IslamicRepublicofAfghanistan
Ministry of Agriculture Irrigation and Livestock

Wheat Manual

May 2016

Preface

Whet is the key to household food and nutrition security inthe Afghanistan. The mean per capita consumption of wheat is 160 kg per year and it accounts for more than half of the population's caloric intake on average. Following three decades of internal war and civil strife, the country has achieved substantial progress in increasing both aggregate production and productivity of wheat in recent years. But wheat yield is lower compared to the neighbouring countries,and production remains vulnerable to annual fluctuations of rainfall and droughts. Imports of wheat grain and flour, even in years of bumper harvests, are still needed to meet the consumer demand for wheat that is increasing with the population growth and per capita income growth of Afghanistan's urbanizing population.

In its quest to achieve self-sufficiency in the production of wheat, the Government requested the Food and Agriculture Organization of the United Nations (FAO) to provide technical assistance in drafting a Wheat Sector Development Programme (WSDP) for the country. This document is meant to be a blueprint for driving nationwide institutional efforts and resource allocation in a coordinated and concerted approach to boost wheat production sufficiently to achieve the goal of self-sufficiency in the medium term by end of 2020. With mor focus on 16 wheat growing provinces.

While organizing this manual, the authors were mindful of the challenges of wheat production in Afghanistan – a country with one of the harshest and most inhospitable agro-ecological environments that probably few countries confront when it comes to wheat production. There is so much variation in the microclimates from valley to valley that the preparation of a single technical guide for the whole country is extremely challenging.

To overcome this difficulty, the authors made extensive use of research results on wheat cultivation conducted in different provinces of Afghanistan over several decades, most of which remains unpublished. The recommendations contained in this manual are based on the results of that analysis and also take into account best management practices followed elsewhere. It is our hope that the ingenuity of Afghan farmers – the bedrock that sustained wheat cultivation in this country over centuries – will mingle withthe manual'stechnical recommendations, to devise and apply the most efficient and effective location-specific solutions to problems of wheat cultivation where they live.

Mir Amannudin Haidari
Deputy Minister for Agriculture and Livestock

Contents

Wheat production and supply scenario of Afghanistan

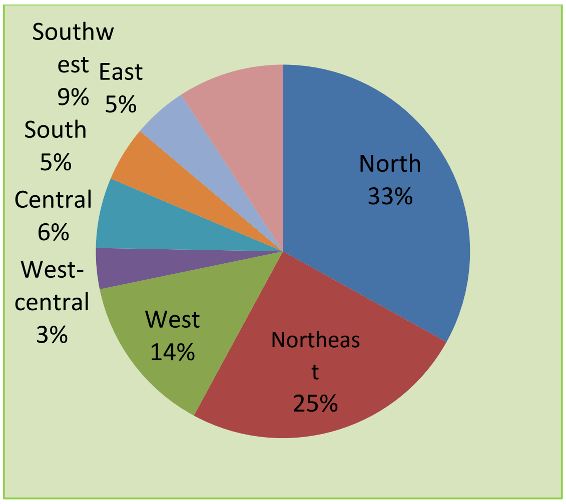
Wheat is the most important cereal cropgrown in Afghanistan. It contributes about 70percent to the country's total output of grain cereals. Wheat is cultivated throughout Afghanistan under both rain-fed and irrigated conditions. The major wheat-growing areas are concentrated in the northern, northeastern, western and southwestern regions.

Figure- 1.

Wheat Production

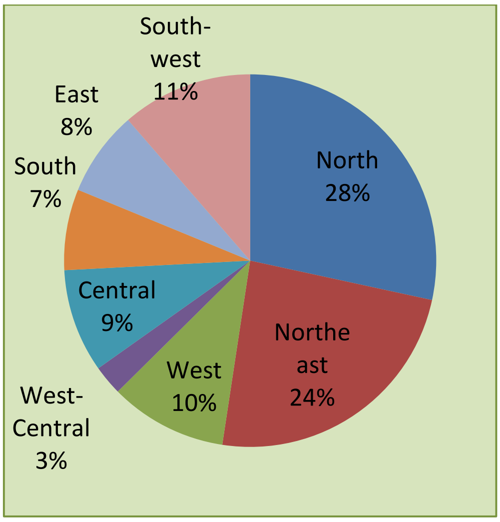
In 2012, 33 percentof the total cultivated area under wheat was in Afghanistan's northern region, while 25 percent was in thenorth-eastern region, 14 percent in the western region and 9 percent in the south-western region(Figure 2). In terms of total wheat production in 2012,the northern region contributed 28 percent, the north-eastern region generated 24 percent, while the south-westernregion produced 11 percent and the western region produced 10 percent (Figure 3).

Figure-2. Wheat area, by region, 2012



Source: SMIO, 2012.

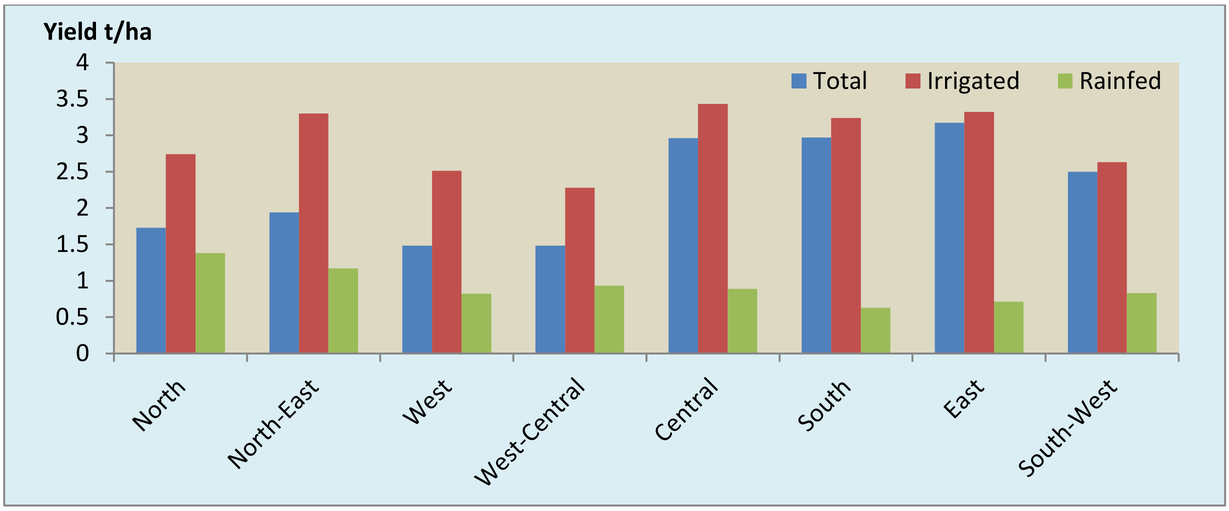
Figure-3. Wheat production, by region, 2012



*Source:*SMIO, 2012.

Average wheat productivity in 2012 was highest in the southern region(at 2.97 tonnes per ha), followed by 2.96 tonnes per ha in the central region. Productivity was higher among the irrigated wheat producers, at 3.43 tonnes per ha in the central region, followed by 3.3 tonnes per ha in the northeastern region. Rain-fed wheat productivity was low in all regions –about one third less than the productivity of irrigated wheat in the southern region and half of the irrigated wheat productivity in the northern region (Figure 4). Irrigated wheat areas concentrate predominantly in the North, with the northern region accounting for 45.9 percent and the northeastern regionfor 29.5 percent of the total irrigated wheat area.

Figure-4. Yield of wheat in Afghanistan, by regions, 2012



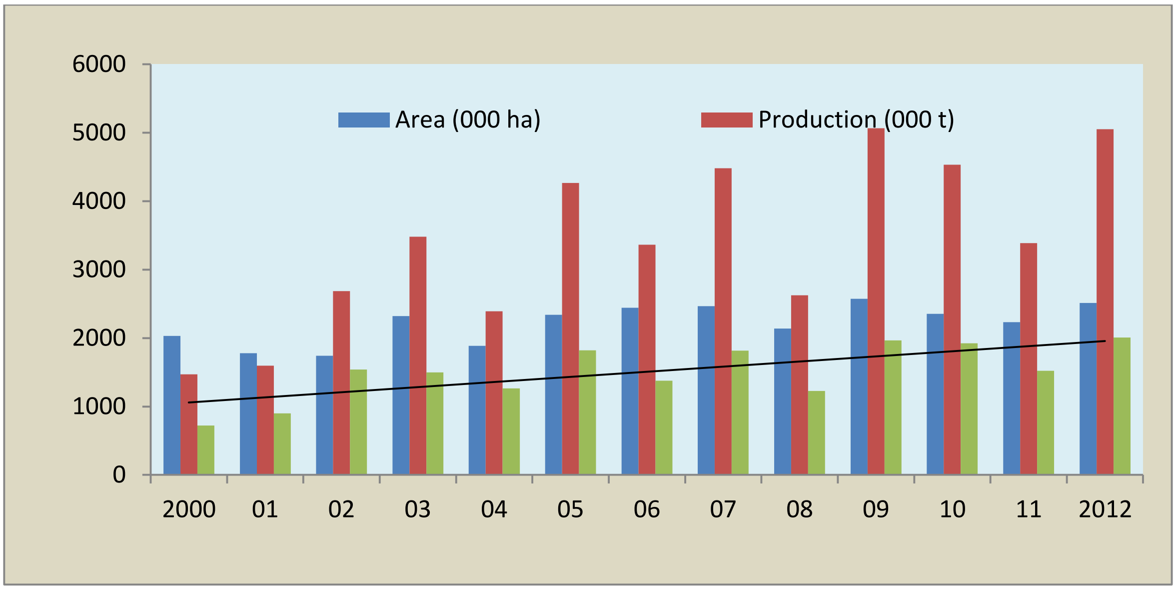
Source: SMIO, 2012.

The wheat area in Afghanistan covered between 2 million and 2.5million ha in 2000–2012. Although wheat production rose rapidly during that time, it was marked by significant annual fluctuations caused by weather variability. Seasonal change, particularly a drop in the amount of annual precipitation and its distribution as well as snow accumulation in the winter, dramatically impact production in rain-fed areas. The country harvested annually an average of 4.08 million tonnes between 2005 and 2012. There were several years when annual production topped the average: 4.26 million tonnes in 2005, 4.48 million tonnes in 2007, 5.12 million tonnes in 2009, 4.53 million tonnes in 2010 and 5.05 million tonnes in 2012 (Figure 5).

Over the past 12 years, wheat production yields have been increasing, but so has the variability. The average yields increased from 0.72 tonnes per ha in 2000 to 1.99 tonnes per ha in 2012. The linear trend projection in Figure 5 shows a yield expectation of 2 tonnes per ha.

More than half (55 percent) of Afghanistan's wheat area is rain-fed, with the remaining 45 percent irrigated (Sharma et al., 2011). But there are substantial annual fluctuations in area, depending on the amount and timing of the rainfall. In 2011, irrigated areas covered 1.16 million ha (51.8 percent of the total area) and rain-fed areas covered 1.08 million ha (48.2 percent) (Figure 5).

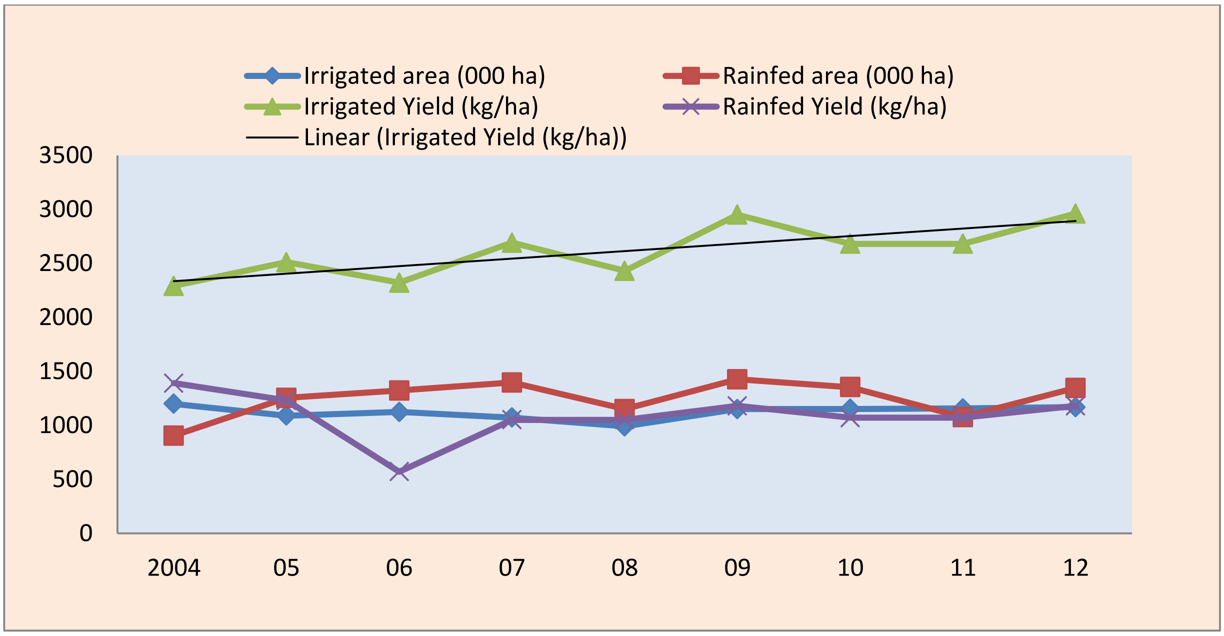
Figure-5. Wheat production in Afghanistan, 2000–2012



Source: FAOSTAT and SMIO, 2012.

In a typical year, irrigated wheat yields are more than double that of rain-fed wheat; but in years of inadequate rainfall and drought, the gap can be much larger. In 2012, the average yield of irrigated wheat was 2.97 tonnes per ha, compared with 1.18 tonnes per ha in rain-fed areas (Figure 6). A shorter trend yield of five years would result in 3 tonnes per ha yield in irrigated areas.

