



Precision
Agriculture



Alfalfa

May. 2024 v1.0

/ Your full guide for Alfalfa success



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/ Introduction - About alfalfa

Alfalfa stands as a linchpin of global agriculture, playing a pivotal role in sustaining livestock, promoting soil health, and advancing sustainable farming practices.

It is the source for High quality protein for livestock feed. Alfalfa is a nutritional powerhouse for livestock and horses. Its protein content, often surpassing 15%, makes it a preferred choice for dairy and beef cattle, as well as other livestock.

Alfalfa's deep root system, extending up to 50 cm, plays a critical role in crop rotation and soil health. This extensive root network breaks up compacted soil, enhances water infiltration, and reduces erosion. Alfalfa fixes nitrogen in the soil, providing an advantage to future crop rotations. It is unique among forage crops, providing pollinator habitat.

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Livestock nutrition:

Alfalfa is a nutritional powerhouse for livestock and horses. Its protein content, often surpassing 15%, makes it a preferred choice for dairy and beef cattle, as well as other livestock. For instance, the dairy industry relies heavily on alfalfa as a primary source of high-quality forage, contributing to milk production. In 2020, alfalfa production in the U.S. reached 55.7 million tons, with a farm gate value of over \$9 billion.

Economic impact:

Globally considered the "Queen of Forages," alfalfa is a highly valuable crop worldwide, with an estimated economic value projected to reach 46.56 USD billion by 2032. Approximately 40 million hectares of alfalfa are cultivated globally each year.

In various regions around the world, such as the Central Valley in California, USA, alfalfa contributes significantly to local economies. For instance, in the Central Valley, alfalfa contributes approximately \$1.2 billion annually to the economy, supporting jobs and local communities. This pattern is replicated in many agricultural regions globally, underscoring the importance of alfalfa to both local and international economies.

Crop rotation, soil health, pollinator habitat:

Alfalfa's deep root system, extending up to 15 feet, plays a critical role in crop rotation and soil health. This extensive root network breaks up compacted soil, enhances water infiltration, and reduces erosion. The ability to break disease and pest cycles through crop rotation is exemplified in Idaho, where alfalfa helps maintain the health of potato crops. In a study by the University of California, crop rotations involving alfalfa improved soil structure by 22% and increased water retention by 24%.

Alfalfa fixes nitrogen in the soil, providing an advantage to future crop rotations. It is unique among forage crops, providing pollinator habitat.

Transforming alfalfa farming for a sustainable future

Alfalfa has been predominantly cultivated using conventional irrigation techniques that heavily rely on water resources. Flood irrigation has been the primary method of irrigation. While this traditional method has served alfalfa farmers for decades, today, this practice threatens the future of this crop for several reasons.:

- **Water scarcity:** Due to reduced water availability across the Western US, where alfalfa is most productive, the proposed solution is taking alfalfa acres out of production.
- **Economic sustainability:** Traditional methods often result in uneven water distribution, impacting the quality and yield of alfalfa crops. This inconsistency can lead to reduced market competitiveness.
- **Environmental impact:** Traditional irrigation systems can cause soil erosion, nutrient runoff, and contamination of water bodies, which harms the environment and increases regulatory pressure on farmers.
- **Energy and operational costs:** Many pressurized irrigation systems require substantial energy input and maintenance expenses, adding to the operational costs of alfalfa farming. Increases in energy, operations and maintenance costs, combined with lower yields, hampers profitability.

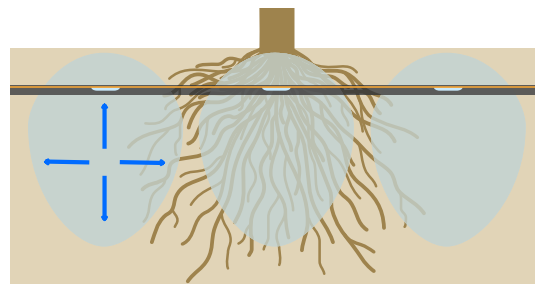
To ensure long-term success and sustainable practices, it is vital for alfalfa farmers to re-evaluate their traditional irrigation methods and adopt modern, efficient, and sustainable irrigation practices.

/ Subsurface drip irrigation (SDI) for Alfalfa

SDI is the ultimate choice for irrigated alfalfa provides optimizing water and fertigation usage and maximize yield. With SDI you get the exceptional ability to irrigate during and immediately following harvest. This promotes rapid re-growth and significantly enhances yields, even when crops are left to dry in the field. SDI eliminates prolonged intervals between harvests, resulting in more cuts and ultimately higher yields per cut and higher quality. This achievement is beyond the reach of other irrigation methods.

