over 60 pounds per bushel) facilitates easy threshing and cleaning. Cylinder speed and concave clearance should be adjusted to avoid splitting the seed. However the seed resists splitting and injury much more than common field beans.

The seed can be dried if too wet for storage. Temperature should be kept reasonably low and the drying process not hurried with large seed. Otherwise, the outside of the seed might be dried leaving the inner part wet. The experiment station has had no difficulty in drying small quantities of seed and maintaining seed viability for several years.

PESTS

Weeds are a major problem in most plantings. Insects become serious enough in some plantings to warrant spraying. Diseases are present in the crop but little is known about control.

Weed Control. Emerging weeds can be killed and the seedbed for weed seed germination dried out by spike-tooth or coil-spring harrowing one week or more after planting and before the crop emerges.

After fababeans emerge, such implements as the weeder, rotary hoe, spike-tooth harrow, or coil-spring harrow may be used to kill weeds. Speed of the tractor, setting of the harrow, or weighting of the rotary hoe to do most damage to the weeds and least to the beans can be accomplished on a "try and adjust" basis.

Herbicide tests were conducted on two trials in 1961 and in 1966-68 at Rosemount. Herbicides that seriously injured horsebeans in 1961 included CDAA + trichlorobenzylchloride (Randox T) at 3½ pounds CDAA per acre preemergence, EPTC (Eptam) at 3 pounds per acre preemergence, propazine at 3 pounds per acre pre- or postemergence, and atrazine at 3 pounds per acre pre- or postemergence. Prometryne (Caparol) at 3 pounds per acre gave good results in 1966 but injured horsebeans in 1967. Simazine was the most promising herbicide and data are reported in table 6.

The USDA has not approved any herbicides for fababeans.

Spring-sown winter rye, annual bromegrass *(Bromus arvensis),* and annual ryegrass were tested as weed-controlling companion crops in horsebeans and the data are reported in table 7. The mixtures would not remain homogeneous in the grain drill so the crops had to be sown separately. The alternate-row plots were sown with the crops in alternate compartments of a partitioned grain drill box. The companion crop was mixed with ground corn so that the drill setting for 180 pounds of horsebeans would also sow the desired amount of companion crop. Winter rye and annual bromegrass sown in the spring do not usually produce many heads. However enough cold weather occurred after planting on April 6 to vernalize the rye so that it headed about 2 weeks later than fall-sown rye. The competition afforded by the rye accounts for the low yield of horsebeans, even though rye gave excellent control of lambsquarters, pigweed, and ragweed. Although annual bromegrass reduced weed growth, control was not adequate. Annual ryegrass headed and produced a seed crop but was too competitive to allow normal horsebean yields.

Insect Control. Gray blister beetles damaged some trials by feeding on leaves in June or July.

Leafhoppers damaged trials in 1966, a year when the insects were unusually numerous.

Black aphids occurred on only a few plants in a few trials. The few plants attacked supported a tremendous population of aphids while plants a few feet away had none.

Bean beetles *(Bruchus spp.)* lay eggs in the flowers or young pods and the larvae bore into the ycung seeds where they pupate. An effective control is to plant seed free of insect holes. This insect has not been found in any experiment station trials or seed. The USDA Plant Quarantine Division requires fumigation of imported seed.

The USDA Pesticides Regulation Division has not approved any insecticides for fababeans. Therefore, only insecticides exempt from this regulation such as rotenone, pyrethrum, and ryania may be used.

Table 1. Yield and other characteristics of fababean collections at Rosemount, 1962-68

Collection	Seed yield per acre	Seed protein[1]	Date first bloom	Date mature	Height	Lodging[2]	Weight of 100 seeds
	pounds	percent	June	August	inches		grams
Cream horsebean	2196	31.1	16	14	38	3.3	38.4
Black horsebean[3] ...	2132	30.4	13	7	29	4.0	40.0
Cream tickbean[3]	1773	30.3	19	4	26	4.4	21.0
LSD (5%)	184						

[1] dry matter basis.
[2] 1 erect, 9 flat.
[3] PI 244345 and 222129 respectively.