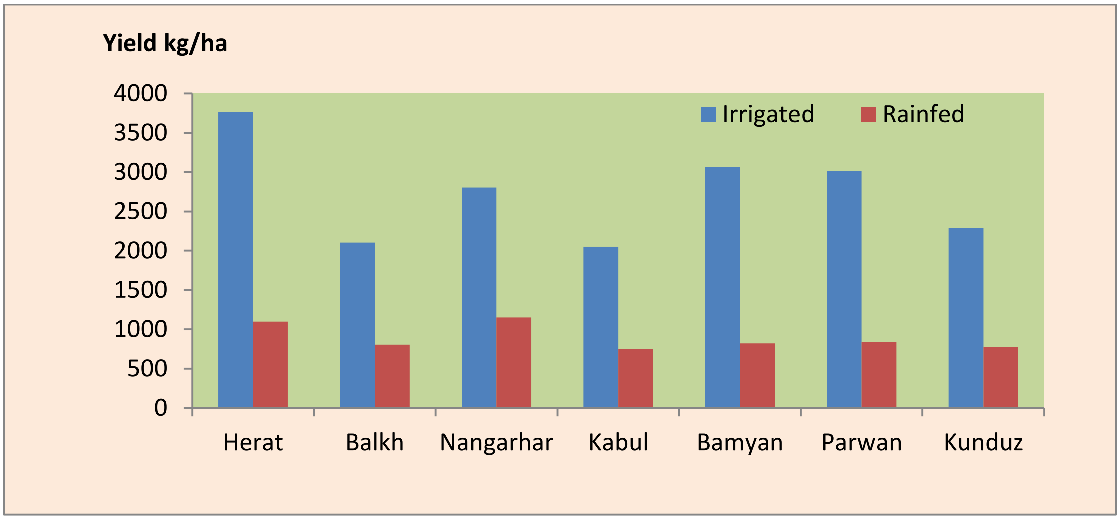
Figure 6. Irrigated and rain-fed wheat area and yield in Afghanistan, 2004–2012



Source: SMIO, various years.

Farmers who have adopted improved varieties of wheat and have applied proper inputshave increased their yields. In a farm-level survey conducted in seven provinces of Afghanistan in 2012, farmers in HeratProvince were found to harvest 3.76 tonnes per ha of wheat from irrigated areas, followed by 3.07 tonnes per ha in BamyanProvince (Figure 7).

Figure-7. Farm-level yields of wheat in selected provinces, 2012



*Source:*FAO, 2013.

In a 2013 farm management survey, the overall average yield of irrigated wheat in the surveyed areas was 2.85 tonnes per ha. The highest yield of rain-fed wheat was reported in Nangarhar Province (1.15 tonnes per ha), followed by Herat (1.1 tonne per ha). The average yield of rain-fed wheat in all provinces was 0.93 tonnes per ha (FAO, 2013).

Despite recent successes in increasing wheat production, the country remains chronically deficit in meeting the consumer demand for wheat and wheat flour. The gap between demand and supply increases dramatically in years when domestic production suffers setbacks due to unfavourable weather conditions. Also, domestic production is failing to grow in pace with the increase in demand for wheat as the population expands and the country enters a phase of increasing urbanizationand per capita income growth.

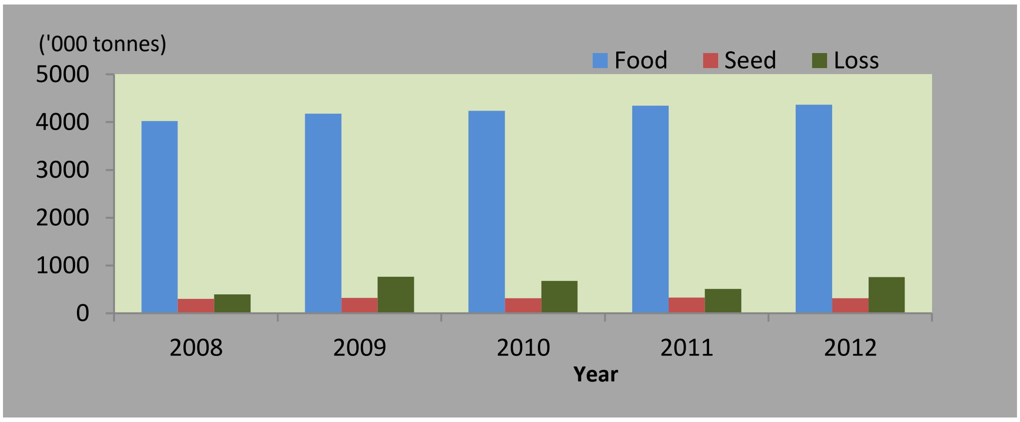
In its annual assessment of marketing-year cereal balance positions,the Ministry of Agriculture, Irrigation and Livestock (MAIL) projects the domestic demand for wheat as a total of the requirement for food, seed and loss and estimates the shortfall in domestic production. Figure 8 provides findings from the collected assessments for 2005 to 2012.In 2011, a year that experienced a poor wheat harvest because of droughts, the deficit rose to 1.79 million tonnes but then fell in 2012 to 386000 tonnes due to bumper harvests of wheat.

Figure-8. Requirement for wheat and wheat production in Afghanistan, 2005–2012

Source: MAIL, various years.

The bulk of the domestic wheat production (about 80 percent) is consumed as food. Farmers use a small portion of their wheat harvest (about 6 percent) as seed, and the remainderdisappears as loss in post- -harvest, handling, storage and transportation (Figure 9).

Figure-9. Use of domestic wheat production in Afghanistan, 2008–2012



A small share of domestically produced wheat is sold in the market; most wheat, however, is consumed by farm households, used to pay land rents or repay debt, is shared with landlords or is bartered (Chabot and Tondel, 2011). Local small-scale mills, known as *asiabs* or *zirandas*, process more than 90 percent of the domestic production. These mills have a particularly important role in rural areas, where transportation prohibits the internal movement of grain (Jalal and Albanese, 2013).

Wheat Supply

The total annual supply of wheat in Afghanistan over the past three years matched the demand, according to United States Department of Agriculture (USDA) estimates (Table 1).

Table- 1. Wheat demand and supply in Afghanistan, MY2010/2011–2012/2013('000 tonnes)

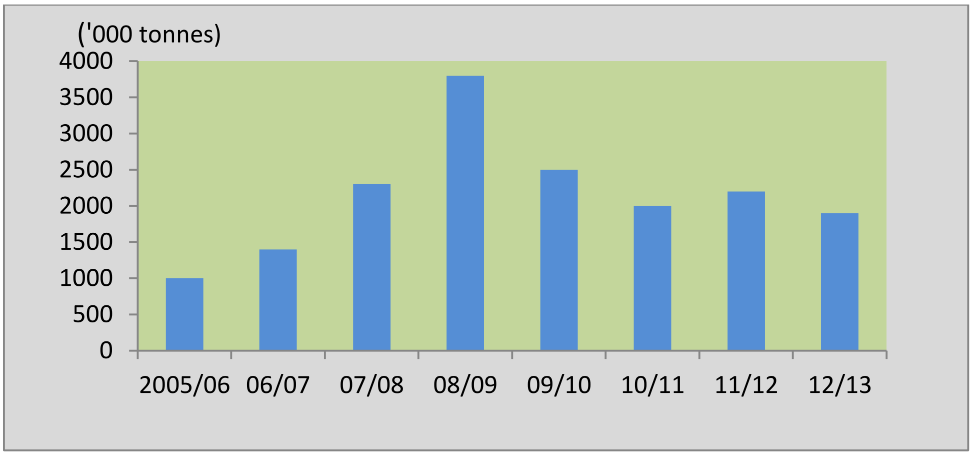
Item	2010 /2011	2011/2012	2012/2013
Beginning stocks	70	70	70
Production	**3700**	**2500**	**4150**
MY imports	2000	2200	1900
TY imports	2000	2200	1900
TY imports from the UnitedStates	38	14	0
Total supply	**5770**	**4770**	**6120**
Feed and residual	300	200	620
FSI consumption	5400	4500	5420
Total consumption	**5700**	**4700**	**6040**

Note: MY = mid-year; TY = total year;
Source: USDA Foreign Agricultural Service PDS database.

Trade has a key role in making up the shortfall in domestic production and keepingsupplies of wheat and flour at adequate levels in the local markets. Wheat is imported by private traders, both formally and informally in cross-border trade. Kazakhstan and Pakistan are the dominant suppliers of wheat flour, together accounting for 63 percent of Afghanistan's import requirements. Markets in the northern areas of the country are oriented towards trade with the Central Asian republics, particularly Kazakhstan. Markets in the East and South have a greater orientation to supplies from Pakistan. The Government occasionally procures a limited amount of wheat from farmers – in years of bountiful harvests, which it stores along with the food aid it receives from donors in the Strategic Grain Reserve, a contingency stock to meet emergency needs.

As evident from Figure 8, wheat imports in Afghanistan hovered between 2 million and 2.5 million tonnes between 2009/2010–2012/2013.

Figure-10. Wheat imports into Afghanistan, 2005/2006 –2012/2013



Source: USDA Foreign Agricultural Service PDS database.

According to Afghan traders, wheat imports from Kazakhstan and Pakistan are linked – if one source has problems with its exports, the traders will shift to the other source (Jalal and Albanese, 2013). This suggestsa relatively good level of grain market integration between urban markets in Afghanistan. Despite large shifts in domestic production, private markets appear to be responsive in supplying adequate supplies of grain (RASTA, 2012).

Types of wheat grown in Afghanistan

Wheat in Afghanistan is cultivated on diverse landscapes that vary in elevations, from 300 to 3500 metres above sea level. The majority of wheat grown in the country is fall-sown. The facultative type of wheat occupies 80 percent or more of the area, while winter types cover 20 percent of the total wheat area.

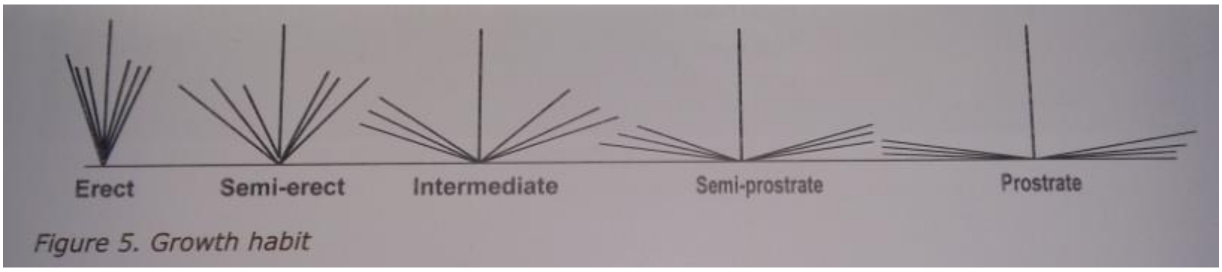
Afghanistan is rich in diversity of wheat genetic resources. The country sits on a hotspot of species diversity, as described by Russian scientist N.I. Vavilov (1941), who identified the Central Asiatic region as the birthplace of common wheat (*Triticum aestivum* L.) and the native home of club wheat (*Triticum compactum* Host). Many types of wild wheat (*Aegilops*) are also found.

Three types of wheat are cultivated by farmers in Afghanistan:*Triticum aestivum* L.,*Triticum compactum* L. and *Triticum durum*,as shown below. It is not uncommon to find a mixture of all these types in a single farmer's field. The most common and important type is bread wheat (*Triticum aestivum*). Small areas of club and durum wheat are also cultivated.

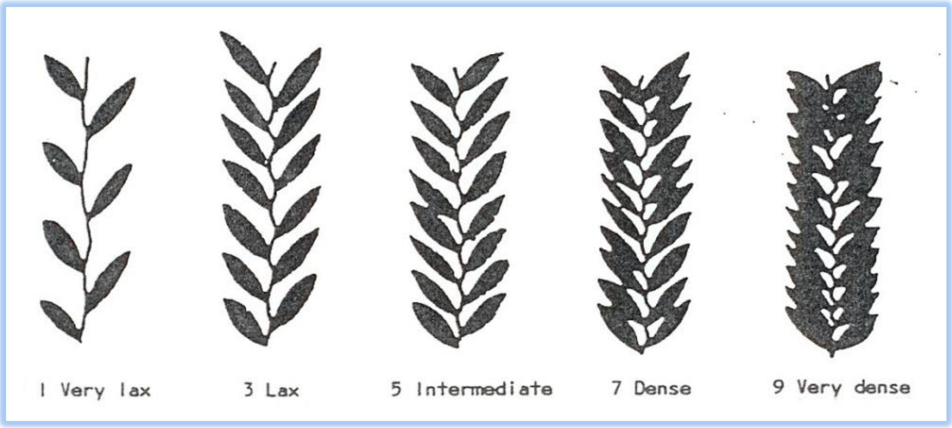
*Triticum aestivum*L.*Triticum durumTriticum compactum* (from left to right)

There are a number of descriptors that characterize a wheat plant. Based onthe growth habit of the young plant (appearance during tillering but before jointing), wheat is divided into five types– prostrate, semi-prostrate intermediate, semi erect and erect. Winter wheat has a prostrate growth habit, while facultative wheat possesses a prostrate, semi-prostrate habit.Spring varieties have mostly an erect growth habit.



By spike density (a visual measure of the density of a spike measured on a scale of 1–9), wheat is classified into five categories. These are very lax (1), lax (3), intermediate (5), dense (7) and very dense (9) (IPGRI, 1985).

Figure- 11. Classification of wheat, by spike density



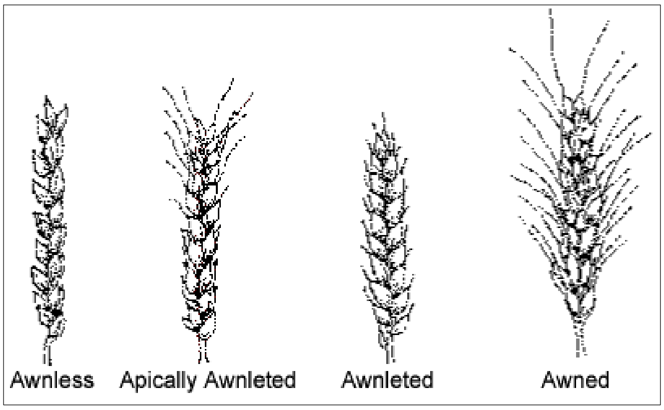
According to seed colour, wheat is divided into three major types– white, amber and red. The red colour is further divided into dark and light red. Afghan farmers tend to prefer the white and amber colours.

Based on texture, wheat is classified as soft red winter, soft white winter, hard red spring and hard red winter. Hard wheat (*T. aestivum*) is good for making bread and chapattis. Soft wheat is suitable for making biscuits, while hard wheat (*T. durum*) is used in making pasta products (Singh, 2013).

The size of the seed is classified into four categories: small, intermediate, large and very large. Based on the appearance of the dry seed after harvest and also measured on scale of 1–9, wheat is divided into plump (3), intermediate (5) andshrivelled (7) groups.

According to the presence of awns, wheat is divided into awn, awn-letted, or short awns, and awned, or conspicuous awns (Figure 12).

