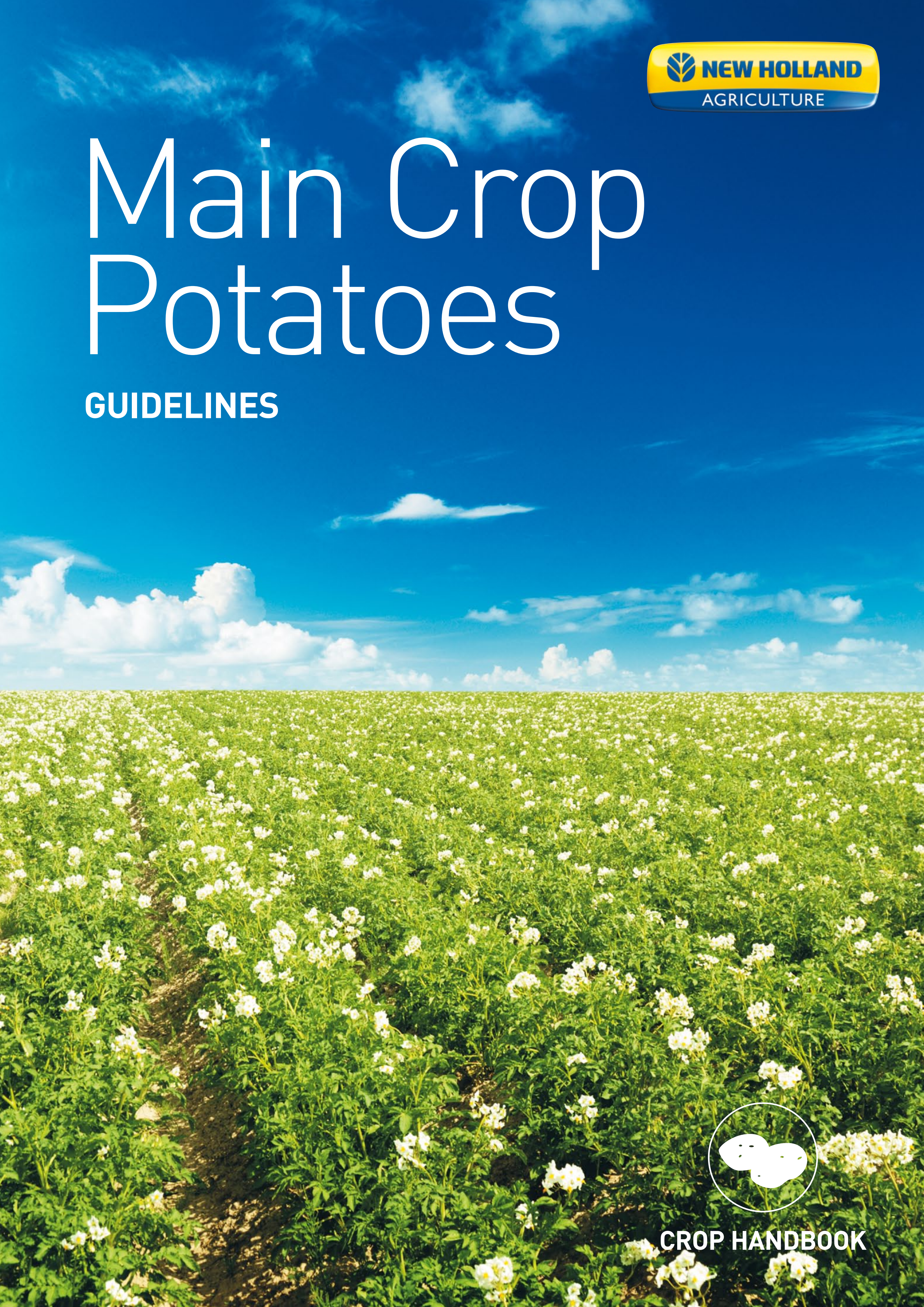
Main Crop Potatoes

GUIDELINES



CROP HANDBOOK

Main Crop Potatoes

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Production Guidelines

POTATOES	
OPERATIONS	AGRONOMICS AND TIMING
Crop rotation	Avoid rotation with other plants of nightshade family, as pepper, tobacco, eggplant. Best previous crop is wheat, soybeans , corn and other cereals. Alfalfa and pastures are not good prior crops. Potatoes should return to the same field after 3 or better 4 years.
Primary tillage	Potatoes require a deep primary tillage. Moulboard plough and disk ripper are commonly used for this task
Secondary tillage	Harrow disks, rototill, tine harrows some days before the planting
Planting or Transplanting (Northern Hemisphere)	
Timeliness	From mid February to mid April for main crop.
Spacing between rows and on row spacing	From 75 to 90 centimeters between rows spacing. In row spacing from 20 to 30 centimeters. Traditionally, also 60 centimeters between rows spacing.
Quantity of seeds	From 2 to 3.5 tons per hectare, depending on seeds size. Target between 50,000 and 70,000 plants per hectare which means 130,000 to 180,000 stalks per hectare
Depth	About 10 centimeters
Soil insecticide	Before planting or at planting
Fertilizying (Guidelines, to be corrected on soil analysis base)	
Nitrogen (N) kg per Hectare	100-150 of which 60% before planting, the rest after 6 weeks. Generally, mature manure spread before primary tillage is very recommended.
Phosphorus (P_2O_5) kg per Hectare	100-150 before planting
Potash (K_2O) kg per Hectare	150-250 of which 70% before planting and 30% top fertilization
Cultivation (hilling)	From 1 to 3 times during the cropping season, to avoiding greening of tubers
Weed control	Pre emergence spraying is common, post emergence after hilling (ridging)
Pest control	Spraying against diseases and insects during the whole growth season
Harvesting	A desiccant is needed to kill the stalks before harvesting: minimum 20% dry matter in tubers and "tough" skin