What is subsurface drip irrigation (SDI)?

Sub surface drip irrigation is a variation on traditional drip irrigation where the dripline is injected beneath the soil surface. The depth and distance the dripline is placed depends mainly on the soil type, roots physiology, planting configuration and tillage practice. SDI is more than an irrigation system; it is a root zone management tool. Fertilizer can be applied to the root zone in a quantity in which it will be most beneficial - resulting in greater efficiencies and better crop performance, lower evaporation, fewer weeds and multiple other benefits.



Sub surface drip irrigation (SDI) advantages

The key benefit of a sub surface drip irrigation system is to apply low volumes of water and nutrients uniformly to every plant across the entire field. SDI delivers many advantages beyond surface irrigation.



Maximize land productivity
by full land utilization



Maximize water use
efficiency



Maximize yield
quantity and quality



Maximize field access simplicity
throughout the season.



Minimize fertilizer and
chemical usage



Suitable for various crops,
enabling crop rotation

Dripline injection depth

Depth depends on the soil type and the plant's root structure. The depth normally determining dripline insertion ranges between:

- Medium: 10-20 cm (Semi permanent crops)
- Deep: 20-40 cm (Permanent crops)

Custom Sub surface drip irrigation (SDI) modules for Alfalfa growers

Our ultimate multi-seasonal irrigation system offers versatile applications, ensuring optimal performance across diverse agricultural scenarios. Recognizing diverse needs and the fact that there is no one-size-fits-all solution, we offer 3 SDI modules tailored to farmers' needs



/ Achieving the maximum out of your SDI system

Receiving the maximum benefit out of your SDI system requires careful recording of crop and system activity.

Critical aspects that need to be considered in order to achieve success in SDI

- **Land preparation** is essential for the future performance of the system and should be applied throughout the entire area at the initial stage of the project.
- **Germination.** In most crop areas, SDI provides enough moisture to germinate the crop. However, in some very dry areas, Netafim's overhead irrigation may also be needed for crop emergence and stand establishment.
- **Routine maintenance.** An SDI system requires regular maintenance to ensure that it performs to specification, since this is long-term permanent irrigation system.
- Long-term planning. Given the potential long life and cost of the SDI system, **crop rotation** and cultivation practices such as deep cultivation must be considered when formulating an SDI plan.

Site evaluation - selecting the best emission device for your application

Site evaluation is the first step in developing a successful SDI system.

It requires the assesment of two critical aspects:

- Assessments of the water quality and availability
- Assessments of soil characteristics and topography.

Listed below are some general guidelines to help in the selection of an emission device for your specific application.

Water quality and availability Assessments

Properly addressing water quality issues often solves most problems associated with the successful operation of the SDI system:

- Physical - suspended particles and filtration
- Chemical - pH, iron, bicarbonates, carbonates
- Biological - bacteria and filtration/chemical treatment



/ Soil Assessments

Soil type and absorption play an important role in determine your optimal solution.

for this you need to create a soil survey, this are the actions required to confirm the feasibility of SDI for the project. to know your soil characteristic by understanding by the different types and by performing appropriate soil survey