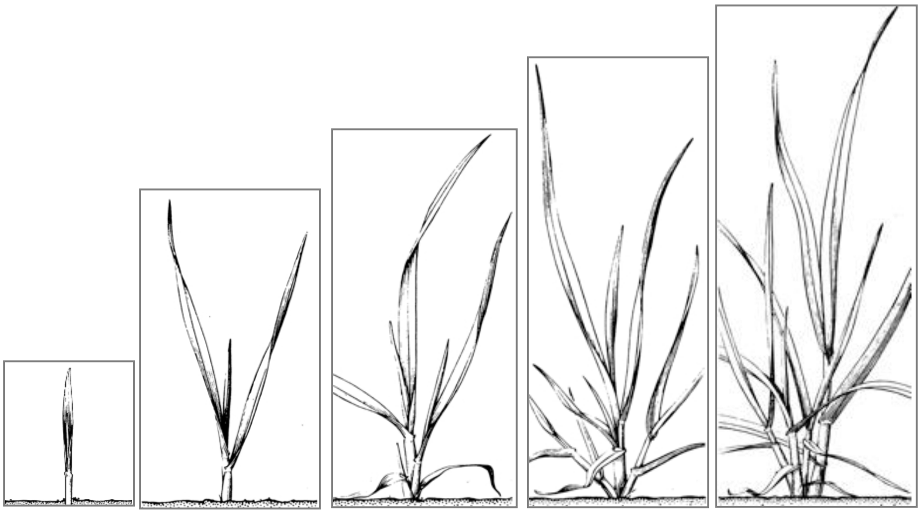
Figure- 12. Classification of wheat, by presence of awns



Steps in wheat cultivation

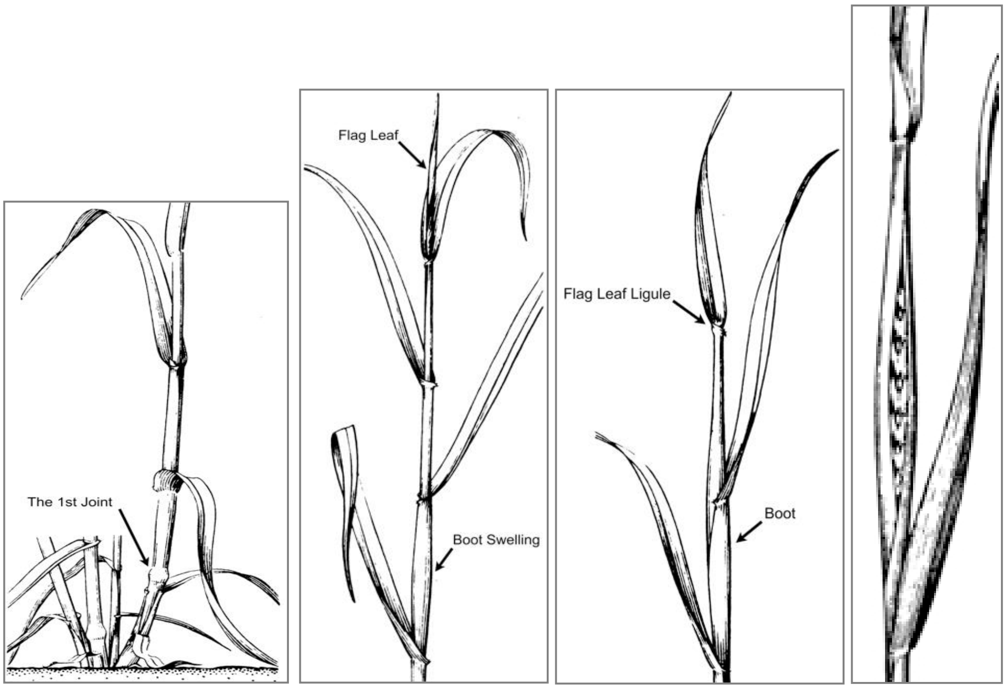
The range of activities required to grow wheat, from sowing seeds in the field to harvesting the grain to storage,are covered as 11 steps in this manual. It is important that you recognize the growth stages of the wheat plant so that you can plan and apply pre-planting and post-planting agronomic and crop management practices that support the efficient use of inputs that lead to healthy growth and development of the crop and ultimately to a high grain yield.The following illustrates the growth stages of the wheat crop plant (Weisz, 1980).

Vegetative growth



Emergence *Three leaves* *First tiller* *Three tillers* *Tillering ends*

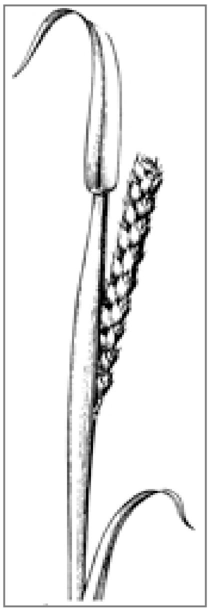
Stem elongation



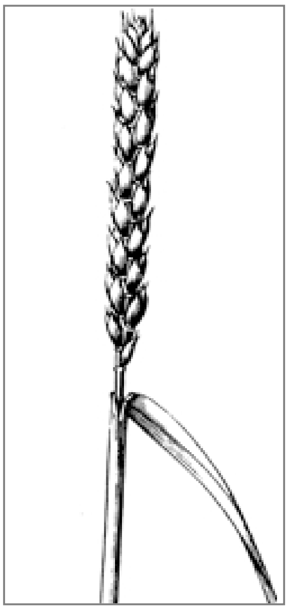
First joint

Flag leaf visible *Flag leaf ligule visible* *Boot splitting*

Heading and flowering



¾ of head visible



Fully headed

Flowering

Kernel formation

Soft dough

Harvestripe

Step 1: Identification of good-quality seed

What are the traits of a good-quality seed?

A good-quality seed is:

- high yielding;
- pure and clean;
- resistant to biotic and abiotic stress
- free from pests and diseases;
- plump and of uniform size; and
- at least 85germination capacity oduce

.

Good seed

What are the benefits of using good seeds?

Good-quality seeds are the basic building blocks of a goodwheat crop. Good seeds have:

- lower seeding rate;
- higher seedling emergence;
- reduced replanting and uniform plant stand;
- vigorous early crop growth and better ability to compete with weeds; and
- less disease and insect attack.

Good wheat crop

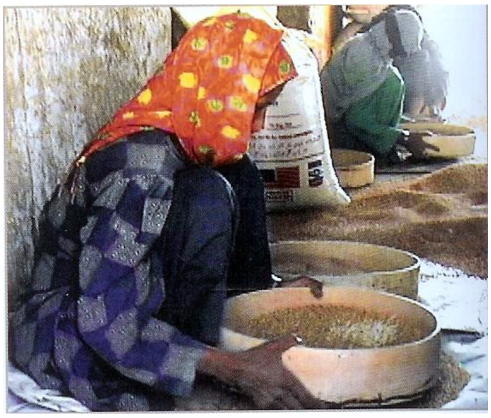
Cleaning the seed lot

The main objective of seed cleaning is to remove unwanted material, such as broken, small and shrivelledseeds, diseased seeds, weed seeds, seeds of other varieties, seeds that areof atypical colourand other inert material.

Seeds mixed with unwanted material

Seeds can be cleaned by the following methods:

- Use a seed cleaner, locally known as *gharbal*,which has sieves of different sizes for use in different crops.
- Clean by hand. Locally made blowers, known as *chaj*,can be used.



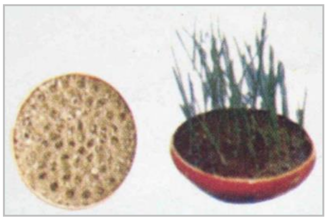
Cleaning seeds by hand

Conduct germination test

Conduct a germination test one week before sowing to determine if your seeds are good.

- Pick a handful of seeds from the seed container for the germination test.
- Use 100 seeds counted randomly from the collected sample (exclude only broken seeds) for setting up the germination test.
- Use an earthen pot or wet gunny bag for conducting the test and follow the next set of recommendations.

Earthen pot method



Fill the pot with moist soil and sow the 100 seeds bygently pressing into the soil; cover the seeds with a layer of moist soil. Do not dibble the seeds too deepor add too much water into the pot. Wet soil may inhibit the germination rate.

Gunny bag method

Cut a one-foot-long rectangular-shaped piece of fabric from an old gunny bag or thick sack.Dip the cloth into water to make it wet. Place 100 seeds in rows onto themoist sack and then fold and fasten it lightly, as shown in the picture. Store the sown seeds in a safe and shady place. Sprinkle water if the sack becomes dry.

7-10 days after setting the test, count how many seeds of the 100 germinated, with developed roots and a shoot. If the germination rate is 85 percent or more, use the prescribed seeding rate. If germination rate is less, use 250-500 g extra seed for each 1 percent reduction of germination.

Seed treatment

Prior to sowing, it is important to treat seeds with fungicides to control seed- and soil-borne diseases, such as bunts and smuts thatcause significant reductions of wheat and barley yields in Afghanistan. Survey data has shown that bunt can reduce the yield of wheat by up to 30 percent, especially in high-elevation areas of the country. The benefit of seed treatment is reflected in a 20–22 percent increase in the number of vigorous and healthy seedlings and a 10–12 percent increase in yields.

For seed treatment, follow these procedures:

- *Dry dust method*: Mix seed with Vitavax 200, a systemic fungicide, at the rate of 1–2 gr per kg seed (1–2 kg per tonneof seed). A low-cost device, as shown here, can be fabricated for the uniform mixing of the fungicide with seeds. Pour the required amount of seed and thefungicide into the device and turn it vigorously several times. In the absence of such a device, pour the mix of seed and fungicide into a tin container or a thick polythene bag. Close the opening tightly, and stir the mix vigorously several times. This will ensure uniform adherence of the fungicide to the seed surfaces.
- *Liquid method*: Prepare a thin paste by using a portion of the required water and the recommendedamount of Vitavax. Stir this paste into the remainder of the water and provide enough agitation to maintain a uniform suspension. This is then mixed with the seeds to give a uniform cover, based on 300 ml per 100 kg of seed.

  Vitavax 200 FF: It is a liquid fungicide for the control of bunt and other seed-borne and soil-borne diseases in wheat and barley. The rate of application is 300 ml per 100 kg seed.

What are the accepted minimum quality standards of wheat seed?

The minimum acceptable standard of quality for wheat seed means it has:

- genetic purity at a minimum of 98-99 percent (depending on the class of the seed);
- germination at a minimum of 85 percent;
- no living insects;
- amaximum of 5–10 weed seeds per kg;
- inert matter that does not exceed 2 percent; and
- a moisture percentage that does not exceed 12 percent.

Step 2: Selection of variety

The quality of a seed is determined by its genetic make-up. Choosingthe right variety alone can make a big difference in yield performance, with all other inputs being equal. Varieties differ in many traits, and it is thus necessary to assess what characteristics are most important for the agro-ecological environment of your production area.

In selecting a good variety, the trait that obviously would receive your foremost consideration is its yield potential. Ultimate grain yield is determined by plant density, tiller number, number of spikes per plant, number of spikelet per spike, number of kernels per spikelet and kernel weight.

Other important characteristics to consider are resistance to pests and diseases and to abiotic stresses, such as frost, cold, heat, salt and drought. The growth habit or seasonal type is an important consideration when deciding which varieties are suitable for fall or spring planting and for fitting into location-specific farming systems.

In areas that receive heavy snowfall, prolonged winter and cold spells, the obvious choice would be for winter-type varieties to be planted in autumn. Facultative-type varieties are suitable for areas that experience milder winters and where sowing is delayed into late autumn. These varieties take advantage of rapid growth with the onset of spring and can be harvested early. Spring-type varieties, which do not have any requirement for exposure to low temperatures in order to flower, are planted in spring and harvested in the fall.

Table 2 lists the improved varieties of wheat released since the 1990s for cultivation in different agro-ecological zones of Afghanistan through assistance from FAO, CIMMYT, ICARDA and FCOMAIL. Of these varieties, Solh-02, Pamir-94 and Gul-96 though they are facultative varieties with winter hardness (winter type) which can be sown in cooler areas., while, Rana-96, Roshan-96, Baghlan-09, Koshan-09 andMoqawim-09 are facultative varieties. The others are spring varieties. Ghori-96, Dayma-96, Lalmi-1, Lalmi-2 and Lalmi-3 are suitable for planting in rain-fed areas.These improved wheat varieties have, in general,been found to out-yield the local varieties by more than 50 percent.

Table-2.Recommended improved wheat varieties and their characteristics

Variety	Average plant height (cm)	Days to maturity	1000-grain weight (g)	Mean yield (tonnes per ha)	Resistance to diseases
Kauz or	86	176–284	36	5.50	Leaf rust: R

Bhaktawar-92					Yellow rust: MR Leaf blotch (score): 3 (0–9 scale)
Gul-96	98	181–287	45	5.78	Leaf rust and yellow rust: 0-MR
Takhar-96	99	195–281	361	5.36	Yellow, leaf and stem rust: R
Roshan-96	94	191–286	35	5.55	Yellow rust: 0-R Leaf blotch (score): 3 Bunt and Smut: R
Rana-96	95	199–269	39	5.02	Yellow rust: 0-R Leaf rust: MS
Ghori-96	Tall	113–175	49	1.38	Yellow, stem and leaf rust: R
Diama-96	Tall	113–175	37	1.25	Yellow, stem and leaf rust: R
Amu-99	100	185–267	39	5.80	Yellow rust: MR-R Leaf rust: 0-MR
Heart-99	96	182–291	39	5.40	Yellow rust: MR-R Leaf rust: 0-MR
Mazar-99	94	175–206	39	5.60	Yellow rust: MR-R Leaf rust: 0-MR
Lalmi-1	97	156	42	5.60	Stem rust: 0 Yellow rust: MR
Lalmi-2	83	153	32	5.80	Stem and yellow rust: 0
Lalmi-3	78	153	40	5.1	Yellow rust: R Stem rust: 0
Solh-02	Medium	-	40	5.70	Yellow, stem and leaf rusts: R
Inqlab-91	Medium	125–135	44	4.44	Yellow and leaf rusts:R
MH-97	87	-	43	4.90	Yellow rust: S
PBW-154	Medium	145	44	4.60	All types of rust: R
Darullaman-07	94	215	43	4.00	Yellow rust: R
Ariana-07	95	214	48	5.30	Yellow rust: R
Dorkshan-08	Medium	-	39	5.00	Yellow rust: R
Sheshambagh-08	Medium		43	5.40	Yellow rust: R
Baghlan-09	95	144	44	4.50	Resistant to Ug99 (stem rust)
Koshan-09	110	130	54	6.80	Resistant to Ug99 (stem rust)
Moqawim-09	95	142	40	5.90	Resistant to Ug99 (stem rust)
Chonte # 1	100	132	40	4.00	Resistant to Ug99 (stem rust)

Note: R =resistant, MR =moderately resistant and S =susceptible.

Step 3: Planting time

Correct planting time is critical in reaping the most of the potential yield of any wheat variety that you have chosen for planting. If you plant too early or too late, it is likely that the crop growth stages will miss the optimum weather conditions, negatively affecting the yield of your crop. The two important traits of your variety that you need to consider in choosing the optimum planting time are the number of days to mature and the vernalization requirement.