DROPLET GUIDE*

ASABE STANDARD S-572.1 DROPLET SPECTRUM CATEGORIES[1,2]	CONTACT INSECTICIDE AND FUNGICIDE	SYSTEMIC INSECTICIDE AND FUNGICIDE	CONTACT FOLIAR HERBICIDE	SYSTEMIC FOLIAR HERBICIDE	SOIL-APPLIED HERBICIDE	INCORPORATED SOIL-APPLIED HERBICIDE	RELATIVE SIZE	COMPARATIVE SIZE	ATOMIZATION
VERY FINE (VF) RED								Point of Needle (25 microns)	Fog
FINE (F) ORANGE	✓							Human Hair (100 microns)	Fine mist
MEDIUM (M) YELLOW	✓	✓	✓	✓				Sewing Thread (150 microns)	Fine Drizzle
COARSE (C) BLUE		✓		✓	✓	✓		Stample (420 microns)	Light Rain
VERY COARSE (VC) GREEN				✓	✓	✓		Stample (420 microns)	Light Rain
EXTREMLY COARSE (XC) WHITE						✓		#2 Pencil Lead (2,000 microns)	Thunderstorm

Droplet sizes are suggestions for each pesticide. [1] Based on VD0.5, the Volume Master Diameter (VMD) designation. Source: Kansas City University.
[2] Revision of Stantard S-572.1 also includes extra-fine and ultra-coarse categories for nonagricultural users.
This droplet guide summarizes suggested droplet sizes for a variety of chemicals, based on the ASABE standard droplet spectrum categories.

Soil and Climate Requirements

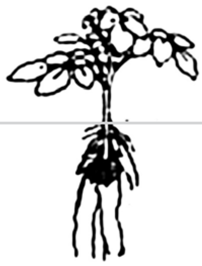
SOIL PARAMETERS	REFERENCE VALUES
Tilth, texture	Silt clay loam, Loam, Sandy loam, friable
Draining	Good draining, level field, avoid ponding
Water table	Minimum 1m deep
Soil depth	Minimum 40 centimeters
pH	6.0 – 7.0; sub acidic soil suitable, acidic soils not suitable
Content in active limestone	< 10
Organic Matter	Good content (2-4%)
Salt content	< 4mS /cm

CLIMATE PARAMETERS	REFERENCE VALUES
Low temperatures	Temperatures below 0°C as well as late frosts damage the crop heavily up to death
Optimum growth temperatures	18 - 20°C; higher temperature also depending on soil moisture content
Max temperature	Temperatures above 30°C slow down or block accumulation of carbohydrates in tubers, also depending on soil moisture content
Rain	Alternating dry and rainy periods brings to tubers damages

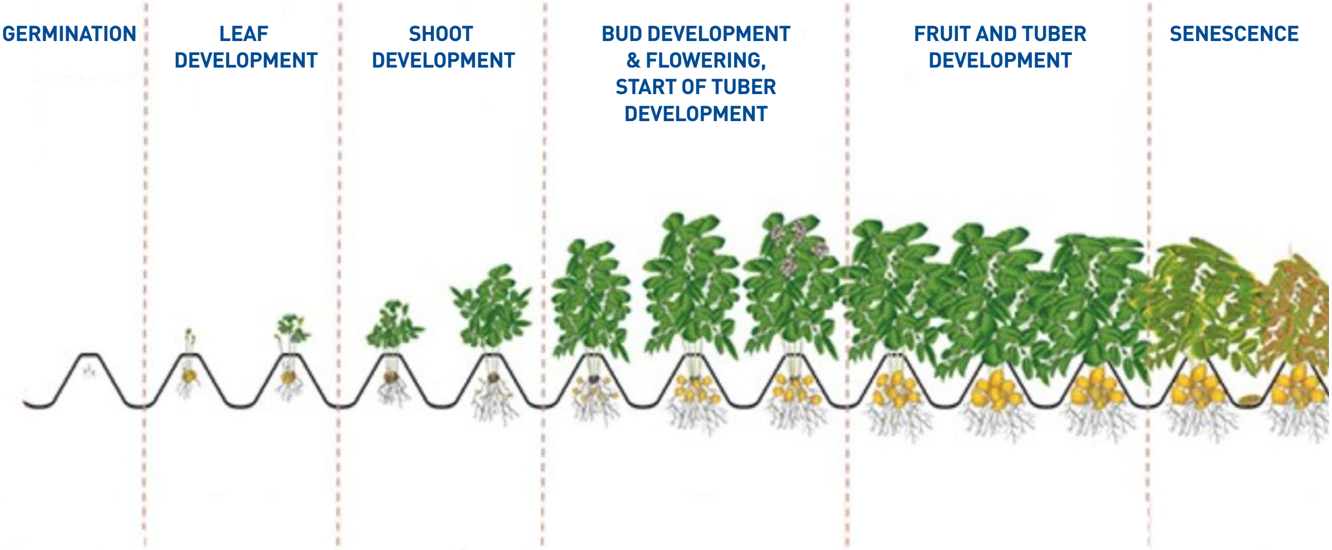
CLIMATIC (ENVIRONMENTAL) AND SOIL REQUIREMENTS

Potato is a rather adaptable plant, and is fit for cropping in plains, hills and also on mountains at higher heights than wheat. Concerning temperature, the plant is sensitive both to excesses that deficiencies. Optimum for germination is 15°C; for flowering 20°C; for ripening about 18°C. Anyway, if moisture content in soil is high, and it meets evapotranspiration demand, then also temperatures of 35°C are not detrimental to the crop. Temperatures from 0°C to -3°C kill the plants, so early and late frosts are very risky for crop. Potato is very demanding concerning water, so irrigation is highly recommended for commercial cropping. Irrigation is carried out frequently and with little water height at a time (not more that 35 millimeters per hectare or 350 cube meters per hectare).

