

AGRI-FACTS

Practical Information for Alberta's Agriculture Industry

Revised November 2001

Agdex 120/22-2

Establishing Perennial Hay and Pasture Crops

Successful forage production means examining several factors: the selection of the correct forage species for the climatic area, the soil type and the forage usage. Choose the variety that meets your needs the best and ensure that the forage is established properly, so it is productive and satisfies your needs.

Choosing the correct species

Before choosing the forage crop you will grow, consider the following points:

- Identify the end use of the forage crop. Pastures usually require a different species of forage than those used for a hay crop. For example, meadow brome grass is a much better pasture grass than smooth brome grass, but smooth brome grass is more productive as a hay crop than meadow brome grass.
- Different forages have different markets. The dehy and cubing industry prefers alfalfa, whereas the hay densifiers prefer timothy.
- Identify the soil type on which the forage crop will be grown. Low pH soils affect the nitrogen fixing capabilities of legume crops. Some forages are more capable of tolerating problem soils (e.g. waterlogged, sandy or high salinity).
- Soil moisture during the growing season greatly affects the growth of forage crops. Some crops are better able to withstand periods of drought or high water tables.
- The stand must be persistent. Some forage crops have a longer life span than others. Short-lived species may work well in cropping rotations while longer-lived species may be necessary for problem soils or in areas that are not easy to cultivate. Winter hardiness of the species should also be considered.

Principles of forage establishment

The successful establishment of small-seeded forage crops depends on many factors. It begins with the use of high quality seed of adapted species and varieties. Other factors include site selection, seedbed preparation, soil fertility, seeding dates and seeding techniques. Good management practices ensure stands will be vigorous and capable of producing high yields of pasture or hay.

Establishment period

In Alberta, the establishment period varies from a few months on irrigated land to a year or more in the dry areas of the southeast. In general, forage crops are not considered established until the stand has survived its first winter.

To understand why a seeding succeeds or fails, it is necessary to know how forage seedlings develop. Seedling development can be divided into three stages: germination, establishment and growth.

Good management practices ensure stands will be vigorous

Germination

Germination of live seeds requires the following:

- Sufficient moisture
 - Drying of fields shortly after seeding can result in poor and patchy germination. Firm seedbeds will help prevent moisture loss after seeding.
- Favorable temperatures
 - This is ensured by choosing the proper seeding dates. The ideal germination temperature for most grasses is 15 to 25°C, although germination will occur at temperatures as low as 5°C.

Table 1. Forage species characteristics and tolerance to soil problems

Crop	Special characteristics	Potential limitations	Hardiness¹	Salinity tolerance²	Alkalinity tolerance³ (high pH)	Acid tolerance⁴ (low pH)	Flood tolerance	Drought tolerance	Normal longevity in years⁵	Uses⁶
Alfalfa (Flemish)	rapid regrowth	hardiness	F - G	X	X				M	H, P, Pr
Alfalfa (Standard)	hardy	regrowth	G - E	X	X				M	H, P, Pr
Alfalfa (Creeping rooted)	drought tolerant	regrowth	G - E	X	X			X	M - L	H, P, Pr
Alfalfa (Siberian)	very hardy	regrowth	E	X	X			X	L	H, P, Pr
Bird's-foot trefoil	bloat-free	hardiness	F		X	X	X		S - M	P
Cicer milk-vetch	bloat-free	establishment	G	X	X			X	M - L	P
Alsike clover	acid and flood tolerant	not drought tolerant	G			X	X		S	H, P
Red clover	acid tolerant	not drought tolerant	G			X			S	H, P
Sweet-clover	plowdown	biennial	G	X	X			X	S	H
Sainfoin	bloat-free	hardiness	F		X			X	S - M	H, P
Orchard grass	rapid regrowth	hardiness	F - G			X			M	H, P
Meadow brome	rapid regrowth	seed size	E	X					L	H, P
Smooth brome	hardy	regrowth	E	X					L	H, P
Timothy	peat soils	drought tolerant	G - E			X	X		M	H, P, Pr
Creeping red fescue	strong creeper		E	X		X	X		L	P
Tall fescue		hardiness	F	X	X	X	X		M	P
Kentucky bluegrass	hardy		G - E						L	P
Reed canary grass	peat soils	alkaloids	E	X		X	X		L	H, P
Creeping foxtail	peat soils early growth	fluffy seed	E			X	X		L	H, P
Meadow foxtail	peat soils early growth	fluffy seed	E			X	X		L	H, P
Slender wheatgrass	reclamation	short-lived	G	X				X	M	H, P
Crested wheatgrass	early growth	regrowth	E	X	X			X	L	H, P
Intermediate wheatgrass			G	X				X	M	H, P
Nothern wheatgrass	reclamation		E	X				X	L	H, P
Pubescent wheatgrass			G	X				X	M	H, P
Streambank wheatgrass	reclamation		E	X				X	L	P
Tall wheatgrass	reclamation		G - E	X			X		L	H, P
Western wheatgrass	reclamation		E	X			X	X	L	H, P