Vernalization(Chilling requirement)means that a fall-sown crop must be exposed to low

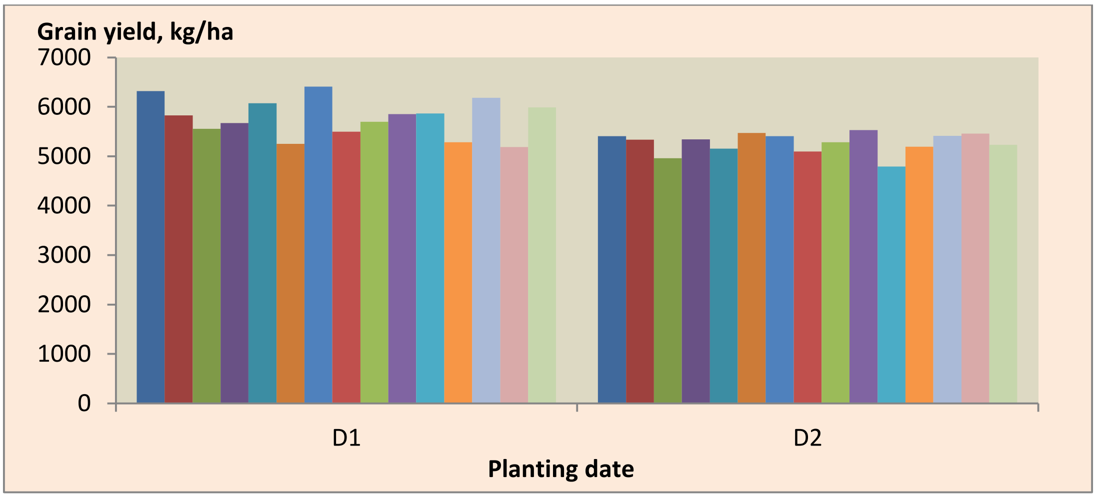
temperatures for a specific length of time in order for it to flower with the onset of spring. The vernalization requirement varies widely with variety. If the temperatures are warmer than usual, the wheat crop waits until enough degree-days are accumulated before heading. This delay in heading usually causes grain filling to occur in the hot and dry days, resulting in lower yields.

Winter wheat crop requires 180–280 days to mature, whereas spring wheat requires 100–130 days. Winter wheat needs vernalization during the early growth stages so that it can head out normally under long days. Winter wheat in the early growth stages shows resistance to frost damage, down to temperatures of -20^{o}C. Facultative wheat also requires a shorter but distinct period of vernalization.

In Afghanistan, both winter and spring types of wheat are grown under a wide range of agro-climatic conditions. The variations of these conditions are so large that while wheat is being planted in one part of the country, the time for harvesting the crop may have arrived in another part. Therefore, it is difficult to recommend the optimum planting date for specific areas. Varietal differences for specific or optimum time of planting have also been observed.

The effect of planting dates was tested in a trial at the Shisham Bagh Agricultural Research Station in Nangarhar Province in the 1997/1998 crop season, using 20 varieties of wheat and two different dates of planting – 25 November (normal) and 25 December (late) (Figure 13).

Figure- 13. Effect of planting date on yields of 15 bread wheat varieties



Source: Wassimi, 1999.

The performance of the three facultative bread wheat varieties depending on optimum fall (first week of October) and spring planting was investigated in a trial conducted in five locations. Fall-planted wheat matured 11–25 days earlier than the spring planting. Loss of yield at the spring planting varied, from 1063 kg per ha to 2503 kg per ha. Optimum fall planting gave more yield than spring planting, depending on the variety, ranging from 28

percent to 86 percent.

Based on these and other research results on planting time, we recommend the following planting periods for sowing wheat in different parts of the country to achieve the best yields (Table 3).

Table-3. Recommended planting times for winter and facultative wheat in Afghanistan

Province	Planting period
Kabul, Wardak, Logar, Parwan, Paktika,Bamyan, Badakhshan, Panjshir, Kapisa, DaiKundi and Ghazni	23 September to 23 October for winter wheat 12 October to 12 November for facultative wheat
Kandahar, Helmand, Farah, Nimroz, Zabul and Uruzgan	6 November to 6 December
Balkh, Juzjan, Faryab, Sar-i-Pul and Samangan	23 October to 23 November
Herat, Badghis and Ghor	6 November to 26 November
Bughlan, Kunduz and Takhar	6 November to 1 December
Nangarhar, Kunar, Laghman, Noristan and Khost	6 November to 6 December

Spring planting should start as soon as possible after the snow melts. However, the following dates are optimum time for spring planting at different elevations (metres above sea level):

- Medium elevation (1200–1800 m): 1 March–15 April.
- High elevation (1800–2500 m): 15 March–15 April
- Very high elevation (> 2500 m): 15 April–15 May.

The recommended planting periods for sowing spring wheat are: April for the central zone and Bamyan/Ghazni provinces; February for northern, western and eastern zones; 5 February to 10 March for the southern zone and rain-fed areas(Wheat Agronomy Factsheet).

Step 4: Seed bed preparation, sowing and fertilizer application

Tillage is important for preparing a good seed bed that creates conditions for easier root penetration, improved water filtration, well aeration and better contact between the seed and the soil. Soils should not be tilled when wet because it willcontributeto soil compaction andformation of large clods, which inhibit the emergence of the wheat seedlings. The amount of tillage necessary topreparethe seed bed depends on the soil type, soil moisture availabilityand the preceding cropping pattern. Excessive tillage may lead to loss of moisture in the soil.

To prepare, sow and fertilize the seedbed:

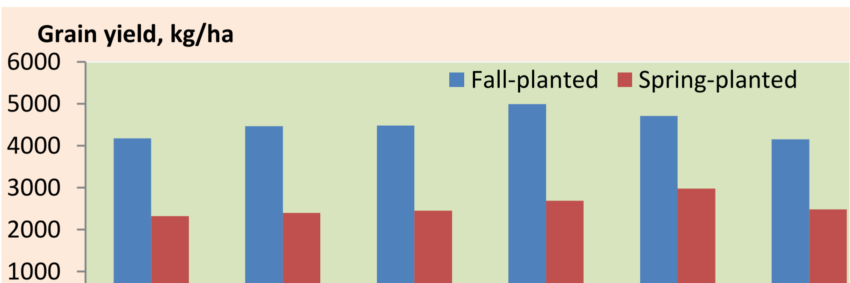
- Plough the soil with draft power or a power tiller as soon as it is dry enough to be worked out. The seed bed should be levelled as much as possible. When the soil is not level, it is difficult to operate machinery, such as seeders and harvesters. Also, when irrigation water is applied, water cannot reach all areas of the land. Some areas are overirrigated and some underirrigated, and you need low water-use efficiency.
- If the moisture content of the soil is low, apply a light pre-sowing irrigation (about 150 mm of water) to bring the soil moisture content to field capacity.
- A farmer may decide whether to pre-irrigate the field and then sow the seeds into the moist soil or to sow the seeds into dry soil and then irrigate to germinate the seeds. Experiments on these two methods of seedbed preparation at different planting times in the fall showed no significant differences between the mean yields obtained by either method of seed bed preparation.
- Broadcast the seeds and fertilize evenly. To ensure uniform distribution, broadcast them separately in directions perpendicular to each other.
- Cover the seeds and fertilize to proper depth by using a*mala*, a local tool pulled by a tractor or oxen, at least twice in directions perpendicular to each other. This levels and presses the soil, thus improving contact of the seeds with the soil and ensures adequate moisture for germination.

Seeding rate

The optimum seeding rate is determined by sowing method and growing conditions. Afghan farmers generally use high seed rates, ranging from 175 kg per ha to 280 kg per ha.They do it to compensate for failure in getting some seeds at the right depth due to the unavailability of seed drills. FAO conducted a seed rate trial in 1996 in farmers' fields in Ghazni Province and found seeding rates that varied from 100 kg per ha to 200 kg per ha. The tests showed that 150 kg per ha (30 kg per jerib) was the optimum seeding rate for the variety Pamir-94 (Wassimi, 1999).

A trial was conducted at theDarul Aman Agriculture Research Station from 1987 to 1992 to test the effect of sixseeding rates and the time of planting (fall versus spring) on the yields of three facultativevarieties of wheat (Nazri, 1992). Figure 15 shows the results for the variety Darul Aman 1. The yield average of all the seeding rates was 4,495 kg per ha in fall planting, compared with 2,556 kg per ha in spring planting. The seed rate of 140 kg per ha produced the highest yield in fall planting, while in spring planting the highest yield was obtained with 157.5 kg per ha. This suggests that if, for any reason, farmers fail to plant facultative wheat in the fall, higher seed rates will be needed for the spring planting to compensate for the reduction in tillering capacity.

Figure-14. Effect of seed rates on the yield of variety Darul Aman-1



*Source:*Nazri, 1992.

Based on those results, the following guidelines in choosing an appropriate seed rate could be recommended.

- If a seed drill or shallow ploughing is used, the optimum seeding rate is 100–125 kg per ha (20–25 kg per jerib).
- If a local plough is used that cannot control the seed depth, the optimum seeding rateis150–175 kg per ha (30–35 kg per jerib).
- Spring-planted wheat requires about 3.5 kg per jerib(17.5 kg per ha) more seed than fall planting.
- For spring-planted wheat,175 kg per ha (35 kg per jerib) is the most suitable rate.
- Under dryland conditions, 60–75 kg per ha (12–15 kg per jerib) is the optimum rate of seeding.
- The recommended seed rates (kg per ha) for the broadcast method of sowing are:125–140 under irrigated conditions and 85–105 under rain-fed conditions. The corresponding rates in row sowing are: 110–120 under irrigated and 85–105 under rain-fed conditions (Wheat factsheet).

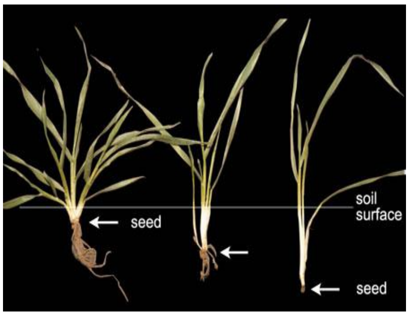
- Usea seed drill, if you have access to one (for example,a two-wheel tractor-operated seeder, as shown here) to sow seeds in line at a pre-determined depth, with line-to-line spacing, and soil levelling at the same time. In addition to saving the amount of seed for sowing, this would improve seed germination and help form a uniform plant stand.
- If the planting date is delayed, seeding rates should be increased by 15–20 percent to compensate for the fewer tillers that will form and because higher densities tend to shorten the time to flowering.

Two-wheel tractor Operated-seeder

- Use certified seeds to make sure you are planting seedsthat havea minimum germination of 85 percent and arefree of noxious weeds.

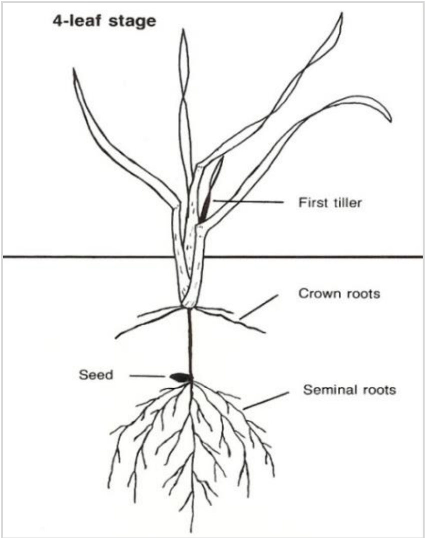
Depth of seeding

Local varieties of wheat in Afghanistan have long coleoptiles that can emerge and come up to the soil surface from greater depth; but the improved higher yielding varieties have shorter coleoptiles, which cannot come up to the ground surface if they are planted too deep. Remember that regardless of the planting depth of wheat, the crown roots will form at about 2.5 cm below the soil surface (Rice, 1970), as shown in Figure 16.



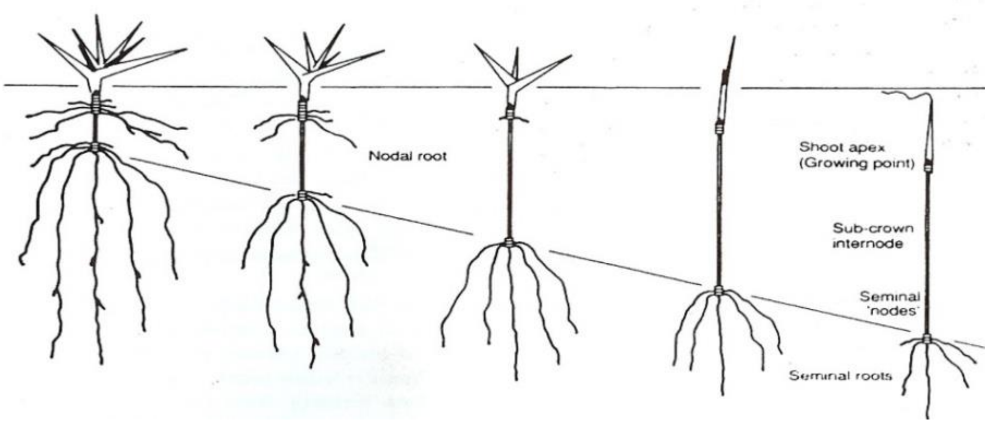
The planting depth of the wheat seed has great effect on thegrowth and development of the seedling and crown root. The deeper the planting of the wheat seed in the soil, the weaker is the emergence andthe growth of the seedlings and the crown root initiation. Figure 17 shows the effect the depth ofplanting seed has on seminal roots, crown root initiation and the growth of thewheat seedlings.