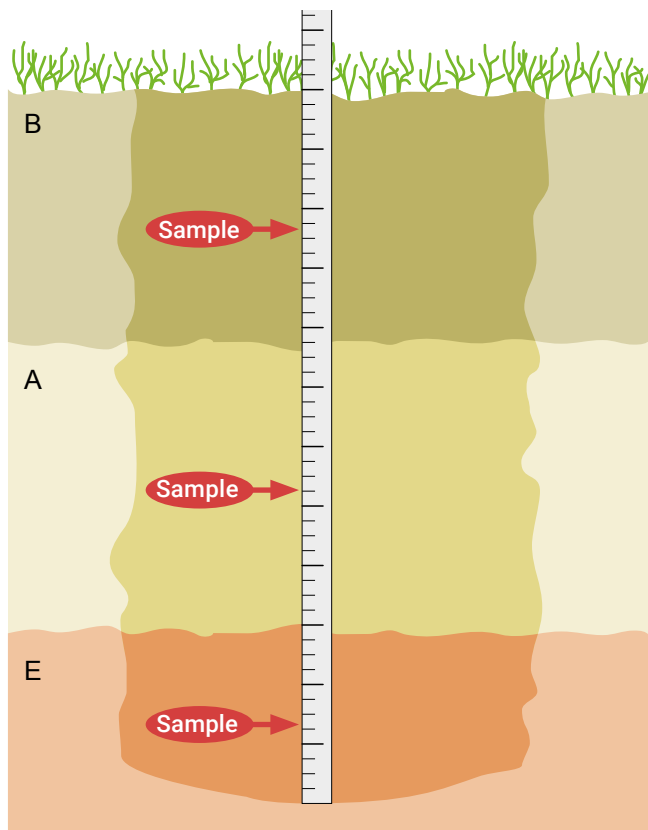
Soil survey

- A basic soil survey should be performed as follows:
- For virgin land, a comprehensive soil analysis with emphasis on chemical parameters is required.
- If the crop has already been grown on the plot, the level of soil survey requirements can be reduced to the physical properties.
- Observe your potential different soil types in the field, and mark the zones. One way to identify the different zones is based on previous yield maps, topography (causing variation in soil texture) and Google Earth maps or satellite imagery that indicate previous crop coverage.
- Once identified, perform a soil survey, sampling each of the marked zones.
- If the field is expected to have a uniform soil type, select a location that is expected to best represent the soil texture. The recommended number of testing samples is 1 for every 15 hectares.

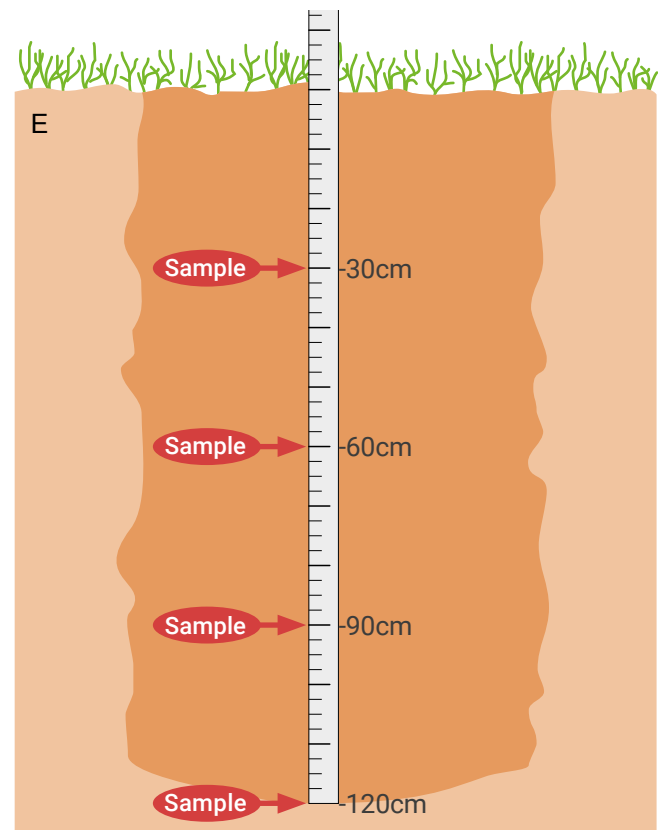
Sample using one of 2 methods:

Method 1 (recommended): Dig a pit 1.2m deep with a shovel or excavator. Based on color and feel, establish whether different layers have different soil textures. Place a measuring tape next to the profile, and use a digital camera to photograph depth markings.

Take a sample of at least 0.5kg at mid-height of each layer.

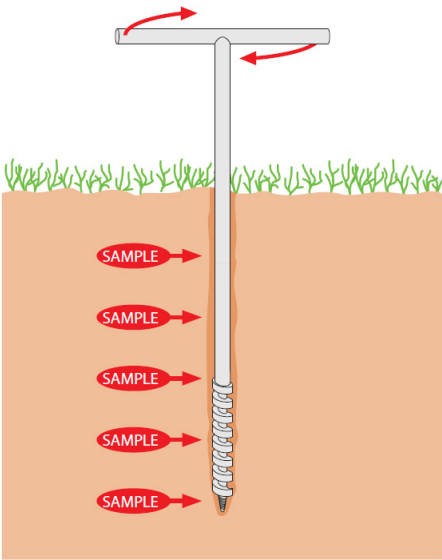


If there are no visible layer differences, take a sample of at least 0.5kg every 30cm.



Send the soil samples to a lab test for physical (% clay, % silt, % sand) and chemical property analysis.

Method #2 (easier but less accurate): Use an earth drill, and take samples of at least 0.5kg each from different depths every 15cm, up to a depth of 75cm (5 samples from each location). Send the samples to the lab.