FAO reports a seasonal volume from 350 to 650 millimeters as a total for average yields. In other words, potato requires much water to give proper yields. Better soil for potato, as well as for other crops, are deep, well drained and friable (sandy loam). Potato can grow well also in clay soil, but then primary tillage must be deeper and better carried out at fall, in order to get the soil wintered and smoothed by frost and tanning. Sandy soils, when properly irrigated and fertilized, give an outstanding quality product.
A proper content in organic matter (2-4%) is crucial, both because it influence the physical structure of soil (tilth) and also it influence the retention of water into soil. Optimal conditions of soil pH (acidity) are between 6 and 6.5, which means sub acidic soils. Anyway the plant can grow properly also in rather alkaline soils (pH about 7).

GROWTH STAGE I	GROWTH STAGE II	GROWTH STAGE III	GROWTH STAGE IV	GROWTH STAGE V
				
Sprout development Sprouts develop from eyes on seed tubers and grow upward to emerge from the soil. Roots begin to develop at the base of emerging sprouts.	**Vegetative growth** Leaves and branch stems develop from aboveground nodes along emerged sprouts. Roots and stolons develop at belowground nodes. Photosynthesis begins.	**Tuber initiation** Tubers form at stolon tips but are not yet appreciably enlarging. In most cultivars the end of this stage coincides with early flowering.	**Tuber bulking** Tubers cells expand with the accumulation of water, nutrients, and carbohydrates. Tubers become the dominant site for deposition of carbohydrates and mobile inorganic nutrients	**Maturation** Vines turn yellow and lose leaves, photosynthesis decreases, tuber growth slows, and vines eventually die. Tuber dry matter content reaches a maximum, and tuber skins set.

GROWTH STAGE



Potatoes Development Stages

Potato takes from 100 to 150 days to give an yield. Most important stages are sprouting, emergence, growth of the aerial part, growth of tubers and ripening. After dormancy, at a temperature of 6-8°C, buds on tubers sprout and seedling start to emerge from soil. Seedling are not "though", so in this stage crust can hinder the emergence of seedling from the soil. At 3-4°C, tubers are in dormancy: at 8°C sprouting begins, but emergence is very slow: at temperature of 12-15°C sprouting goes quickly. After emergence, sprouts develop in stems that can branch at the leaves insertions. The growth of the aerial part, stems and leaves, is influenced by temperature, optimal being 25-28°C, moisture availability and presence of nutrients into the soil. After the formation of 14 to 19 leaves, or about 50-60 days after emergence of sprouts, first flowers begin to form. Best condition are long days, high moisture and night temperature about 15-18°C. Flowering continues for two weeks in each flower and up to two months on the whole plant: the formation of the terminal flower means the full growth of the plant. Flower forms also fruits that are of no consequence for production.

The initiation of young tubers at the tips of the stolons (stolons aere underground stems) usually occurs when the plants are 15 to 20cm high, or from 5 to 7 weeks after planting . Tuberization (formation of tubers) is affected by many environmental factors and depends largely on hormones, translocation and storage of carbohydrate reserves in excess of that needed by other parts of the plant in its growth and metabolism. Growth of the young tuber is the result of both cell division and elongation and storage of translocated carbohydrate reserves within the cells. Tuberization is not dependent upon flowering. Potato plants will form tubers without any flowers ever appearing on the tops. Any shortage (water, nutrients) during growth of tubers negatively affects yield.
Growth of tubers depends on growth of the aerial part of the plant, stems and leaves, on the physiological efficiency of the plant and on cultivar. These factors affect the formation of carbohydrates and their storage in tubers. A sufficient level of moisture is crucial for translocation of carbohydrates and thus for tuber growth. A longer season means a bigger production, a short season means less production. This is the reason because late cultivar are more productive in long season and early cultivar do best in short season.

Ripening is characterized by yellowing of leaves and stems. The skin of tubers begins more hard to detach from pulp. At the end, leaves and stems dry out and fruit fall. It is difficult to scratch the skin from the pulp with thumb pressure. Depending on conditions, high or low temperatures bring to the drying of the plants. In many cases, a desiccant treatment is applied for ending the vegetation and making harvesting operations easier.

Potato takes advantage from a consistent soil texture, meaning a rather soft and porose soil. Soil texture can be improved, among other, also by manure applications. New Holland delivers outstanding spreaders for all farming acreages.

Crop Rotation

As for the large majority of plants, length of rotation between potato crops and other plants grown in rotation with potatoes can impact potato production and sustainability of soil health status.
Many potato pests (weeds, insects as wireworms and Colorado beetle, nematodes and diseases such as white mold, pink rot, pythium leak, Verticillium wilt, and powdery scab) build populations in proportion to the frequency of potato cropping and other host plants presence.
In general, longer rotations (3-5 years) result in increased yields, best tubers' quality and reduced fertilizer and pesticide requirements. The fact that certain rotational crops also serve as a host for potato pests should be considered before selecting fields. For example, dry beans, canola and tomatoes are susceptible to white mold, so they should be excluded from rotation or enter rotation in longer periods. Growing these crops in rotation with potatoes can increase the severity of white mold in the potato crop. Verticillium wilt has many alternative plant hosts, such as mint, alfalfa and many weed species. Nematodes and insects can also have alternative hosts and build significant populations in the years potatoes are not grown. Pasture grasses serve as a good host for wireworms and should be avoided altogether as a rotational crop if the field has a history of wireworm damage. Clover and alfalfa are also hosts for wireworms and other soil dwelling insects.