Figure- 15. Wheat root initiation and development



Shallower seedling speeds emergence and increases tillering (Rawson and Macpherson, 2000)

Figure-16. Effects of planting depth of the wheat seed on seedling growthand crown root development



Consider the following in deciding the depth of planting wheat seed in your field:

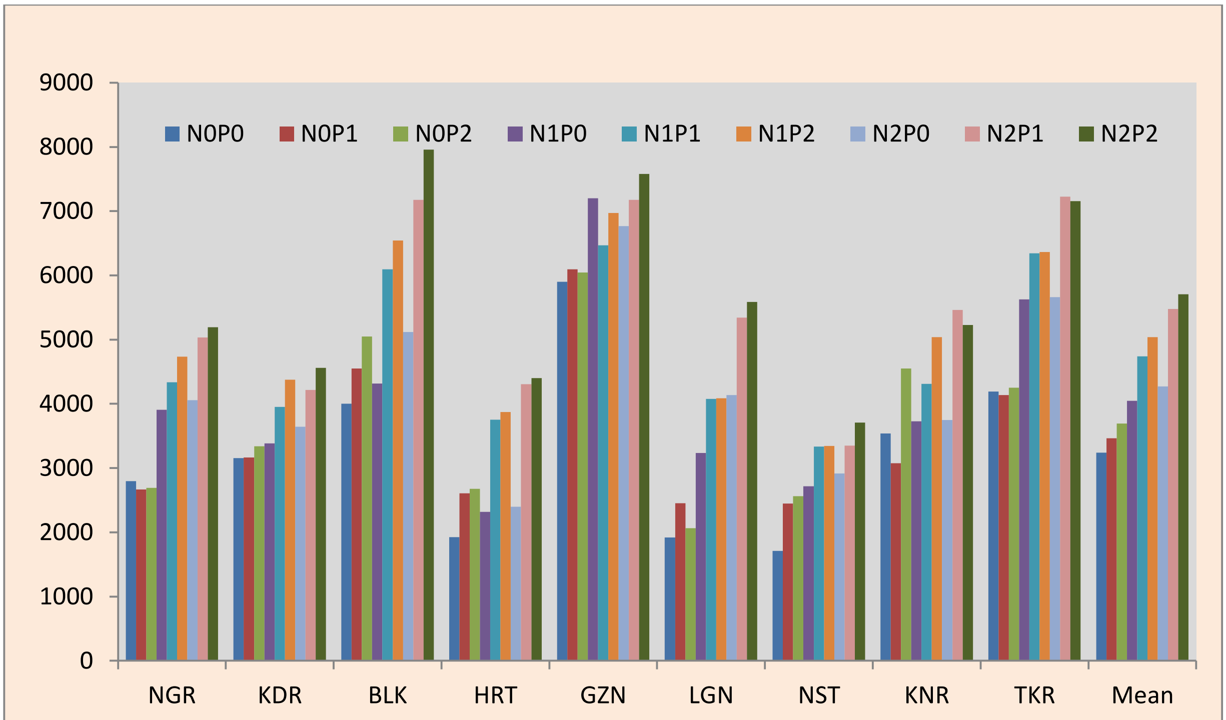
- Plant seeds to a depth of 2.5 cm in a level and compact seed bed under optimum soil moisture conditions.
- Under typical farm conditions, 3–6 cm appears to be the near optimum planting depth. Planting deeper than 6 cm results in reduced seedling.
- Avoid excessively deep planting.It causes delayed emergence and low seedling vigour.This, in turn, affects tillering, cold resistance and the ability to compete with weeds.

Fertilizer rates

Soil fertility is a primary yield-building component in wheat management. Maintenance of adequate soil fertility depends upon application of both mineral fertilizers and organic manures. The recommendations on fertilizer application take into account the amount of plant nutrients removed with yield, among which nitrogen (N) and phosphorus (P) are the major ones.

To develop such recommendations, fertilizer rate trials were conducted in nine provincesfrom 1996 to 2000and that involve nine treatments of nitrogen and phosphorus, with the levels of N (kg per ha) ranging from 0 to 115 and of P_2O_5 (kg per ha) ranging from 0 to 92 (Wassimi, 1999). The results of these trials are shown in Figure 18.

Figure- 17. Effect of different rates of N and P on grain yield of wheat, 1996–2000



Locations: NGR-Nangarhar, KDR-Kandahar, BLK-Balkh, HRT-Herat, GZN-Ghazni, LGN-Laghman, NST-Nooristan, KNR-Kunarha, TKR-Takhar

$N-P_2O_5$ (kg/ha): N_0P_0 (0-0), N_0P_1: (0-46), N_0P_2 (0-92), N_1P_0 (57-0), N_1P_1 (57-46), N_1P_2: (57-92), N_2P_0: (115-0), N_2P_1: (115-46), N_2P_2: (115-92)

The treatment with N_2P_2 (115 kg N per ha and 92 kg P_2O_5per ha) produced the highest yield of wheat in all provinces, ranging from 3,710 kg per ha to 7,957 kg per ha, with an average yield of 5,707 kg per ha. The treatment of N_2P_1 (115 kg N per ha and 46 kg P_2O_5per ha) produced the second-highest yield, with the average at 5,476 kg per ha.

Based on those results, we suggest that farmers take into account the following in deciding the rates and methods of fertilizer application:

- If it is affordable, the highest dose (115 kg N per ha and 92 kg P_2O_5 per ha), equivalent to 50 kg ureaper jerib and 40 kg superphosphate per jerib, can be applied to obtain most yields. But nitrogen fertilizer prices have increased significantly and are currently at an all-time high. Also, good-quality phosphorus fertilizer is difficult to find in Afghanistan. Therefore, choosing the proper rate and timing of application is critical in terms of making an economic yield.
- The second-highest dose (115 kg N per ha and 46 kg P_2O_5 per ha), equivalent to 50 kg urea per jerib and 20 kg super phosphate per jerib, which is more economical, is recommended for use. These rates are applicable for the improved varieties of wheat. For the local varieties, half of these amounts (25 kg urea per jerib and 10 kg superphosphate per jerib) should be used because using the same levels of fertilizer on local varieties as the improved varieties will cause lodging, which leads to yield reduction.
- The optimum fertilizer rates for application in dry-land areas are 12 kg urea and 5 kg superphosphate per jerib.
- Nitrogen fertilizer (urea) should be applied in two equal splits. Apply half at the planting time and the remainder during the first irrigation after first weeding in the spring. A delay in the second application of the urea will delay the maturity of the wheat crop.
- Apply all of the phosphorus fertilizer at the planting time. If nitrogen is applied in the ammonium form and sulphur is used, it is better to band the phosphorus with ammonium nitrogen and sulphur rather than to apply them separately. The uptake of phosphorus by wheat roots is better and more efficient when it is mixed with the ammonium form of nitrogen. Compared with broadcast application, band application of phosphorus increases its availability and early access to the young wheat plants. Early access to fertilizer produces more vigorous plants, and thus wheat competes better with weeds. Also, the banding of phosphorus can improve winter survival of wheat in areas where winter-kill is a problem (Cook et al., 1991). The common basic calcareous soil of pH 8.2 in Afghanistan is low in available phosphate.
- Research results have shown that potassium and other micronutrients are not now limiting factors in wheat production in Afghanistan. Using micronutrients gives no benefit on wheat yield improvement in Afghanistan (ARIA, 1971).

Step 5: Irrigation and water management

Wheat has two types of roots:i) seminal and ii) crown, or tiller roots. Seminal roots are produced from the embryo carried in the seed, and crown roots are produced from the base of the tillers, beginning after the four–leaf stage, when the first tiller emerges. In the very early stages of wheat growth, nourishment comes from the endosperm of the seed. After germination of the seed, the absorption of water and nutrients from the soil takes place through the seminal or seedling roots. Wheat develops its crown roots about two weeks after plant emergence and continues developing them until the plant reaches the jointing stage (Cook et al., 1991;Weisz, 1980). By heading time, most roots have been established. Both types of roots are shown in Figure 17.

- Wheat usually emerges in 9–11 days, with the normal and optimum dates of planting. If emergence is poor and spotty due to the lack of moisture, a light irrigation should be given as soon as the problem is evident (Rice, 1970).
- Generally, the first irrigation should be applied 21–25 days after planting. This is a critical time for irrigation, because wheat tillers begin to differentiate and crown roots begin to emerge. Usually, the crown root forms about 2.5 cm beneath the soil surface. When the surface of the soil is dry, the crown roots system and tillers will not develop well. This irrigation should be light, with approximately 5 cm of water just to moisten the surface of the soil.
- Farmers must be convinced of the need and importance of irrigating wheat at the crown root initiation stage, in spite of their tradition to postpone irrigation until the spring. Fall irrigation is especially needed for the dwarf wheat varieties because of their longer growing season in the fall (Rice, 1970).
- To obtain the highest yield, apply four irrigations: at the crown root initiation, the jointing, the heading and the milk dough stages. If there is shortage of irrigation water, three irrigations (at the crown root initiation, heading and milk dough stages) will still produce higher yields.

Farmers should consider the following in deciding the total amount and scheduling of irrigation water:

- Wheat requires 450–650 mm of water during its growing period. The flowering period is the stage that is most sensitive to water deficit. Winter wheat's active rooting depth is up to 1.2 m, with maximum at 1.5–2.0 m, and the active rooting depth of spring wheat is 0.9 m, with the maximum at 1.2–1.5 m.
- Wheat's water extraction pattern is related to root density. In general, 50–60 percent of the total water uptake is from a soil depth of up to 0.3 m. Then, 20–25 percent of water uptake comes from the second 0.3 m, while 10–15 percent comes from the third 0.3 m. less than 10 percent comes from the last 0.3 m of soil depth.
- Maximum evapotranspiration of wheat is about 5–6 mm per day.The best time for applying water is when 50–60 percent of the available water can be used before the next

irrigation (Doorenbos et al., 1979).

- Wheat varieties differ in their requirement of irrigation water. An irrigation experiment conducted on the variety Darul Aman-4,a facultative tall wheat variety,atthe Darul Aman National Agricultural Research Station during 1988–1991 found that applying 450 mm water was enough for this variety. This amount of water was divided intofour applications, as follows:
  - Two irrigations in the fall: 150 mm pre-irrigation and 50 mm at crown root initiation.
  - Two irrigations in the spring: 150 mm at the heading stage and 100 mm at the grain-filling stage (ARIA, 1989)
- Avoid using too little (water stress) or too much of irrigation water (waterlogging). Water stress arises from drought or when irrigation is not applied often enough or deep enough. Waterlogging arises from excessive rainfall, overirrigation too often and/or too much water added.
- The symptoms of water stress are poor crop stand, reduced tillering, rolled or wilted leaves, dull grey-green leaves, leaves dying (especially the tips) and lower grain weight.
- The symptoms of waterlogging are bright yellow or dead lower leaves and pale yellow upper leaves. Roots may be discoloured (brown) (Marsh and Jackson).

Supplementaryirrigation

Supplementary irrigation is the addition of a limited amount of water to the rain-fed crop during times when natural precipitation or rainfall fails to provide enough moisture for plant growth.

What are the benefits of supplementary irrigation?

Supplementary irrigation has three major benefits:

- increase in yield by providing a crop life-saving irrigation;
- stabilization of production; and
- provision of conditions suitable for use of high-technology inputs.

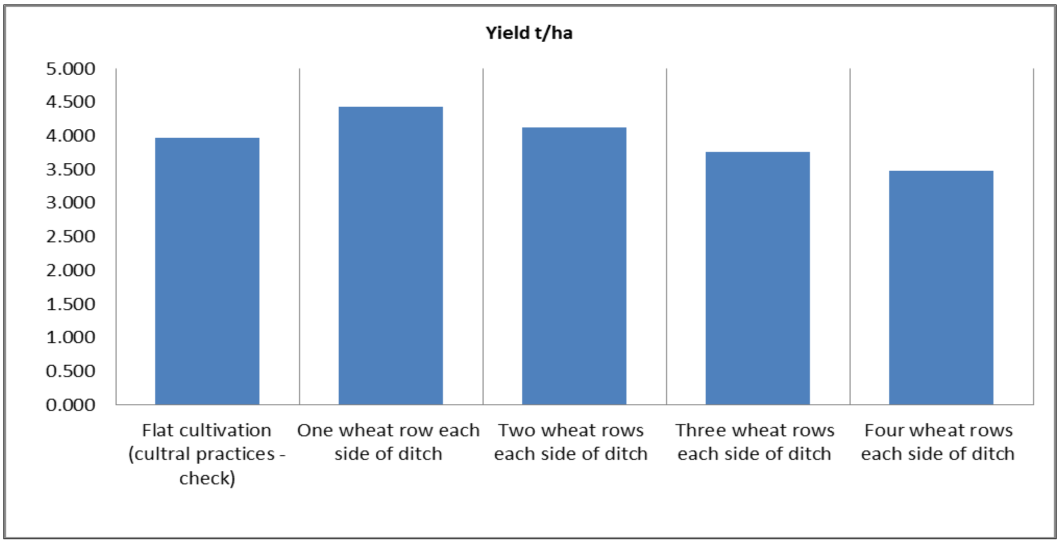
These benefits were demonstrated in research on dryland wheat cultivation(Oweis, 1979). Application of 75 mm of supplementary irrigation increased the wheat yield, from 2.25 tonnes per ha to 5.9 tonnes per ha in the dry crop years when total rainfall was 234 mm. In wet years of more than 500 mm rainfall, the yield increased, from 5.04tonnes per ha to 6.44 tonnes per ha, by using the same amount of supplemental irrigation. In average years with total rainfall of 316 mm, dryland wheat yield increased, from 2.3tonnes per ha to 5.6 tonnes per ha, by applying 120 mm of supplementary irrigation.

Economy in irrigation water use

A raised bed system of planting facilitates considerable reduction of the amount of irrigation water because it involves fewer furrows and minimum loss when conveying water within the fields. The advantage of this method of planting was demonstrated in a 2011–2012 trial conducted at the Badam Bagh Research Station (Figure 19). It showed that the raised bed technology could contribute to saving 20–50 percent irrigation water.

The important point to consider in making furrows is the soil type. In the clay soil, the distance between two furrows can be more because the water can move both vertically and horizontally with less infiltration rate. In sandy soil, the distance between rows should be less to compensate for high infiltration rates.

Figure- 18. Raised bed wheat planting saves 20–50 percent of water



Raised bed system with two rows ofseedlings on each bed

Winter hardiness

You may need to take into account winter hardiness of your wheat crop in areas where winter is long and temperatures remain well below the freezing mark. Consider the following management practices to increase winter hardiness:

- Adjust the planting date so that the wheat crop enters the winter with one to three tillers. Wheat exhibits maximum winter hardiness at this growth stage.
- If planting is delayed, wheat seedlings are likely to be in the early growth stages (the one- to two-leaf stage) at the onset of winter. If planted too early, many tillers will have formed by the time winter arrives. In both cases, wheat crop is more likely to be winter-killed than are seedlings that are just starting to tiller.
- Shallow-seeded wheat is hardier than deep-seeded wheat.

Winter survival

Vegetative growth damaged

In areas where there is a problem of killed wheat due to cold winter weather, the following steps should be taken:

- Choose winter-type varieties that are more resistant to cold.
- Do not plant seed too deep. Plants that are seeded deep neverfully recover from February frost, whereas those that areplanted shallow tend to remain healthy and grow normally.
- Adhere to the recommended dates of sowing in the fall.
- Plants thatare in the three- to four-leaf stages and have developed good root systems before the onset of cold weather are at the proper stages for both winter survival and rapid recovery in the spring(Cook et al., 1991).

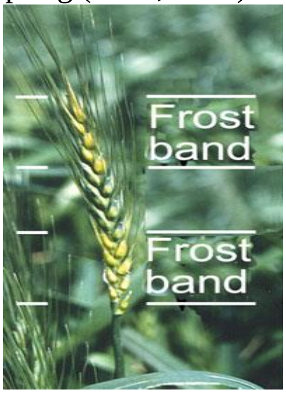
Frost damage

Wheat is vulnerable to spring frost damage during the jointing, heading and flowering times. Exposure to spring frost causes plant sterility, which reduces yield, and there is more bird damage, especially in isolated wheat fields.