Table 1. continued

Crop	Special characteristics	Potential limitations	Hardiness ¹	Salinity tolerance ²	Alkalinity tolerance ³ (high pH)	Acid tolerance ⁴ (low pH)	Flood tolerance	Drought tolerance	Normal longevity in years ⁵	Uses ⁶
Altai wild rye	fall pasture	establishment	E	X				X	L	P
Russian wild rye	fall pasture	establishment	E	X				X	L	P
Dahurian wild rye	ease or establishment	short-lived	G	X					S	H, P

Notes:

- ¹ Hardiness rated as Fair (F), Good (G) or Excellent (E).
- ² Salinity – for the purpose of this chart, forages are considered to be tolerant if they are adapted to soils of 4 to 6 mS/cm (mmhos) salinity in the top three to four feet of soil under average moisture conditions.
- ³ Alkalinity (pH above 7.0) – for purpose of this chart, forages are considered to be tolerant if they are adapted to soils with pH of 8.5 or more.
- ⁴ Acidity (pH below 7.0) – for purpose of this chart, legumes are considered to be acid tolerant if they are adapted to soils in the range of pH 5.5 to 6.0. Grasses are considered to be tolerant if they are adapted to soils with pH lower than 5.0.
- ⁵ Longevity rated as Short (S) 2 to 3 years, Medium (M) 3 to 5 years and Long (L) 5 plus years.
- ⁶ Uses – Hay (H), Pasture (P) and Processing (Pr).

For a more complete description of these species, see the *Alberta Forage Manual* Agdex 120/20-4

- Permeable seed coats
 - Many legumes tend to produce some seed with impermeable seed coats (hard seeds) that do not allow oxygen or moisture to pass through. Scarification may be needed to scratch or crack the seed coat to promote germination.
- Sufficient air
 - Oxygen may become limiting when forage seeds are sown in low-lying areas of heavy clay soils that are extremely wet.

Establishment

The failure of germinated seeds to establish seedlings may result from the following:

- Seeding too deep
 - Seeding too deep is the most common reason for wasted seed and establishment problems.
- Failure to cover the seed
 - When a forage crop is seeded too shallow or the seed is improperly covered, the seeds are subject to rapid changes in moisture and temperature.
- Drought after seeding
 - Germinated seeds can be easily killed if subjected to drying before a root system develops.

- Freezing at a critical stage of growth
 - Legumes, particularly alfalfa, may be killed if seeded too late in the fall. Injury is less likely if the plant has been given sufficient establishment time to develop a strong root system, which can be affected by late seeding or competition from cover crops and weeds. Fall seedings (dormant seeding) can germinate early in the spring and be subject to spring frosts.
- Crusted soil surface
 - Crusting may be a factor in the establishment of forage crops grown in heavy clay soils with low organic matter, such as Grey Wooded soils.

Growth

Seedlings may die shortly after establishment because of:

- Drought
 - Drought is a common cause of stand failure, especially in the drier areas of Alberta.
- Competition
 - Other crops and weeds may compete successfully with forage crops for light, moisture and plant nutrients. Lodging of cover crops can cause forage seedlings to be smothered and large areas of the field to be killed.