- Cereals are good crops in rotation with potatoes, but they bring high quantities of residue as stalks and straw. Adding large quantities of residue as corn stalks, grain straw or similar materials that are very high in fibrous carbon residues can present problems with planting. Potato Nitrogen nutrition can be hindered. In these cases, it is important to remove the residue or spread the residue uniformly and work it into the soil as early as possible the fall before potato cropping. Microbes will begin decomposing the residue if the soil has adequate moisture and a small amount of nitrogen (about 10kg of N per ton of residue) remains from the previous crop and/or is applied as fertilizer.
- The effects of Verticillium wilt can be significantly reduced with long rotations and incorporation of green-manure residue of oilseed radish, yellow mustard, barley, wheat, corn, and various other crops. The effects of Rhizoctonia stem canker and black dot may also be suppressed with green manures. In addition to reduced soil concentrations of certain pathogens, other benefits of using green manure trap crops include increased potato yields, improved soil tilth and water-holding capacity, reduced nitrogen leaching into groundwater, improved weed suppression, reduced soil erosion, and potential suppression of nematodes.
- Soil insect populations can also be favored if the previous crops/weeds were hosts for the insect in question, such as with certain grass species and wireworms. The Colorado potato beetle is another serious insect pest. Prevention is aided by avoiding planting in or close to fields where potatoes were grown or where volunteers potatoes were not controlled the previous year. Closely related plants, such as nightshade weeds, can also serve as a host for the Colorado potato beetle and should be controlled. Green peach aphid is another major pest of potatoes. As with Colorado potato beetle, nightshade is a favored host of green peach aphids. Effective control of nightshade and other plant hosts for aphids can help reduce problems. Preventing weeds is as important as controlling the weeds. Weeds, especially potato volunteers and closely related species, should be controlled in rotational crops and in field borders. In summary, length of time between potato crops and the number and types of species grown in rotation with potatoes can impact potato production and the sustainability of the soil. In general, longer rotations result in increased yields and reduced fertilizer and pesticide requirements.

SOME DATA ABOUT POTATOES PRODUCTION IN 2013 (MILLIONS OF TONS)

Country	Production year 2013 (millions of tons)
People's Republic of China	88.9
India	45.3
Russia	30.2
Ukraine	22.3
United States	19.8
Germany	9.7
France	7.0
Bangladesh	8.6
Netherlands	6.8
Poland	6.3
World total	368.1

Source: UN Food & Agriculture Organization

Tillage

PRIMARY AND SECONDARY

- Primary tillage is better performed in summer or autumn, after the harvesting of prior crops, better a cereal like wheat. Potato growers commonly use a moldboard plow (better reversible) or chisel plow for their primary tillage method. Depth commonly is 30-35 centimeters, but in heavy soils it can reach 45(!) centimeters . After ploughing, the land should be left fallow during the winter, so pest pressure on following crop can be very much reduced. Cultivation with heavy field cultivator can be carried out in winter, to kill weeds and level the soil. A proper drainage of fields is crucial for achieving high yields, because potato has no resistance to ponding.
  In alternative to plough, ripping with a combo tool is possible, specially where ponding of fields is likely in spring.
- Secondary tillage and seedbed finishing to be done in spring, some days before the planting. Recommended tools are power harrow, tine harrow or light disk harrow. All these operation should be completed by early March. It is better to avoid the use of rototillers, because their output is a very fine soil that can give some structure problems during the growing season, specially in clayish soil, and they can also spread the roots of perennial weeds (bindweed, creeping or "cursed" thistle).
- Tillage serves several purposes for preparing the land to support crop growth. Timely tillage improves the physical condition of the soil which helps roots to develop and explore the soil profile in depth in order to acquire nutrients for growth. Tillage helps to control weeds, and it may be used to incorporate fertilizer, lime, manure, residue, or other agricultural compounds. Tillage is necessary to develop a well prepared seedbed, which allows for uniform planting and stand establishment. On the other hand, excessive or poorly timed tillage destroys soil structure and compacts the ground besides wasting fuel. Working the ground when it is wet can also destroy soil structure and compact the land.
- Fall plowing offers advantages by decreasing the amount of work that has to be done the following spring. Fall tillage generally results in warmer soil temperatures in the spring which allows for earlier planting; it allows for greater breakdown of crop residues; and the freezing and thawing action of winter helps to break up clods and improve tilth.

PRIMARY TILLAGE

A **Disk Ripper** is an alternative to plough, destroying compaction and hard pans. If a compaction pan exists just below or near mold-board plow depth, this hard pan can be disrupted by sub soiling to a depth of 16 to 18 inches to allow the development of a more extensive root system. Sub soiling also helps increase water infiltration.

Summer or fall ploughing is still the most viable option for potato cropping. In heavy soils, working depth can reach 40 centimeters.

SECONDARY TILLAGE

For potato, better choice is an autumn primary tillage. In spring, a field cultivator creates a firm, level seedbed that provides uniform soil distribution for faster dry down. This allows earlier planting dates for an extended growing season with faster germination. Secondary tillage in spring must provide proper shallow seedbed tillage and levelling of surface avoiding large losses of moisture.

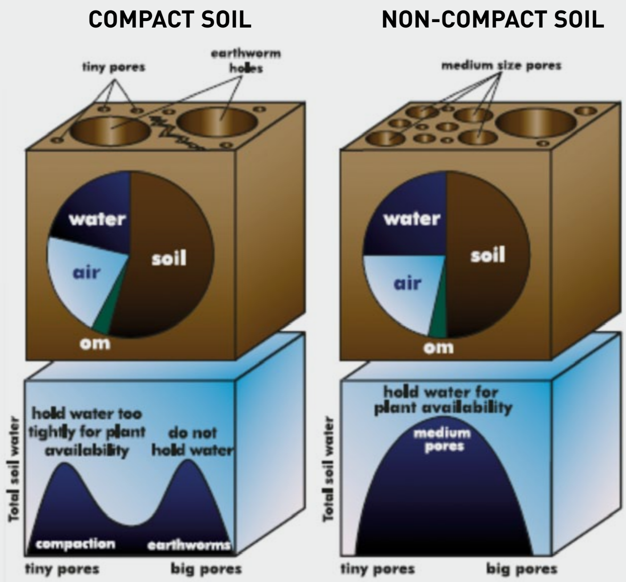
WATER MANAGEMENT THROUGH TILLAGE

We can not manage weather or soil texture. But we can manage tillage.