Take the following measures to minimize spring frost damage:

- Select the right planting date to avoid exposure of the crop growthstages most sensitive to frost damage.
- Select early-maturing varieties, such as Pirsabak-85, PAK-81,Kauz (Bakhtawar-92) and Takhar-96, which are seeded in the fall and will head early in the spring, thus avoidingexposure to spring frost.
- Avoid late-spring frost damage by sowing seeds of the adapted varieties and by not planting too early in the fall. In some cases, such as the facultative wheat varieties

mentioned previously that were late planted, the seed will survive in soil covered with snow and will germinate in early spring (Saari, 1992).



Spikelet damaged by frost (Rawson and Macpherson, 2000)

Step 6: Weed management

Weed control is one of the key aspects of your wheat crop management practices. The following are the reasons why you must pay adequate attention to the management of weeds in your crop:

- Weeds compete with wheatfor all the resources that a plant needs to grow. These are space, sunlight, water and nutrients. By competing with weeds, wheat plants may not be able to capture enough of these resources, which will be reflected in the reduction of yield. For example, *Phalaris* (Domb robah fox tail) uses three times more water and nutrients. *Sinapis* (Gundom wahshi) uses ten times more water and nutrients. And oats (Ulaf, Silselah or Lashak) use 15 times more water and food than a wheat crop.
- Severe weed infestations can reducewheat yields by at least 70 percent if left uncontrolled (Smith, 2012). Some weeds can damage the crop by producing toxic substances or acting as hosts for disease. Research on yield losses is not available in Afghanistan due to weed infestation. But in one observation on three wheat varieties, Pirsabak-85, Roshan-96and Takhar-96, 40 percent yield reduction was recorded due to weed infestation. An assessment of the wheat yield losses due to weed infestation in Pakistan showed a wheat yield loss at 17.3 percent (FAO, 1997).
- Weeds develop the ability to shatter seeds before wheat matures. Weeds can be a problem during harvesting; weed seeds can contaminate the grain, and the green matter from late maturing weeds can contaminate the straw.
- Weed seeds stay in the soil for many years and then germinate (some germinate after more than 27 years in the soil). Some weed seeds can grow from as deep as 15 cm in the soil.
- The presence of weedy plant fragments may also reduce the food and feed value of wheat.

The following illustrates the major weeds that attack wheat in the various zones of

Afghanistan:


Field bindweed (Convolvulus arvensis) *Wild oats (Avena fatua)*
Local name: Paichak *Local names: Ulaf,Silselah or Lashak*


Canada thistle (Cirsium arvense) *Wild mustard (Brassica kaber)*
Local name: Latakhar *Local name: Sharsham*


Russian knapweed (Acroptilon repens) *Rye (Secale cereal)*
Local name: Talkhak *Local name: Jowder*

Johnson grass (Sorghum halepense)
Local name: Ghomai

Foxtail (Setaria spp.)
Local name: Domb robah

Wild clover (Trifolium spp.)

Local name: Shafdar wahshi

What can you do to control weeds?

Too late to tiller, dominated by broadleaf weeds

There are several ways to manage the weed threat:

- When buying seeds for sowing, make sure those seeds are certified and weed-free. If you are using your own seed and your seed samples commonly have weed problems, consider preparing a small weed-free area on your farm solely for producing seed for planting next season. This will save work in the long term.
- Prepare a good seed bed so that the crop emerges quickly anduniformly and attains dense stand.
- Annual weeds compete most effectively with wheat during the seedling stages and early tillering. Plant seeds at the proper time and rate.
- Once the crop is covering 50–70 percent of the soil surface at jointing, it will dominate most newly germinating weeds.
- Perform weeding operations as soon as the crop emerges. Remove weeds when they are small, which is when they are most susceptible to damage.

- If a few weeds escape earlier control, remove them prior to flowering to avoid seeding, but do not damage the crop. Weed seeds mature extremely quickly.
- If you are using chemical weed killers (herbicides), survey the crop field to know the type of weeds before choosing herbicides. These come in various formulations designed to deliver action on specific types of weeds at different stages of growth.
- While using herbicides, follow the directions on the label closely and ensure the application timing is most appropriate to deliver the lethal effect. Never exceed the recommended dose. A strong mix may damage the crop. Apply the herbicide uniformly with a calibrated sprayer. Do not use the same herbicide year after year.
- Check on alternative herbicides that can be used to control difficult weeds. Post-emergence herbicides that are absorbed by leaves work better when the weeds are growing actively. Spraying early morning after thedew has lifted may be better than late afternoon. Do not spray if it is raining or about to rain.

Types of herbicides

There are four categories of herbicides, as described in Table 4.

Table- 4. Types of herbicides

Herbicide	Mode of action
Soil sterilant	Applied on the soil to control all weeds and plants.
Pre-plant	Applied prior to planting to control early weeds that grow before the crop is planted.
Pre–emergence	Applied immediately after planting.
Post–emergence	Applied after weeds have emerged in the field. This method is practised by some farmers in Afghanistan

Table-5. Dosage and time of application of some herbicides used in wheat

Herbicide	Dose range/ha	Plant growth stage for application and types of weed controlled
Chlosulfuron	12–23 g	From 2-leaf to boot.
Metsulfuron-methyl	7 g	From 2-leaf stage until just before booting. In durum wheat, from 4-leaf stage to boot.
Thifensulfuron	35–42 g	Winter wheat: after 2-leaf stage and before the third node is detectable. Spring wheat: from 2-leaf stage but before first node is visible.
Tribenurron	12–23 g	From 2-leaf stage but not after first flag leaf is visible.
Bromoxynil	0.25–0.5 kg	Apply as post-emergence until just before booting.

Clopyralid	.070–0.25 kg	Post-emergence broad leaf control and Canada thistle suppression.
Dicamba	0.1–0.15 kg	Winter wheat: after dormancy breaks in spring and before wheat begins to joint. It is best used in combination with other broadleaf herbicides.
2,4-D	0.5–0.85 kg	Apply to seedling weeds after full wheat tillering has begun (about 5 leaves) and before the boot stage. Often injures winter wheat.
MCPA	0.25–0.5 kg	Apply to seedling weeds after wheat tillering has begun (about 5 leaves) but before the boot stage.
Diclofop-methyl	0.85–1.4 kg	Post-emergence control of wild oats and some annual grasses in the 1- to 3-leaf stage.
Difenzoquat	0.7–1.1 kg	Post-emergence control of wild oats in fall-seeded wheat and spring barley.
Fenoxaprop-ethyl	0.12–0.18 kg	Post emergence control of wild oats and several other annual grasses in wheat.
Imazamethabenz-methyl	0.2–0.5 kg	Post emergence control of wild oats and many Brassicaeae.
Isoproturon	1.5–2.5 kg	Pre-emergence control of wild oat and pre- and early post-emergence control of several annual grasses and broadleaf weeds in wheat and barley.
Triallate	1.4 kg	Pre- or post-seeding control of wild oats.

*Source:*Labrada, 1994.

Chlorsulfuron controls many broadleaf weeds and suppresses some grasses. It has foliar activity, but is most effective after root uptake. It can be applied after the two-leaf stage and before the boot stage of wheat. The addition of a surfactant is required. It persists in the soil, so there may be rotational cropping restrictions; it should not be used if the soil pH is higher than 8.0. There have been several problems with weed resistance to chlorsulfuron, and its use has been restricted because of the rapid development of resistance (FAO, 1997).

A combination of Bromoxynil and MCPA (produced by Bayer as a new herbicide named Buctril M)applied at the rate of 1,000–1,500 ml per ha has also been used for the control of broad-leaf and narrow-leaf weeds. The best time of application is from the two-leaf stage to early tillering. Arelon (Isoproturon) 50 has been applied at the rate of 1,785 ml per ha for the control of narrow-leaved and, to some extent, broad-leaved weeds. DicuranMA

(chlorotoluron combined with MCPA) at the rate of 6 ml per litre of water is used for the control of both broad-leave and narrow-leave weeds. Graminnon, at the rate of 2 kg per ha, is used to control narrow-leaf weeds in wheat fields.

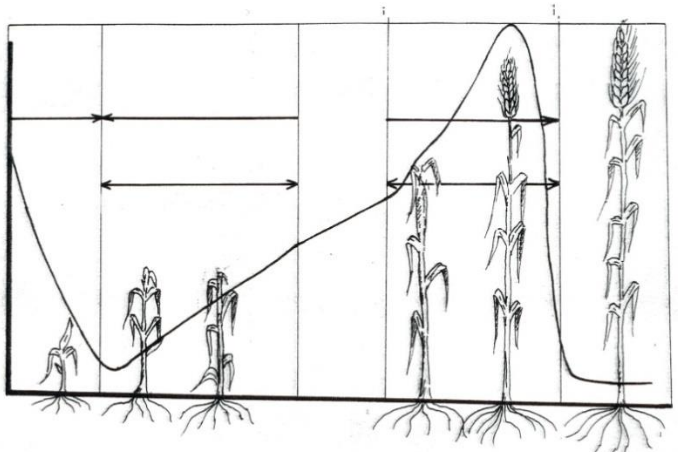
Pikto (topik) is used for the control of grass in a wheat field, at the rate of 180–200 cc per ha.Puma (Super or Ralon Super) is used for the control of wild oats in a wheat field, at the rate of 0.8 l lit./ per ha during the tillering time of wheat.

Remember that herbicides must be applied when the field is wet and soil moisture is near field capacity since some of these herbicides are systemic. Application in the dry soil will not give good results because the weeds are not in a lush growth or at a susceptible state.Also herbicides should be applied when weeds are young and in an early growth stage and the wheat crop is in tolerant stages of growth. Figure 20 shows the proper time of post-emergence herbicide application on a wheat crop.

Figure-19. Proper time for post-emergence herbicide application

Highest damage

Lowest damage



Seedlingtilleringjointing Booting floweringmaturity

Step 7: Disease management

There are many diseases that affect wheat. In Afghanistan, fungal diseases are common and cause most of the damage to the wheat crop (Table 6).

Table-6. Diseases affecting wheat in Afghanistan

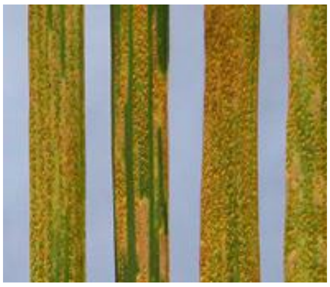
Disease Fungal diseases	Distribution	Importance
Stem rust	General	Major
Leaf rust	General	Major

Stripe rust or yellow rust	General	Major
Common bunt	General	Major
Loose smut	General	Minor
Flag smut	General	Minor
Powdery mildew	Southeast, Central	Minor
Tan spot	Southeast, Central	Minor
Spot blotch	General	Minor
Septoria tritici blotch	General	Minor
Take all	General	Minor
Nematodes		
Seed-gall	Southeast	Minor

As evident from Table 6, rusts and bunt are major diseases of wheat in Afghanistan. Three types of rust diseases occur: stripe rust, or yellow rust(*Puccinia striiformis*),leaf rust,or orange rust (*Puccinia recondita*) and stem rust,or black rust (*Puccinia graminis*). Of the three rusts, stripe rust (yellow) is most serious and causes tremendous yield losses in Afghanistan.

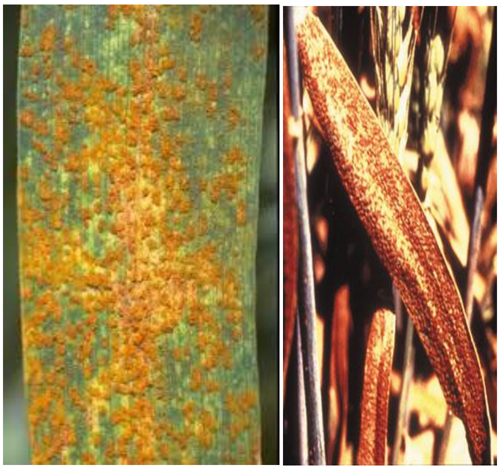
Identify symptoms of the diseases that attack your crop

Stripe rust: Also known as yellow rust, it has bright yellow sporesthat appear as stripes on the upper surface of leaves. It prefers moist conditions and low temperatures (8°–15° C), particularlycoolnights (<10° C), and occurs during early growth stages of the wheat crop. It generally occurs during tillering and heading stageswhen the temperature ranges from 3°–15°C. Yield losses are heavy, ifthis disease attacks the wheat crop in early growth stages, such astillering to heading.But if it attacks after heading, yield reductionis less.



Stripe rust

Leaf rust: It produces light brown pustules mostly on the upper surface of the leaf. These pustules are filled with spores of the fungus. Rubbing an infected leaf will leave rusty coloured areas on your fingers. It causes no rupture of the epidermis. As with stem rust, the pustules may spread to stems late in the season. Leaf rust is in all cereal-growing areas. It thrives in moist conditions, with temperatures of 15°–25°C.



Leaf rust

Because the disease develops during favourable temperature conditions, the yield losses are particularly severe.

Stem rust

Ug99 race of stem rust

Stem rust: It has dark brown pustules that can tear through the leaf surface and spread to stems and spikes. It appears late in the season,particularly in humid, warm areas (15º–30°C).Recently, the Ug99 race of stem rust has beenposing a devastating risk to wheat yields in warm areas. First discovered in Uganda in 1999, the disease spread with the wind to Iran. This new strain of stem rust is virulent on morethan 85 percent of all wheat varieties globally andis a threat to global food security. Unchecked,Ug99 can destroy wheat crops through explosive epidemics. According to conservative estimates, Ug99 can cause up to20 percent reduction in Afghanistan's annual wheat production..

Common bunt: Also known as covered smut or stinking smut(caused by the fungus*Tilletia caries* or *T. foetida*),it is a major disease in Afghanistan. It generally occurs more at higher elevations. It is disseminated by spores that can be soil-borne or seed-borne. Infected plants areslightly tainted, and spikes emerge later than normal.The tissues of the spike remain intact, but the seed is destroyed. The masses of smutspores appear in "bunt balls", which are heldin the seed coat of the grain. Stinking smutgets its name from the foul odour it produces similar to rotten fish. During harvest, the bunt balls are easily ruptured, and millions of spores are

deposited on the surface of healthy seeds.

Loose smut

Covered smut (bunt smut), arrows point to bunt balls

Loose smut: The disease is caused by the fungusspecies *Ustilago tritici*. Loose smut causes the tissues in the spike to be replaced by masses of powdery spores. The fungus sporesinvade the embryo of the developing seed and survive there until the seed germinates. Infection is most likely during cool, moist conditions. Plants are most vulnerable to infection,from the flowering stage up to eight days later.

Other leaf diseases

Powdery mildew: It is caused by the fungus*Erisyphe graminis* f.sp.*tritici*. Itappears as white cotton-like spots piled in patches on any green surface. Infected areas turn dull grey and may contain black spherical points that are the fruiting bodies. It occurs in damp conditions.

Powdery mildew

Spot blotch: Also known as leaf blight (*Bipolaris sorokiniana*), it has become significant in the warmer humid areas of Asia, causing major yield losses. It can be seen as small blotches with minimal necrosis on the lower leaves of seedlings; but during stem elongation and heading, it can spread rapidly up the plant to damage most ofthe leaves and eventually infect the seed with black point.