Table 2. Comparative forage production of horsebean + oat mixture and oats alone

Sowing mixture per acre	Forage			
	Moisture	Protein[1]	Yield[1] per acre	Protein[1] per acre
pounds	percent	percent	pounds	pounds
		Rosemount 1962-66		
Horsebeans 60 + oats 64	66	8.6	5,738	494
Oats 80	64	6.0	5,766	347
LSD (5%)	1		397	
		Duluth 1962-63		
Horsebeans 60 + oats 64	72	10.7	5,405	629
Oats 80	69	6.8	5,516	391
LSD (5%)	3		931	
		Waseca, Lamberton, Crookston, Grand Rapids 1964		
Horsebeans 60 + oats 64	72	8.7	5,670	493
Oats 80	69	7.2	5,685	409

[1] 15% moisture basis.

Table 3. Effect of green manure crops on the following year's corn crop at Rosemount, 1966-67

Green manure crops, 1965-66	Corn 1966-67		
	Yield per acre	Ear moisture	Stalks per acre
	bushels	percent	
Horsebeans + vetch	99.2	34.8	15,064
Oats + alfalfa	86.3	34.4	15,949
Oats	68.6	33.8	15,060
LSD (5%)	15.9	1.9	

Table 4. Effect of planting depth on emergence, blooming date, height, and yield of horsebeans at Rosemount, 1965-68

Depth planted	Emergence of planted seed	Days from planting to emergence	Date first bloom	Height	Seed yield per acre
inches	percent		June	inches	pounds
1	80	18	13	36	2,953
3	90	19	14	37	2,791
5	87	22	15	36	2,807
7	81	25	16	34	2,343

Table 5. Comparison of conventional planting, plow-under planting, plow-sole planting, and row widths for horsebeans sown at 180 pounds per acre in 1966 at Rosemount

Planting method	Row width	Days from planting to emergence	Weed control[1]	Date mature	Height	Seed yield per acre
	inches				inches	pounds
Conventional	6	19-28	7.5	July 31	38	988
Conventional	12	19-28	7.2	July 31	39	953
Conventional	30	19-28	8.5	August 1	36	881
Plow-under	broadcast	32+	6.9	August 5	33	807
Plow-sole	30	36+	6.9	August 10	30	376
				LSD (5%)		97

[1] 10 = weed-free, 1 = complete weed cover.

Table 6. Effect of simazine herbicide on weeds in horsebeans at Rosemount

Treatment and rate per acre	Weed control[1]					Horsebean seed per acre		
	1961 trial 1	1961 trial 2	1966	1967	1968	1961 trial 1	1961 trial 2	1967
pounds							pounds	
Untreated	6	6	3.4	8.7	5.0	1470	588	2107
			preemergence applications					
Simazine, 3	9	8	9.9	10.0	—	1518	696	1675
Simazine, 2					8.5			
Simazine, 1			8.3	9.7	—			1876
Simazine, 1 + propachlor, 3				9.7	7.7			2027
			postemergence applications					
Simazine, 3	6	—	10.0	10.0	—	1530	—	1807
Simazine, 2					6.8			
LSD (5%)								512

[1] 10 = weed-free, 1 = complete weed cover.

Table 7. Spring-sown winter rye, annual bromegrass, and annual ryegrass for weed control in horsebeans at Rosemount

Sowing mixture per acre	Weed control[1]	Seed yield per acre
pounds		pounds
Sown April 6, 1963		
Horsebeans 180	5.0	954
Horsebeans 180 + rye 50	9.0	162
Horsebeans 180 in alternate rows with rye 50	9.0	234
LSD (5%)		234
Sown April 18, 1964		
Horsebeans 180	3.3	960
Horsebeans 180 + bromegrass 20	5.0	846
Horsebeans 180 in alternate rows with bromegrass 20	5.0	1026
LSD (5%)		324
Sown May 4, 1965		
Horsebeans 180	4.0	1632
Horsebeans 180 + ryegrass 30	7.7	840
Horsebeans 180 + bromegrass 20	4.7	1782
LSD (5%)		612

[1] 10 = weed-free, 1 = complete weed cover.