- Lack of nutrients
 - Nitrogen, phosphorous, potassium and sulphur are essential for plant growth. A lack of nitrogen is the most frequent nutrient related cause limiting grass growth. Soil tests should be taken to determine what and how much is needed. Several years supply of phosphorous, potassium and sulphur can be incorporated into the soil (banked) prior to seeding.
- Poor legume inoculation
- Insects, such as grasshoppers
- Diseases

- Winter-killing
 - Choose species and varieties adapted to your area. Management of the forage stand can affect the winter hardiness of the crop.
- High soil acidity
 - Alfalfa is very sensitive to soils with a pH below 5.8 - 6.0.
- High soil salinity
 - Some species of forages are better adapted to saline soils than others

Table 2. Seeding rates for pure forage stands

	Approximate number of seeds		Approximate number of seeds/sq. ft at	Seeding rate in lb/ac (or kg/ha)	
	seeds per lb	seeds per kg	1 lb seeding rate	6 in. (15 cm)	12 in. (30 cm)
Legumes					
Alfalfa	200,000	440,000	5	8	5
Bird's-foot trefoil	375,000	825,000	9	8	
Alsike clover	700,000	1,540,000	16	5	
Red clover	275,000	605,000	6	6	
Sweet-clover	260,000	572,000	6	9	6
White clover	800,000	1,760,000	18	5	
Cicer milk-vetch	130,000	286,000	3	13	8
Sainfoin (pods on)	23,000	50,000	1	30	20
Grasses					
Kentucky bluegrass	2,180,000	4,800,000	50	6	4
Meadow brome	80,000	176,000	2	12	7
Smooth brome	136,000	300,000	3	8	5
Reed canary grass	535,000	1,175,000	12	6	4
Creeping red fescue	615,000	1,353,000	14	5	3
Meadow fescue	230,000	506,000	5	8	5
Tall fescue	225,000	500,000	5	8	5
Creeping foxtail	750,000	1,657,000	17	5	
Meadow foxtail	575,000	1,270,000	13	5	
Orchard grass	650,000	1,439,000	15	6	4
Timothy	1,230,000	2,710,000	28	5	
Crested wheatgrass	175,000	385,000	4	7	5
Intermediate wheatgrass	88,000	194,000	2	10	6
Northern wheatgrass	155,000	340,000	4	7	5
Pubescent wheatgrass	100,000	220,000	2	10	6
Slender wheatgrass	160,000	350,000	4	8	5
Streambank wheatgrass	155,000	344,000	4	8	5
Tall wheatgrass	79,000	174,000	2	12	9
Western wheatgrass	110,000	242,000	3	10	6
Altai wild rye	55,000	121,000	1	14	12
Dahurian wild rye	88,000	193,000	2	12	7
Russian wild rye	175,000	385,000	4	8	5

Factors affecting establishment

Seed size and quality

The seeds of most perennial forage crops are very small and contain little stored food material. This situation makes seed placement and other seeding factors especially critical with these crops. High quality seed will germinate quickly and produce a vigorous seedling. One way to accomplish this is to use certified seed of named varieties.

When purchasing certified seed, the dealer must supply a copy of the certificate of analysis. This certificate will identify the weed seed content by weed kind and indicate the germination of the seedlot (see *How to Purchase High Quality Forage Seed*, Agdex 120/45-1).

Another factor associated with the seed quality of legumes is the percentage of hard seeds. This impermeability of the seed coat to water or oxygen is of particular concern with cicer milkvetch. Scarification is often required and should be done carefully to prevent damage to the seeds.

Seeding rates

Seeding rates (Table 2) are based on many factors including seed size, percentage germination, characteristics of the species being seeded and conditions under which the seeding occurs. More seeds are used than might appear to be needed. Overplanting is necessary to offset losses in germination, emergence and the early death of weak plants. Insects, weather, competition and sometimes carelessness causes additional losses. A rule of thumb is to sow 25 to 35 seeds per foot of row for dryland seedings. In Alberta, row spacing varies with available moisture as follows:

- Brown soil zone, 18 to 25 inches
- Dark Brown soil zone, 12 to 18 inches
- Black and Grey Wooded soil zones, 6 to 9 inches

The seeding rate, based on 25 to 35 seeds per foot of row, should be increased for irrigated land and high rainfall areas, as well as for small-seeded forage crops such as Kentucky bluegrass, and for broadcast seedings. The number of plants needed to make a productive stand varies. Generally 10 - 15 plants /foot of row is sufficient.