Septoria tritici(blotch) produces irregular lesions with black specks. Late in the season, under humid, warm conditions, the disease infects the glumes and spike, causing grey blotching and shrivelled seeds.

What can you do to control wheat diseases?

Septoria blotch

The most effective and economical method of wheat disease control is to sow disease-resistant varieties. Genetic resistance is the primary means of controlling fungal-leaf diseases. Seed-borne and soil-borne diseases are controlled primarily by seed treatment and crop rotation. Resistance is generally not available for these diseases. Adherence to recommended seeding time, soil fertility and crop management practices – all components of an effective integrated pest management (IPM) regime –contribute to successful disease management for these and other diseases.

Take the following measures to control diseases in your wheat crop:

Rusts and powdery mildew

- Plant resistant varieties that have been released more recently. Keep in mind that varieties, once developed as resistant to these diseases, are not resistant all the time. The level of genetic resistance these varieties offer is gradually overcome by new races of rust pathogens. Keep changing varieties as frequently as possible with support from the agricultural extension staff working in your area.
- Avoid cultivating the same variety over large areas.
- Apply fungicides if an epidemic level is reached, particularly for yellow rust.

Smuts

- Plant resistant varieties.
- Use only clean seed harvested from a clean field. The best method to do this is to designate a specific area of your wheat field for seed purpose and apply effective weed control and sound crop management practices.
- Apply pre-sowing treatment of seeds with fungicide, if resistant varieties are not available. Vitavax at the rate of 2 g per kg of seed can be used (FAO, 1997).
- Pre-irrigate or plant into moist soil. Faster germination minimizes early infection.
- As soon as you notice any infected spikes of loose smut, uproot the plants and burn them outside the field

***Blotch diseases* (*Septoria*spp., tan spot)**

- Use resistant varieties and change varieties as often as realistically possible.
- Avoid cultivating the same variety over large areas.
- Avoid continuous cropping of wheat on the same field. Rotate wheat with a legume crop.
- Avoid planting into the residues of the previous crop.
- Avoid excess nitrogen fertilizer and high seeding rates. Dense foliage encourages faster development and spread of the disease.

Step 8: Insect pest management

The major insect of wheat is the **armyworm** (*Pseudaletia unipuncta*),which is found all over the country. It is brown to black in colour. Larvae have three orange, white and brown stripes running the length of each side. It eats the leaves of wheat; even sometimes the awns are completely eaten.

Wheat fields should be checked for the presence of armyworms when wheat is at the heading stage.

- To control this insect, apply Malathion at the rate of 2cc per litre. Alternatively, baits can be prepared by mixing the following materials in 8–10 litres of water: 5 kg wheat bran, 5 kg sawdust, 500 g sugar and 125 g Dipterex.Apply the prepared bait at the rate of 5 kg per jerib in the field.

Armyworm infestation

Moroccan locust (*Dociostaurus moroccanus*Thunb.): It is a chewing insect that damages wheat and other crops. They are 22–39 mm long, reddish yellow with dark spots and red on their hind legs. The young nymphs only eat the leaves of their host plants, but as they grow, they will also eat green stems, grain and the fruit of crops.

Locust on wheat

Moroccan locust cause major losses to wheat in the northern and north-eastern parts of the

country. The economic effect is reportedly serious (Seddiqi, 1975; FAO, 1999). Apply a mix of mechanical, biological and chemical methods to control the damage, as follows:

- In the cooler months, identify the sites where the locusts lay their eggs (about 2 cm below the surface). Plough the fields (at least 4 cm deep) to bring pods to the surface, where eggs are destroyed by sunlight and heat.
- Use shallow trenches to trap and then bury the young as they crawl towards the crop fields.
- Spray insecticides. These include organophosphates (such as methylparathion orMalathion), pyrethroids (such as fenvalerate orDeltamethrin) and chitin inhibitors (such as diflubenzuron and flufenoxuron).
- Conduct field monitoring. Economic injury level for the Moroccan locust is two to five nymphs per m².

Sunn pest (*Eurygaster integriceps* Puton): It negatively affects wheat crops at their vegetativegrowth, heading and maturity stages. It feeds by piercing plant tissue and sucking fluids. Sunn pest causes two types of damage in wheat: yield losses as high as 90 percent and grain quality damage.If 2–5 percent of the grains in a lot have been fed upon by Sunnpest, the entire lot may be unusable to make bread. The dough made from thisflour will be difficult to process and the bread will not rise.
Four generas of sunn pest are available in Afghanistan. Namely Eurygaster, Aelia,Dolicaris and Carpocaris.

Sunn pest

It is an important pest in Herat, Badghis, Juwzjan, Faryab, Sar-i-Pul and Helmand provinces and Mazar-i-Sharif city (in Balkh). They produce one generation per year. Also *Aelia*genera. is able to feed on dry grain at the end of the season.It may produce two generations per year.

The following procedures are effective in controlling Sunn pest infestation:

- Collect Sunn pest from overwintering sites and cereal fields. The insects can be easily collected by hand or by net from wheat fields early in the season, before their eggs have been laid, and from overwintering sites.
- Plant wheat early and use early-maturing varieties. Early planting of wheat using early-maturing varieties maximizes use of rain water, helps in early maturity and the harvest of the crop and prevents significant losses by breaking the cycle of the insect pest peak feeding and heading.
- Harvest your crop early. The wheat crop should be harvested as soon as it reaches maturity or it will be prone to Sunn pest damage.
- Encourage natural enemiesto Sunn pest. Conservation and planting of shrubs, trees and flowering plants is recommended in the neighbouring areas of wheat and barley fields because they provide favourable habitat andfood to the natural enemies of Sunn pest,

such as parasitoids and predators. The use of flowering medicinal plants is also recommended in the cropping system because they provide food for Sunn pest egg parasitoids.


Sunn pest egg parasitoid   Benificial insects attracted to a flowering medicinal plant

- Inspect your field regularly to make a judgement on pesticide application. Spray your crop with a recommended pesticide, using the dose suggested on the label and taking necessary precautions for the safe application of the insecticide.

Aphids: Aphids are small, soft-bodied insects that can befound in wheat anytime during the growing season. Damage from this pest can reduce kernel size and lower grain-test weight.Aphids are also vector for a viral disease named barley yellow dwarf (BYD) and a related disease called cereal yellow dwarf. Infection can occur from seedling emergence through heading, but yield lossis greatest when plants are infected as seedlings in the fall.

Aphids of wheat

- Apply Larsban at the rate of 1–2 cc per litre ofwater (Parker et al., 2001).

Cereal leaf beetle (*Oulema melanopa* L.): Adult beetles are 5 mm long and blue-black with a reddish thorax (neck) and legs. Larvae are yellow-white and up to 6 mm long but appear shiny and black. Larvae are present during wheat head emergence through the dough stage. There is one generation per year. It damages the leaves of wheat, but its economic effect is reportedly mild on wheat, especially fall-planted wheat. Chemical control is best (Seddiqui, 1975; Parker et al., 2001).

Cereal leaf beetle

- Cereal leaf beetle can be effectively controlled by one application of an insecticide to foliage.

Corn ground beetles (*Zabrus tenebrioides* Goeze): It causes serious damage to wheat crop in Afghanistan.The adults feed on developing heads and larvae feed on roots and leaves. This is more important in the north and north-eastern areas of Sholgarah District in Balkh Province, Kunduz

Corn ground beetle

Province and Taloqan city of Takhar Province, where farmers do not follow crop rotation in wheat. They plant wheat and rice continuously.

- To control this insect, avoid continuous cereal cropping and follow crop rotations.
- Use Dipterex before the planting of wheat (Seddiqui, 1975; Parker, 2001).

Wireworm: These are found in the soil. Damage is done by the larval stage, which is a thin, yellowish brown worm that has a shiny, tough skin. Wire worms feed on roots of emerging plants, killing the seedlings and reducing the stand. Infestation with wireworms is frequent when wheat is planted after rice or wheat after wheat rotations.

Wire worm damages on wheat *Wire worm*

Wireworm infestations are difficult to detect prior to visible plant injury. Chemical controls, if used, must be applied pre-planting or as seed treatment.

Step 9: Seed selection and harvesting

Seed selection

If you are planning to set aside a portion of your harvest for use as seed in the next cropping season, there are certain steps that you can take to improve the quality of your saved seed:

- Inspect your wheat field three to four times during the time that spikes emerge and the crop matures. Look for plants that are off-types and stand out from most of the plants in the field. These may be wheat plants growing from a variety other than the one you used or other crop plants and weeds. Each time,manually uproot these off-typeplants.
- The plant characteristics that you may choose to decide which plants are true to type and which are unwanted and need to be discarded are:
    - ***Plant height***: If some plants are distinctly higher or lower in stature than most plants in the field, then these plants are suspect.
    - ***Presence or absence of awns***: If most plants do not have awn and some have awn, or vice versa, then those plants need to be discarded.
    - ***Flag leaf:*** Wheat varieties are distinct by colour, shape and size of the flag leaf: narrow or broad, erect or drooping.
    - ***Spike colour: wheat varieties are distinct in spike color (red, white)***
    - ***Glaucosity of Plant***
    - ***Beak length***
    - ***Ear density***
    - ***Last node hairiness***
    - ***Straw Cross section***
- Uproot and discard non-typical plants and use them for other purposes.

Harvesting

The most important step that you need to take at this stage isto identify the appropriate time to start harvesting. Do not start too early;nor should you be late – both are equally bad and will cost you in lost production. Look at your crop as it is
approaching maturity. If certain parts of the plant still look green, as shown in the photo, it means that it is not yet time to begin harvesting operations. The perfectly matured crop, which is ready for harvest, is the one in which no parts ofthe plant look green; the entire crop will have a bright, shiny golden colour (see the photo below).

Green plant not yet ready for harvestMature plantready for harvestt

But be cautious while you are waiting to catch the most appropriate time for harvesting. If you delay and somehow miss this time, the crop will no longer be suitable for proper harvesting, as shown in the photo below.

Overmatured and lodged plants – too late to harvest

Before harvesting, considerthe following:

- Harvestingshould start when the field is draped in a bright shining golden colour. At this stage, the grains become hard,dry and will not shatter from the spike.You can test this by picking up a spike and gently pressing in your thumb. The bright coloured grains will emerge from the spike. If you scratch the surface of the grains with your thumbnail and no spot is left, it indicates that the wheat has matured and is dry enough to begin harvesting. When the kernels reach 13–14 percent moisture, the grain is harvest ripe (Weisz, 1980).
- If you harvest before maturity, there will be a low recovery of grain and more immature and broken seeds of poor quality. The grain will be prone to disease during storage.
- If you delay,the dry plants,as shown in the photo above,are no longer able to bear the

weight of the spikes and will lodge, causing shattering and spillage of grains on the ground – which will mean a substantial loss of your production. Also, the crop will be exposed to birds, rodents, insects and pest attacks.

- Perform harvesting operations in dry summer days to minimize post-harvest losses. Conduct harvesting by using the proper methods and improved equipment and, where possible, machinery.
- Avoid direct sun drying and excessive drying. Grain moisture content in storage should be less than 12 percent.

Harvesting methods and post-harvest operations

In Afghanistan, harvesting is mainly done manually by using a sickle or other type of knife, leaving 3–6 cm of wheat straw above the ground level. Choose a clear sunny day and allocate sufficient time because this method is labour-intensive and needs more time to complete. The following photos demonstrate manual harvesting of wheat in Afghanistan.


In northern provinces, such as Balkh, Juwzjan, Faryab, Bughlan, Kunduz and Takhar, and in the southern and south west provinces of Kandahar, Helmand, Herat and part of Nangarhar, farmers, in a limited scale, use combine harvesters and reapers attached to two-wheel tractors, which are now becoming popular.


In recent years, through different development projects, two-wheel tractor-operated reaper (also called harvesters) has been demonstrated among farmers for its popularization.

The manually harvested wheat crop is tied into small bundles and stacked in bunches of 10–15 bundles, which are left in the field for one to three days to dry.

Threshing

Threshing is often done manually in the field or the bundles are transported to a threshing floor where they are spread out to dry in the sun and wind for a few days. The threshing and separation of the grain from the straw is done in a variety of ways. The wheat crop may be beaten with sticks or trampled by oxen.

Power-operated threshers are now becoming increasingly popular throughout the country. The power of operating threshers is provided mainly by tractors. The two-wheel tractors are also being used to operate small threshers.

Step 10: Processing for storage

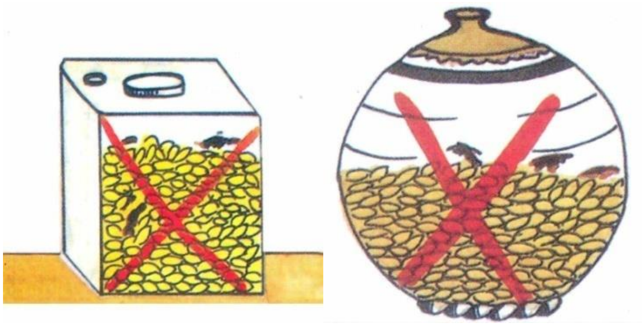
- Processing could be done either manually or by processing plant. If it done through processing plant then the seed will be graded and treated for future planting.
- Dry and clean your grain. The time it will need depends on the weather. If possible, dry the grain on a cement floor or a hard, smooth, crack-free floor. Otherwise, use plastic sheets or tarpaulins spread on the ground. Stir or turn the grain for uniform drying.
- Bite a grain to test its moisture content: if it cracks when you bite it, it is dry enough to store. But if breaks without a sound, it still contains moisture above the level required for long-term storage. For best preservation, moisture content in the grain during storage should be 12 percent or less.
- Cool the warm sundried seeds in a shady place before storing in such containers as earthen bins, polyethylene bag or plastic drums. Cooling is not necessary if stored in metallic drums.
- Separate the small and shrivelled seeds by sieving with 1.75–2.50 mm screens,and store healthy and plump seeds for planting in the next season.

Step 11: Storage procedures

In Afghanistan, grain is stored at the farm-level in a variety of traditional storage structures. These are *mahali kandoo* (a mud brick structure joined together using mud plaster), underground pits (wrapping of grains in plastic tubes or envelopes and placing them in pits) and metal bins (Ahmed, 2013). Grain is also stored in hessian and cloth bags.

The two environmental parameters that largely determine grain quality in storage are: i) relative humidity (moisture content) and ii) temperature. Therefore, to prevent deterioration and improve the longevity of your grains in storage, you need to consider the following:

- Use any clean container –metal bins, plastic containers, earthen pots of suitable size – that are approved for use as a grain storage container.These should have lids that can be closed tightly.
- Sealing airtight produces best results because it prevents the absorption of moisture from humid air and extends storage life.
- If any earthen pot or drum is used, paint it with any colour to close tiny pores, thus preventing entry of air or moisture.
- You may also use clean bags – gunny bags, hessian bags, cloth bags or polythene bags. Whenloading the bag with grains from the top, shake it well so that all grains are properly settled at the bottom. Exhaust as much air as possible by gently pressing, and then close with a twist tie. Place the tied bag into a second similar bag, exhaust the air and tie.
- Fill the containers fully with seed without leaving any space (IRRI KnowledgeBank).
- Place the containers on any raisedstructure above the ground and away from walls to prevent absorptionof moisture.