PONDING

MISCONCEPTION: PONDING IS A RESULT OF TOO MUCH RAINFALL

Not necessarily. Usually ponding is a result of poorly managed soil. When soil is compacted, it cannot absorb water. Compacted soil is like a sponge that is squeezed tight: there is no space for air and water. To make matters worse, compacted soil forms an impenetrable layer that prevents excess water from draining through. The result is ponding.



Potatoes Tuber-Seeds

The choice of cultivars to be planted is a crucial moment for successful cropping. Most important facts to be considered are:

- Final use of product; fresh market or processing industry
- Uniformity of shape, colour and size of the tubers
- Pulp colour
- Cooking qualities (frying, boiling)
- Content in dry matter
- Resistance to diseases

Length of growing cycle (early, medium, late cultivars).

SEED SELECTION

Seeds should be retained no more than three times at high elevations and twice in lower areas. Retained seed should be between 30-60mm in diameter and be free from disease. Certified seeds are highly recommended. Seeds must be free from diseases, bruising, frost damages and sprouts longer than 2 centimeters.

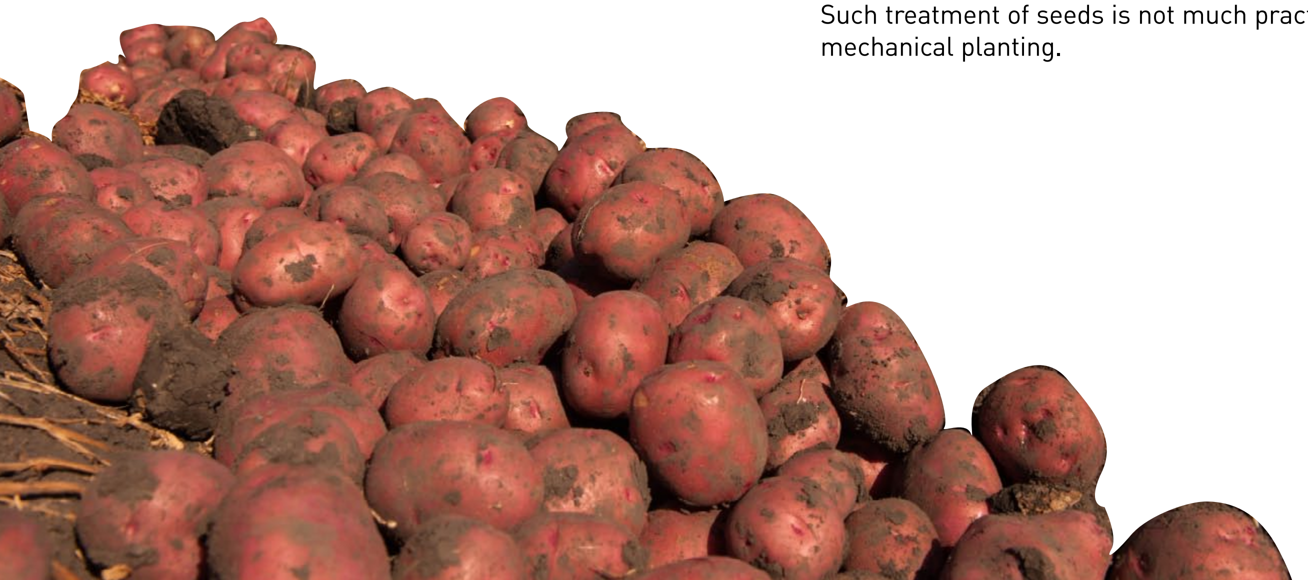
Planting

Spacing varies depending on varieties, availability of irrigation and soil structure. The target is to get from 130,000 to 180,000 stalks per hectare at harvesting, which means a spacing of 75-90 centimeters between the rows and a spacing of 20-30 centimeters between seeds on the row. This means to put into soil from 50,000 to 70,000 tubers seeds per hectare.

Commercial crops are planted mechanically.
The seed rate should be between 2,000 kg and 3,500 kg per ha, dependant on the potato seeds quality and size and the desired tuber size of the crop. The crop should be sown no later than mid April but early planting depends on confidence in frost-free conditions.

Cultivar characteristics like tuber number per plant (tuber set), average tuber size profile, and days to reach maturity need to be defined prior to selecting the seed piece spacing. Wider in-row spacing may be used to increase average tuber size when growing late-maturing cultivars in season-limiting regions. Closer in-row spacing may be more desirable when season length, moisture, and nutrients are not expected to be limiting.
Excessively large tubers may develop defects such as hollow heart, knobs, and growth cracks. Reducing the in-row spacing to minimize oversized tuber production may lead to higher quality tubers.

Traditionally before planting performing a pre-sprouting was common, in order to get stout sprout before putting the seeds into soil and an early thickening of cuts. Pre sprouting needs temperature of 14-15°C, air moisture about 80-90% and diffused lighting. To get sprouts, from 20 to 30 days are needed. Sprouts must not exceed 1.5 centimeters length and they must be robust. If seeds tubers are large sized, they can be cut in smaller pieces.
Such treatment of seeds is not much practical for mechanical planting.