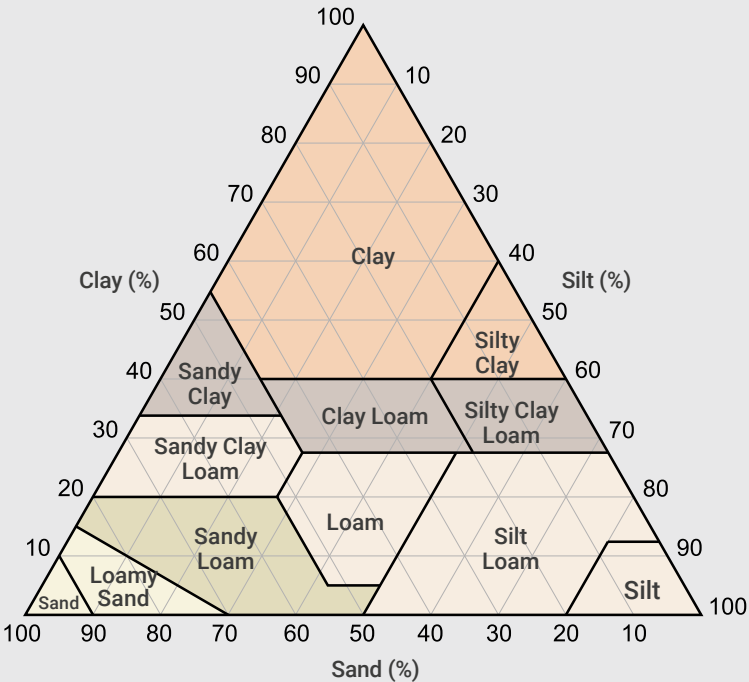
Conclusions

Soil survey result	Suitable for SDI	Action to consider
Top and bottom layers in the top 40cm are similar in texture.	Yes	
There is no gravel layer or coarse sand in and below the expected dripperline location.	Yes	
Soil texture is not consistent between the expected depth of installation and the soil surface.	No	Installation of the dripperline in the upper level will resolve the problem. Will require adequate tillage depth.

Soil composition

The following grouping of soil types relates to the hydraulic conductivity of soils (the ability of water to move between soil particles). This information is useful in deciding about the position of the dripperlines in the soil.

Soil group	Soil texture	Porosity (%)	Ksat (cm/h)
A	Sand	39.5	63.36
	Loamy sand	41.0	56.16
B	Sandy loam	43.5	12.49
C	Silt loam	48.5	2.59
	Loam	45.1	2.50
	Sandy clay loam	42.0	2.27
D	Silty clay loam	47.7	0.612
	Clay loam	47.6	0.882
	Sandy clay	42.6	0.781
	Silty clay	49.2	0.371
E	Clay	48.2	0.461

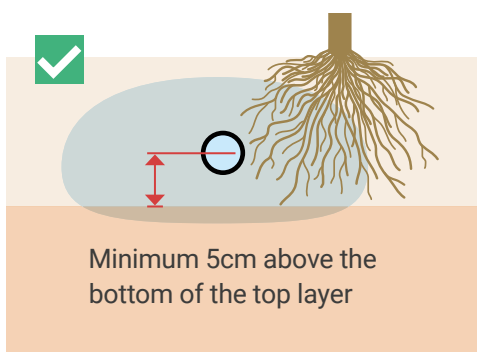
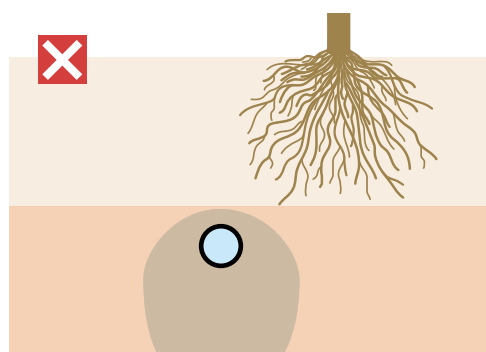


/ Dripline position and planting pattern

Dripline position in different soil layers

Always position the dripperline in the top soil layer.

From 5cm below the dripperline location and upward toward the surface, the texture must be consistent. If it isn't, consider elevating the dripperline position.

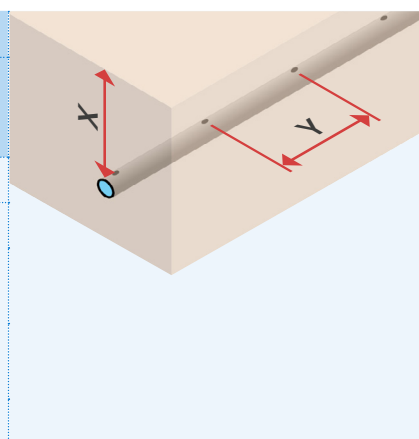


NOTE

Sandy soils have superior water conductivity when saturated, but conductivity in dry soil is inferior, and therefore, water does not move laterally for long distances from the dripper.