No space should be left empty inside the container

Wheat in crop rotations

Wheat is grown under different rotation systems in different parts of the country. Generally, farmers use the following rotations:

1. Wheat–fallow–wheat.
2. Wheat–feed legumes (vetch, peas, chickpea)–wheat.
3. Wheat–food legumes(mung bean or peanut)–wheat.
4. Wheat–maize–wheat (maize is used for animal feeding in high altitudes and used as a food in lower altitudes).
5. Wheat–paddy–wheat (in rice-growing areas).
6. Wheat–clover-maize-wheat.
7. Wheat–turnip–wheat.

The 2012farm management survey of 6,020 households conducted in seven provinces of Afghanistan identified a wide variety of cropsthat are grown in rotation with wheat (Table 7).Under irrigation, wheat is rotated with a wide assortment of crops, including cereals (barley, rice, maize), legumes (chickpea), potato, cotton, melon,watermelon, and vegetables. The vegetables normally grown in summer are okra, tomato, eggplant, pepper, pumpkins, cucumbers, spinach, lettuce, potato and others. The winter vegetables are onion, cauliflower, turnip, spinach, radish, carrot, cabbage, etc. Irrigated cropping systems were more intensive (double- or triple-cropped) than rain-fed ones, mostly double- and single-cropped wheat) (SMIO, 2012).

Table-7. Important cropping patterns in selected provinces and cities of Afghanistan

Province/city	Cropping pattern	
	Irrigated	**Rain-fed**
Kabul	Wheat/barley–fallow Wheat/barley–fallow/vegetables	Wheat/barley–fallow
Parwan	Wheat/barley–fallow	Wheat/barley–fallow

Herat	Wheat–rice Wheat–vegetables Wheat–vegetables/rice Wheat–barley/potato Wheat–barley/wheat cucumber/chickpea/sesame Wheat–barley/vegetables	Wheat Wheat–watermelon Wheat–chickpea/ lentil/wheat Wheat–chickpea
Nangarhar/Jalalabad	Wheat–rice/vegetables (onion, potato, okra) Vegetable–rice Wheat–cotton Wheat–maize–vegetables	Nil
Balkh/Mazar-i-Shariff	Wheat Cotton–vegetables Wheat/barley/falx Wheat/barley–vegetables	Wheat/watermelon, melon Wheat/sesame
Kunduz	Wheat–rice/maize	barley–wheat wheat/ melon, watermelon
Bamyan	Wheat/barley Wheat–vegetables Wheat–rice	Wheat/ barley

Source: SMIO, 2012.

What are the benefits of growing wheat in rotation?

There are several benefits to rotating your weak crops:

- Crop rotation helps make weed management easier by changing the growing conditions that favour the build-up of specific weeds.
- It helps in managing some diseases. Rotating wheat with other crops can help reduce such diseases as *Septoriatritici* blotch of wheat, Fusarium crown and root rot. Grain rotations are useful for managing a number of diseases in vegetable crops and broadleaf field crops, such as cotton, bean and sugar beets.
- Wheat in a rotation can also reduce populations of several nematode species that can be harmful to trees, vines and broadleaf crops (Marsh and Jackson).
- Wheat in rotation with other crop will also reduce the population of some insect such as sunn pest
- Wheat grown in rotation with other crops typically yields more than in monoculture. This was demonstrated in a wheat-based cropping pattern trial conducted at the Darul Aman Agriculture Research Station in 1989 (Table 8).

Table-8. Mean yield of wheat in cropping patterns tested

Cropping pattern	Mean yield (kg/ha)	% increase over continuous cropping
Wheat–wheat–wheat	3636	0
Wheat–clover–wheat	5466	50
Wheat–maize–wheat	5386	48

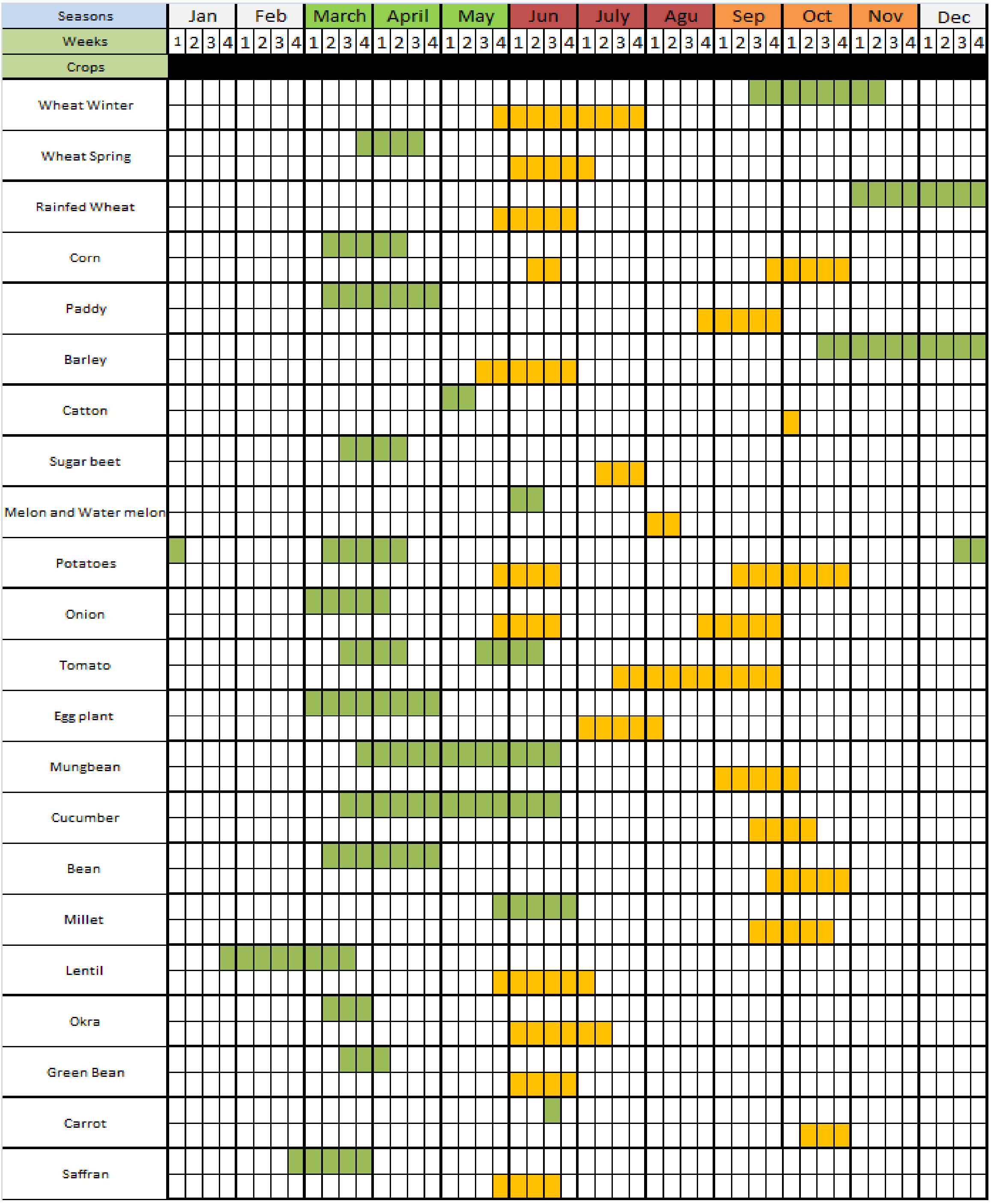
Wheat–turnip–wheat	4007	10
Wheat–fallow–wheat	3942	8

Source: ARIA, 1989.

Tailoring crops in rotations

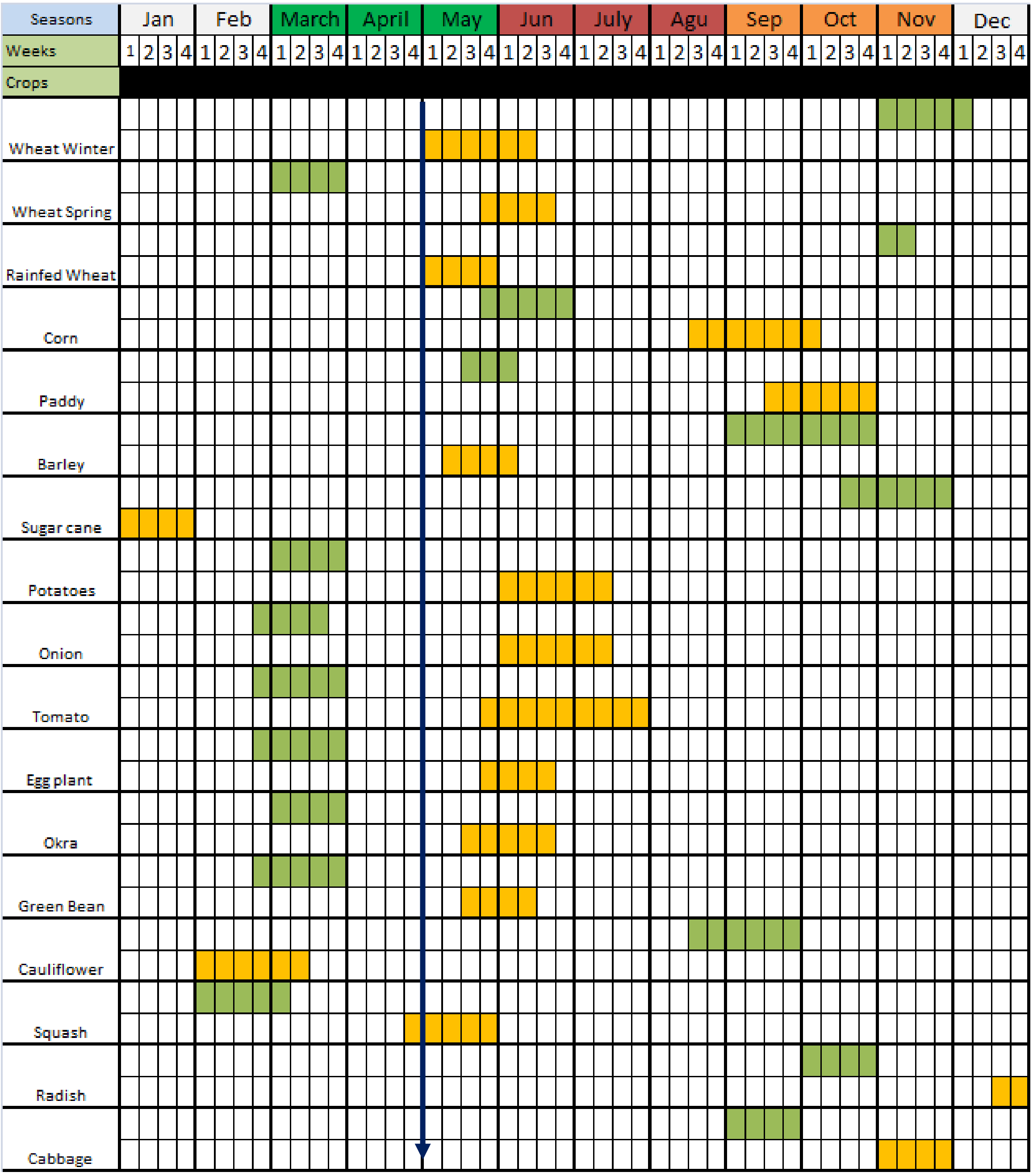
Cropping calendars are suitable for planning your rotations. Figures21 and 22 show crop calendars for the provinces of Herat and Nangarhar. The blue line drawn through the chart indicates the beginning of the wheat harvesting season. For all crops, the sowing time, which is to the right side of the line, potentially can be grown in rotation with wheat.

Figure- 21.Crop calendar for Herat Province, Afghanistan



Seasons
Weeks
Crops
Jan
Feb
March
April
May
Jun
July
Agu
Sep
Oct
Nov
Dec
1 2 3 4
Wheat Winter
Wheat Spring
Rainfed Wheat
Corn
Paddy
Barley
Catton
Sugar beet
Melon and Water melon
Potatoes
Onion
Tomato
Egg plant
Mungbean
Cucumber
Bean
Millet
Lentil
Okra
Green Bean
Carrot
Saffran

Figure 22. Crop calendar in Nangarhar Province, Afghanistan



Sowing period Harvesting period:

Profitability of wheat cultivation in Afghanistan

Overall, wheat cultivation is profitable in Afghanistan. Irrigated wheat is more profitable than rain-fed wheat. This was demonstrated in the farm household-level survey conducted in 2012 in seven provinces of the country: Herat, Balkh, Kabul, Parwan, Nangarhar, Bamyan and Kunduz (FAO, 2013). Item-wise costs were estimated per ha basis, while gross return was estimated on the basis of average yield: 2.85 tonnes per ha for irrigated wheat and 0.93 tonnes per ha for rain-fed wheat. Table 9 shows the breakdown of costs and returns. It will also help you to make your own farm budget.

Table-9. Cultivation of wheat in Afghanistan: Estimated costs and returns –Average of seven provinces, 2012($/ha)

Variable costs	Irrigated wheat avg. yield: 2.85 tonnes per ha	Your farm avg. yield:______	Rain-fed wheat avg. yield:0.93tonnes per ha	Your farm avg. Yield:________
Seeds	58.4	____________	20.6	____________
Fertilizers				
Urea	84.5	____________	19.5	____________
DAP	115.0	____________	20.3	____________
Other materials				
Pesticides	3.5	____________	0	____________
Diesel for irrigation	3.2	____________	0	____________
Non-material inputs				
Land preparation	27.2	____________	46.5	____________
Human labour	109.6	____________	115.7	____________
Sowing	15.0	____________	15.0	____________
Irrigation	19.4	____________	0	
Weeding	13.6	____________	4.8	____________
Drug spray	3.8	____________	27.9	____________
Harvesting	35.7	____________	55.9	____________
Threshing	20.5	____________	12.1	____________
Other	1.6	____________	0.0	
Total variable costs	**401.40**	____________	**222.7**	____________
Fixed costs				
Land rent	100.0	____________	100.0	____________
Depreciation	8.5	____________	9.3	____________
Interest on operating capital	20.1	____________	11.1	____________
Total fixed costs	128.6	____________	157.6	____________
Total costs	563.8	____________	**380.3**	____________
Gross return	950.5	____________	471.3	____________
Gross margin	**549.2**	____________	**248.7**	____________
Net return	**386.8**	____________	**91.0**	____________
Benefit–cost ratio	**1.74**	____________	**1.23**	

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