Fertilization

BASAL FERTILISATION

Requirements for Phosphorous (P_2O_5) and Potash (K_2O) can only be correctly identified following a soil sample on a field by field basis. Once the current fertility of the field has been established the deficit can be calculated from the following table. The table gives kilograms of the actual chemical compound, therefore the percentage of P or K in the proposed fertiliser must be known in order to calculate the gross amount needed.

Phosphorous (P_2O_5)

mg/l: below	kg/ha
10	350
15	300
25	250
45	200
70	100

Potassium

mg/l: below	kg/ha
60	350
120	300
240	250
400	150
600	100

For example: A field with a soil sample analysis of 14mg/l of P and 230mg/l for K would need 100/18x300= 1,666kg/ha of 'Super' (content 18% P_2O_5) and 100/60x250= 416kg/ha of 'Potash' (content 60% K_2O)

Basal fertiliser must be applied before, or early in, initial land preparation. This will achieve good incorporation and initiates the release of the elements. Phosphorus encourages early tuber growth and gives good skin strength whilst potassium is responsible for keeping the dry matter content of the tuber low, thereby reducing bruising. Potash is very important in several ways: strengthening of plant tissues, increasing of resistance to low temperatures, improving of vegetative activity, activation of sugars metabolism and translocation, better conservation of tubers after harvesting.
Reference quantities of nutrients which are removed from soil per 1ton of tubers are as follows.

N	4.0kg per ton
P_2O_5	1.5kg per ton
K_2O	6.0kg per ton.

Nitrogen
N doses to be applied vary depending on reasonable yield forecast, and status of N and Organic Matter into soil. Once the soil type and nitrogen status, based on previous cropping history, has been identified, the total nitrogen requirement for specific estimated yield can be determined.

Requirement of N	Residual N		
	Zero	Fair	Good
sandy/shallow soils (kg/ha)	240	200	130
other mineral soils (kg/ha)	220	160	100
organic soils (kg/ha)	180	130	80
peat soils (kg/ha)	130	90	50

For example: If the nitrogen source is Ammonium Nitrate (content 34.5% N) the soil type is a sandy loam and the nitrogen status is fair, the required application will be 464kg per ha of fertilizer or 160kg per Hectare N (160/34.5x100). The Nitrogen can be split infirst half being applied at planting; and the remainder six weeks later. A portion of the Nitrogen requirements can be supplied by the application of farmyard manure. A rate of 40 tonnes of cattle manure per hectare is equivalent to applying 60kg N, 80kg P_2O_5 and 160kg of K_2O respectively per hectare.

Ridging or Hilling

When sprouts are well visible on the soil surface, a ridging is performed to enhance stolon development, kill weeds, prevent tubers greening and facilitate harvesting. When the plants have 2 or three leaves, a second ridging is performed with the same goals. The ridge height should be about 20 centimeters. After the second ridging, post emergence herbicides are applied. In some cases, in loose soils and after heavy rains, a third ridging is performed to avoid greening of tubers.

In some low and flat areas in humid regions, it may be desirable to place the seed at a level above that between the rows. This is done to protect the seed pieces from excess water which may stand on the surface because of poor or slow drainage.

In any case, purpose of such cultivations and ridging operations includes maintaining proper soil aeration, shaping ridges to allow space for maximum tuber growth and minimize tuber greening, establish irrigation furrows if needed and depending on irrigation system, and control weeds.

If a cultivation operation does not accomplish one of these purposes, the operation is a waste of effort, fuel and labour. No matter what type of cultivating or hilling implement is used, tillage should not take place in wet soils. Working wet soils results in compaction and clods that will present problems at time of harvest.

Irrigation

Most important parameters to be considered for correct irrigation are:

- Growth stage of plants: potato has noticeable needs for water. These water requirements, if not satisfied on time, will have negative consequence on yield and tuber size and quality. The most critical stage is formation and growth of tubers, which occurs from 15-20 days before anthesis (the flowering period of a plant, from the opening of the flower buds) to 30 days after anthesis. In this period frequent irrigations are needed, but maximum watering height (volume) per single watering must not exceed 250-350 m^3/ha, or 25-30 millimiters.
- Irrigation system: best system when possible is trickle system, because water is delivered directly to the roots on the soil and foliage is not wetted, therefore hindering the spreading of fungi diseases. On large acreage sprinkler systems (pivots and similar) are very common, as well as infiltration systems. These last, however, need higher water volumes and can damage soil structure, which makes harvesting more challenging.
- Water eight must not exceed 350 m^3/ha, because the root system of the plant is not very efficient in extracting water fro the soil.

DRIP IRRIGATION

With drip irrigation, starting investments per hectare are higher than with other systems. Anyway, there are some agronomical advantages as

- Fertirrigation
- High efficiency of water used in irrigation
- High uniformity concerning water height and fertilizers' rates
- Leaves are not wetted and diseases spreading is hindered

Crop Protection

DISEASES CONTROL

Though potatoes suffer from many viral diseases transmitted by aphids and in some cases by soil, use of virus free seed stock and good crop rotation will ensure a minimal effect. In years of high aphid populations, pyrethroid insecticides can be successfully applied. One of major fungal disease affecting potato production is potato blight (Phytophtora infestans). This can be devastating to late planted crops where the summer is warm and wet. Fungicides can be used, when conditions require. Where infestation occurs the haulm must be destroyed early to prevent the disease spreading to the tubers.

PEST CONTROL

Potato Cyst Nematode will build up in the soil without adequate rotation practice. Nematocides will have to be applied if the rotation is less than one year in six.

A severe problem is infestation by Colorado Beatle: the insect can be controlled by pyrethroid insecticide applications or speciality chemicals. Aphids can be controlled as described above but at low infestations levels this may be uneconomic.