Mixtures

Choose mixtures that are compatible in maturity, height, aggressiveness and adaptable to the same type of soil and moisture conditions. Throughout the field, there may be many different soil types and moisture conditions. It is best to control the urge to use a “shotgun” approach to mixtures. Many companies sell mixtures containing several species and, in some cases, varieties of forages. The idea is

that the species best suited to a specific soil and moisture condition will predominate.

This approach is not only expensive, it is impractical. If the forage is to be grazed, the cattle will concentrate in the areas of the forage they prefer to graze and will overgraze those areas and undergraze the others. It is better to divide the field into similar soil and moisture types and use a single species or a two-species mixture compatible to each of the areas.

When purchasing a commercial mixture, ensure the mixture is made from certified seed of varieties and species compatible to the soil and moisture conditions it will be grown in. Table 3 outlines some mixtures compatible for each soil climatic area of the province.

Time of seeding

The ideal time to seed forages is early in the spring. At this time, soil moisture is generally adequate and allows an even germination from shallow seedings. Forages can be seeded until the end of June with good success. Seedings after this period may be successful, but the risk of failure is much greater. There must be sufficient growth before freeze-up for plants to develop strong root systems. Plants with weak root systems will decrease the winter hardiness of the forage crop and may result in serious winter kill.

Spring seedings should be made as early as the seedbed can be prepared. Late summer seedings may be hazardous if insects are present or if the soil is excessively dry; legumes should only be seeded in the early part of the period. Late fall seedings, just prior to freeze-up, are primarily a means of placing the seed in the soil for very early spring germination. For this approach to be successful, the soil temperature must be too cold to allow germination.

Depth of Seeding

Seeding depth is related to seed size, soil texture and moisture conditions. Seeding too deep will affect the emergence of the forage crop. Most forage seeds are very small and do not have enough energy to emerge from deep seedings. Care should be taken to place the seed at 1/2 to 3/4 inches into a firm seed bed. In sandy soil with poor moisture conditions, the seeding depth may be increased, but in heavier soils, deeper seedings will greatly reduce emergence (Figure 1). Seeding too deep is the major reason for establishment failures. There are many ways to seed forages successfully and the method used is not important as long as the seed is placed at the proper seeding depth and then covered with soil.

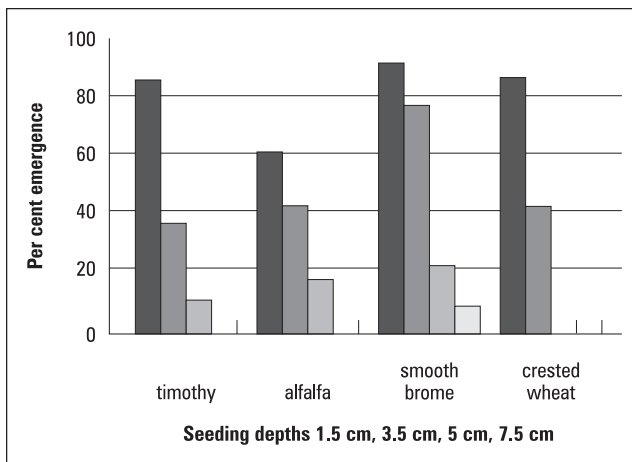


Figure 1. Percentage emergence from different seeding depths. Adapted with permission from K.W. Clark *Principles and Practices of Commercial Farming* – 1997

Seedbed

A seedbed for forage crops should be firm enough so that footprints in the soil will be not more than about 1/4 inch deep. The soil must also be firmly packed around each seed to permit water to move by capillary action from the soil to the seed. The seedbed may require packing or rolling after the seeding.

Unpacked soils dry out quickly, which may result in too little moisture in the seed zone. A firm seedbed tends to decrease surface drying and also permits uniform, shallow coverage of the seed. A loose seedbed makes it impossible to control the depth of seeding because the tires of the seed drill sink into the soil.

Inoculation of legumes

Legumes inoculated with rhizobia have the capacity to “fix” atmospheric nitrogen and make it available to the plants. Shortly after the legume begins to grow, rhizobia invade the root hairs. The rhizobia multiply and the legume responds by forming root nodules in which the rhizobia live. The legume supplies the necessary energy in the form of sugars, and the rhizobia use the energy to change free nitrogen from the air to a form the plant can use.

Several factors are known to inhibit good nodulation. First, and most important, is the absence of live and proper nitrogen-fixing rhizobia. When purchasing rhizobia, ensure that it is specific for the legume you are seeding. Store the inoculant in a dark, cool place until you are ready to seed your legumes. Apply the rhizobia with a sticking agent such as a commercial sticking agent, wall paper paste or sugar solution. Once the rhizobia is applied, the seed should be seeded as soon as possible. If there will

be a delay in the seeding, store the seed in a cool, dark place, but resume seeding as soon as possible. **Remember; inoculant is live bacteria and care must be taken to ensure it is alive when put in the ground with the seed. Wear rubber gloves when handling live bacteria.**

Nodulation is less effective in cool soils. Shading by weeds or a companion crop may also reduce nodulation.

Pre-inoculated seed is available, and if you feel you cannot do a good job of inoculating the seed yourself, use the pre-inoculated seed to ensure the seed is placed in the soil with live rhizobia.

Methods of seeding

A double disc drill equipped with depth control devices and a seed agitator in the seed box is excellent for seeding forage crops. Many producers are using a “brillion” seeder for seeding forage crops to ensure the seeds are not seeded too deep. This machine leaves the soil surface very smooth. Sometimes seedling emergence problems occur with this equipment, especially on heavy clay soils, which tend to crust after heavy rains. Both the brillion seeder and drills with depth control bands prevent the placement of seed too deep.

Some producers have successfully used seed drills by removing the downspouts and dropping the seed in front of the disc or hoes. The discs or hoes toss the soil over most of the seed. This method requires extra packing, harrowing or rolling after seeding to ensure good seed-to-soil contact. Other producers have moved the downspouts to drop the seed behind the openers, and the press wheels pack the seed in the seed row. This method closely resembles the brillion-type seeders.

Broadcast seeding of forage seeds is also commonly used. Spinner type spreaders will work, although forage mixtures containing small and large seeds are difficult to spread accurately. Fluffier seeds, such as smooth brome grass, are not flung as far as the heavier hard seeds, such as alfalfa or clovers, which can affect the mixture within the stand. For this reason, more producers are using a dribble type of boom spreader with either air or mechanical distribution systems. These systems include the floaters, Tera-Gator and Velmar type systems. Accuracy of seed distribution is generally very good, and many permit the application of fertilizer at the same time. The field should be harrow-packed, harrowed or rolled after spreading the forage seed. The final operation is needed to cover the seeds with soil and provide good seed-to-soil contact.