WEED CONTROL

It may be necessary to use non-selective control of weeds in a fallow period to 'clean' the field. Once the weed populations have been suppressed, a lower level of selective herbicides combined with cultural techniques can be employed. However, often mechanical and chemical weed control of both broad leafed and grass weeds is necessary. Following planting, herbicide such as metribuzin and quizalofop can be applied with a second application probably required after second ridging, depending on actual weeds presence.

VINE KILLING

Vine killing does not necessarily result in improved tuber quality but it can help achieve a desired skin set and may help reduce bruising and increase storability of the crop. Surely vine killing makes harvesting operations a lot easier. In the past, it was not unusual for potato vines to have died and dried up from various causes before harvest. Pest damage, lack of fertility, or decreased moisture was often responsible for vine death. Foliar feeding insects, Verticillium wilt, and late and early blight diseases contributed to the death of vines well in advance of harvest.

New pest control materials and strategies have reduced the insect and disease effects on potato plants. Better irrigation and fertilizer practices also contribute to maintaining healthy green vines later into the season, particularly where drought is not a concern.
The improvement in these and other cultural practices has resulted in increased yields and has enhanced the economics of potato production. It also has made it necessary to include the practice of artificial vine killing to bring about vine death in preparation for harvest. In areas that produce late fall potatoes, frost sometimes kills the vines, especially during the late part of the harvest season; but during the early part of the harvest, even in these areas, artificial killing of the vines may be necessary. The length of time between the application of vine-killing materials and vine desiccation and skin set depends on a number of factors. Harvesting is easier when vines are dead. The goal is to have potato vines dead and dry and the tuber skins set at harvest time.

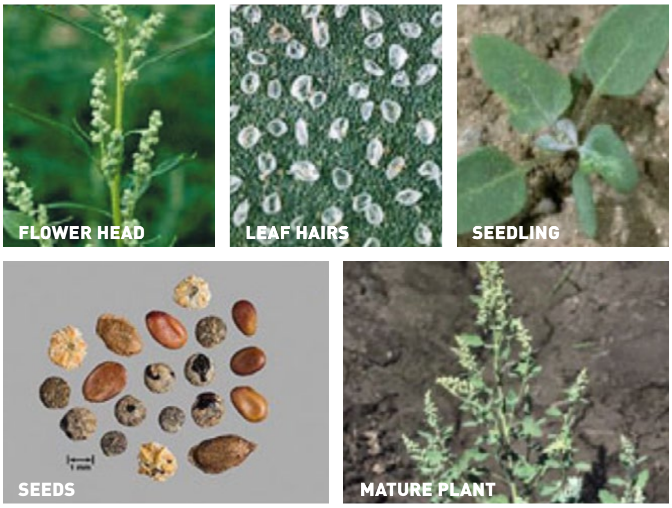
Two general methods used for vine killing are mechanical and chemical.

Mechanical:
Flail beaters and rotary choppers are popular mechanical methods. Machines should be adjusted to avoid disturbing the soil so tubers will not be exposed to sunlight, frost or mechanical damage. Rolling vines before killing can lead to virus spread and tuber damage. Early vine killing can be used to prevent the spread of virus diseases when there is a late-season aphid infestation. Timely vine killing allows the skins of tubers to toughen so the tubers can be harvested with a minimum of skinning and bruising. When late blight or pink rot is present at harvest, a higher amount of tuber rot in storage can result. The organisms can enter the tubers through harvest damage such as skinned and bruised areas. In storage, infected tubers continue to break down. Presence of these diseases is not always readily apparent at harvest.

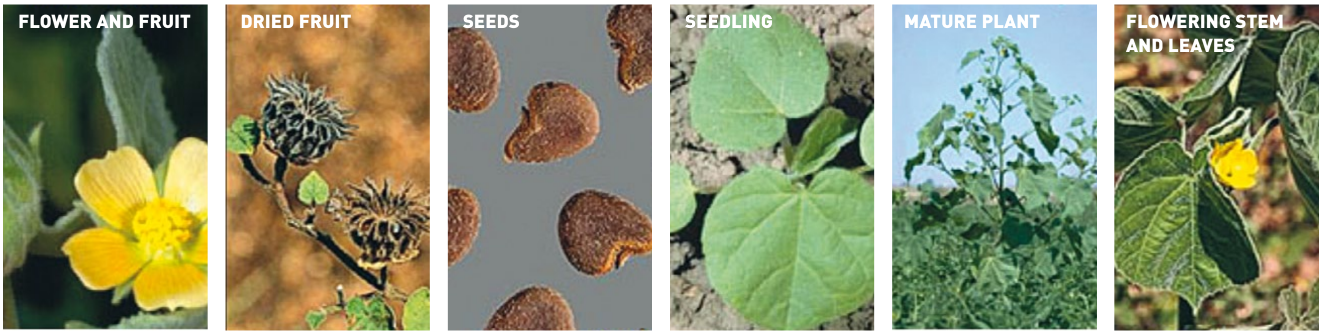
Chemical:
Vines are difficult to kill when soil moisture is high or plants are large, green and vigorously growing. It takes more time for these plants to die than plants that are naturally maturing. Cool and cloudy weather conditions also retard vine death. Vines need to be killed two to three weeks before harvest. Cultivar, fertility and growth conditions can have an effect on vine killing.
Vine killing is an added cost and has been known to adversely affect internal quality of the tubers. Discoloration of the vascular ring at the stem end of tubers can occur when vines are killed rapidly. Usually the discoloration is confined to the stem end but on occasion it extends the entire length of the tuber. The problem is usually more severe when soil conditions are dry and weather is hot at the time vine-killing chemicals are applied. Chemicals that result in rapid death of the plant are more likely to cause discoloration than those that cause a slow kill. Removing vines by cutting, burning, or pulling seldom results in discoloration of the vascular tissue.
Vascular discoloration may be severe enough to reduce fresh market tuber grade. Tubers with a discolored vascular ring do not make good chips or French fries as the discolored area shows up as a dark area in the finished product. This discoloration has no effect on seed quality but often causes concern since it resembles the vascular discoloration caused by Verticillium wilt or Fusarium wilt.
To reduce the danger of severe vascular ring discoloration from vine killing, the following practices are suggested:
Avoid using a chemical vine killer during hot weather, particularly if the soil is dry.
If vines must be killed when soil is dry and weather is hot, reduce the rate of material used and use a chemical that tends to kill the vines more slowly.
If irrigation is available, have soil moisture adequate at the time of vine killing.
Effectiveness of vine killing can be increased by practicing the following:
Do not apply vine-killing chemicals during cool, damp, or extremely hot, dry weather.
Under some conditions, split applications of chemical vine killers may be more effective than a single application. If the labeled use permits, use less than the full application rate, followed by a second application several days later.
Use spray adjuvants that are recommended.
Increased effectiveness has been shown with applications late in the day.

WEEDS

PIGWEED



LAMBSQUARTER



VELVET LEAF

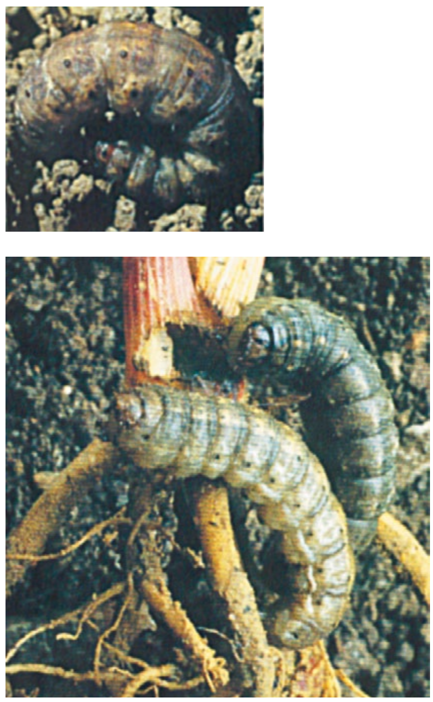
SOLANUM NIGRUM LEAFS FLOWERS FRUITS

by Harald Hubich - photo taken by Harald Hubich.

INSECTS AND DISEASES

APHIDS

WIRE WORMS



CUTWORMS

Spraying

Guardian™ Front Boom Sprayers have clearance and balance which are crucial facts from agronomic point of view.

Delivering consistent droplet size is a critical part of sprayer operation. This function can be more important depending on which chemical is used and on what canopy type.

Harvesting

Main crop potatoes are harvested when the skin (periderm) is completely thickened. At that time, tubers are fully matured, it is difficult to peel the skin with thumb pressure and bruising during harvester is more manageable.
Another accepted parameter is the content in dry matter of tubers, which should not be lower than 20%.

The haulm of main-crop potatoes is usually destroyed before harvesting because this initiates the maturity phase of the tubers, which comprise, amongst other things, skin development and thickening.

This is necessary to avoid damage to the tubers during harvesting and subsequent handling and storage. 'Skin set' takes between ten and twenty days after vine killing, depending on the amount of top growth. Harvesting operations are the main cause of bruising, therefore mechanical harvesting produces less damage to the tubers if conveyors are operated at proper speed, shaking beds are kept at full capacity, rubber padding is placed wherever potato bruising might occur to soften the landing of tubers: the use of rubber-covered bed links helps reduce tuber bruising. Limiting drop height to 15cm or less will also help. Padding placed in areas of the truck where loading begins, such as on the sides and bottom is of additional benefit. When loading the truck, build the load to full height in the padded areas first, then continue loading on previously built mounds to reduce the distance the potatoes fall.

Soil conditions also are important: best to harvest when soil is soft and friable (sometimes a light irrigation can help in reaching such condition).

Of course, after harvesting tubers should not be kept in full light, to avoid greening and formation of toxic alkaloids.

Machinery

IMPLEMENTING YOUR GROWTH PROJECTS

Crop producers know that their soil is the most precious natural resource, and better soil conditions mean higher crop yields. New Holland knows that every individual plant counts towards your bottom line and that's why we design our equipment specifically to help you maximize yield potential.

PRIMARY TILLAGE

Primary Tillage in potato farming is an essential operation, because product is growing into soil. New Holland T.6, T7 and T8 Series are sized and powered for any possible tillage pattern, from levelling to ploughing to ripping to finishing and seed bed preparation.

TRACTORS

SmartTrax II, T8 Series combine power and manoeuvrability. They find application in tillage, fertilizing and hauling operations. Despite the size, this series are enough manoeuvring for allowing an inter row usage in row crops cultivations and hilling.

CROP PROTECTION

Crop Protection is extremely important in potato farming. Uncontrolled insect or diseases can completely destroy a field in a few days. On large acreage, New Holland Guardian front boom sprayers are the tools of choice for proper pests' control. On lesser acreage, pull type sprayers are convenient tools. New Holland T.6 and T.7 tractors Series have the power, the manoeuvrability and the hydraulics for managing such sprayers.

HARVESTING

Digging and hauling potatoes is a hard task, because the count goes in tons and tons of tuber per hectare to be processed. Also here, T7 and T8 tractors, both wheeled and Smart-Trax II versions, are reliable machines to accomplish the job.

IRRIGATION

Irrigation is a necessity in many farming conditions, especially on potato. New Holland delivers power unit, suitable for powering all irrigation systems from drip irrigation up to centre and frontal pivots.

AT YOUR OWN DEALER

APAC

Visit our website: **www.newholland.com**
Send us an e-mail: **international@newholland.com**

New Holland prefers AMBRA lubricants

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