Table 3. Forage mixtures commonly used in Alberta

Row spacing		Crops	Approximate seeding rate*	
			Hay	Pasture
(in.)	(cm)			
Brown soil zone				
12 - 18	30 - 45	Alfalfa and smooth brome (moisture areas)	2+7	1-2+7
18 - 24	45 - 60	Alfalfa and crested wheatgrass	2+4	1-2+4
12 - 18	30 - 45	Alfalfa and intermediate or pubescent wheatgrass (moister areas)	2+8	1-2+8
24 - 36	60 - 90	Alfalfa and Altai wild rye	–	1-2+4
18 - 24	45 - 60	Alfalfa and Russian wild rye	–	1-2+3
Dark Brown soil zone				
12 - 18	30 - 45	Alfalfa and smooth brome	2+7	1-2+7
12 - 18	30 - 45	Alfalfa and crested wheatgrass	2+5	1-2+5
12 - 18	30 - 45	Alfalfa and intermediate or pubescent wheatgrass	2+8	1-2+8
18 - 24	45 - 60	Alfalfa and Altai wild rye	–	1-2+6
12 - 18	30 - 45	Alfalfa and Russian wild rye	–	1-2+5
Black soil zone				
6 - 8	15 - 20	Alfalfa and meadow brome	5+7	1-3+10
6 - 8	15 - 20	Alfalfa and smooth brome	5+6	1-3+8
6 - 8	15 - 20	Alfalfa and smooth brome and creeping red fescue	–	2-3+6+2
6 - 8	15 - 20	Alfalfa and smooth brome and timothy (moister areas)	5+6+2	2-3+6+2
6 - 8	15 - 20	Alfalfa and orchard grass	5+6	2-3+6
6 - 8	15 - 20	Alfalfa and timothy	5+2	2-3+3
6 - 8	15 - 20	Alfalfa and crested wheatgrass	5+4	1-3+7
6 - 8	15 - 20	Alfalfa and intermediate wheatgrass	5+7	1-3+9
6 - 8	15 - 20	Alsike clover and creeping or meadow foxtail (moist and flooded areas)	4+4	2+5
6 - 8	15 - 20	Creeping or meadow foxtail (moist and flooded areas)	5	5
Grey Wooded soil				
6 - 8	15 - 20	Alfalfa and meadow brome	5+7	1-3+10
6 - 8	15 - 20	Alfalfa and smooth brome	5+6	1-3+8
6 - 8	15 - 20	Alfalfa and smooth brome and creeping red fescue	–	2-3+6+2
6 - 8	15 - 20	Alfalfa and creeping red fescue and intermediate wheatgrass	–	2-3+6+2
6 - 8	15 - 20	Alfalfa and red clover and timothy	2+3+4	–
6 - 8	15 - 20	Alfalfa and timothy	5+3	2-3+3
6 - 8	15 - 20	Alfalfa and orchard grass	5+6	1-3+6
6 - 8	15 - 20	Alsike clover and reed canary grass (moist and flooded areas)	4+5+4	2+6
6 - 8	15 - 20	Alsike clover and creeping red fescue and timothy (moist areas)	4+1+3	2+3+2
6 - 8	15 - 20	Alsike clover and creeping or meadow foxtail (moist or flooded areas)	4+4	2+5
6 - 8	15 - 20	Alsike clover and timothy	4+4	–
6 - 8	15 - 20	Creeping or meadow foxtail (moist or flooded areas)	5	5
Irrigation				
6 - 8	15 - 20	Alfalfa and kentucky bluegrass	–	2+10
6 - 8	15 - 20	Alfalfa and smooth brome	5+6	2+8
6 - 8	15 - 20	Alfalfa and meadow brome	5+8	2+10
6 - 8	15 - 20	Alfalfa and orchard grass	5+8	2+8
6 - 8	15 - 20	White clover and meadow brome and orchard grass	–	2+8+6

* Increase seeding rates by one-half if broadcasting the seed and harrowing it into the soil.

Cicer milkvetch at 5 - 6 lb/ac (kg/ha) can be substituted for alfalfa in the pasture mixtures.

Sainfoin at 10 - 15 lb/ac (kg/ha) can be substituted for alfalfa in the pasture mixtures.

Mixtures containing sweet-clover are useful on poorly structured Grey luvisol soils where crusting and compaction occur.

The higher seeding rates of alfalfa in the mixtures for pastures is advantageous for yield and quality but may require the use of bloat control measures.

Companion crops

Many producers use a companion crop during the establishment year of the forages. Severe competition by companion crops for light, moisture and nutrients can be very harmful to the development of small forage seedlings. If a companion crop is used, it should be seeded at half the normal seeding rate and with reduced nitrogen levels.

If possible, remove the cover crop as silage or greenfeed rather than grain. This approach will open up the canopy and allow the seedlings to establish better. If the crop is removed as grain, remove the straw from the field, or chop and spread it. If the straw is allowed to remain in a windrow, it will smother the seedlings growing under it. If a companion crop is used, remember that the forage production following the companion crop year will be reduced by up to one-half.

Weeds

Weeds must be controlled during the establishment year. If the field is known to be weedy:

- delay seeding
- consider using pre-plant herbicides to control perennials such as quackgrass
- work the field one more time before seeding
- pre-emergent herbicides may be used on some legumes to control weeds
- post emergent herbicides are available to control weeds after emergence

Check *Crop Protection*, Agdex 606-1, or contact a forage specialist before using herbicides to ensure your forages will tolerate the herbicide used. Mowing works well to control competition from weeds. Clipping weeds off just above the forage will remove the seed heads and open up the canopy for the seedlings. If the volume of weeds is too high, use a swather and bale up, and then remove the weeds from the field. If the swaths are left on the field, they will smother the seedlings.

Steps to a successful seeding

- Select the most productive site
- Select the most suitable species to meet forage needs and soil type
- Choose high quality seed of adapted varieties
- Test the soil and fertilize as required
- Prepare a firm seedbed
- Inoculate legume seed
- Sow seed shallow and use proper seeding rate
- Seed early
- Eliminate competition for light, moisture and nutrients
- Control annual weeds
- Be patient before calling a new seeding a failure

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