Optimal dripline insertion depth and drip spacing for different soil textures (excluding germination)

Group	Soil texture and profile	X	Y
		Maximum dripperline insertion depth (cm)	Recommended dripper spacing (cm)
A	Sand; Loamy sand	30	30-40
B	Sandy loam	40	50-60
C	Silt loam; Loam; Sandy clay loam		
D	Silty clay loam; Clay loam; Sandy clay		
E	Silty clay; Clay		

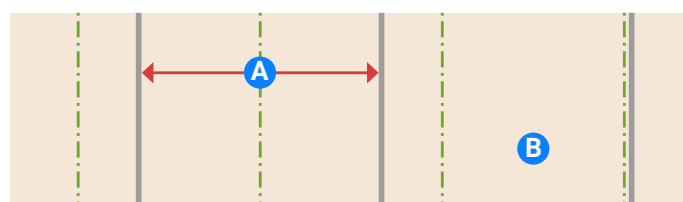


Group	Soil texture and profile	Maximum allowed horizontal distance between dripline and crop row (cm)
A	Sand; Loamy sand	40
B	Sandy loam	50
C	Silt loam; Loam; Sandy clay loam	
D	Silty clay loam; Clay loam; Sandy clay	
E	Silty clay; Clay	

Full-coverage concept - 100 cm lateral spacing non-precise planting

Alfalfa and other broadcasted crops require a full coverage system in order to have a precise water and fertilizer to the root zone of each of the plants.

Such a system will be suitable to any other crop in the rotation



- A** Horizontal distance between dripperlines: 70-100 cm
- B** Horizontal distance between crop rows: 15-20 cm

/ Soil preparation and pre-installation guidelines

after we design the system characteristic depth and position and spacing another element we need know is how to do proper soil preparation

Soil moisture conditions for installation

Soil moisture should be at a medium (50%) level to avoid excessive drying and production of large clods. Also it should not be too wet and sticky, so that passage of a shank through the soil doesn't leave an open trench or create a sealed tunnel.

Autumn installation (installation before the rainy season): The recommended time for dripperline installation is 1-2 weeks after a significant rain (30-50mm). Autumn dripperline installations are the most highly recommended, as winter rains tend to have a good impact on soil structure, and therefore, on soil water conductivity when the system is operated in the spring.

Spring installation (installation prior to planting): Wait for the soil to drain and reach an optimal moisture level as explained in the first paragraph of this section. This normally happens 30-50 days after the last significant rain, depending on soil type. Installation in sandy soils can start earlier and usually results in better quality. Heavy soils are not favorable for spring installations, as they often require installation in wet soil, and if it is heavy, the shank may cause a "chimney" effect.

Ripping

Autumn installation: Ripping should be done to a depth of 10cm below the intended depth of dripperline installation, and at least 40cm. below the surface.

Spring installation: It is best to rip a shallower depth of 5cm above the intended depth of installation. This is to improve water movement toward the surface in conditions where soil packing is not optimal. If possible, it is recommended that the soil be prepared for spring installation during the autumn season.

- In cultivated land, rip only in the direction of expected dripperline installation.
- In virgin land, cross-rip.
- For medium and deep insertions, it is highly recommended to perform subsoiling 3 to 4 times along the path of the flushing manifolds and sub-mainlines to enable easy and swift penetration of the dripperline insertion shank into the soil.

Plowing

Plow the field to a depth of 25-30cm.

Disking (or rotovator/cultivator)

Disking with a heavy disk harrow should be done to ensure that the soil has no large clods.

Leveling

In case of visible height differences, it is best to use a leveler (Triplane) to ensure that the micro-topography doesn't affect the dripperline insertion depth.

Prior to planting

- It is advisable to use a roller before sowing in order to close the soil cracks that were created by the ripper activity.
- The aim is to prepare a crumbly soil surface, with maximum contact between the soil particles and the seeds and a high moisture content at the depth of sowing (usually at 7cm).
- Autumn installation: For crop success, it is best to plant in moist soil, preferably after the first rain and as close to field capacity as possible.



ATTENTION

Remember - you are installing a system that should serve for 15-20 years, so take the time to do it right!

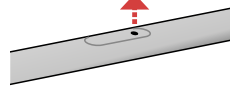
/ Top 19 most important installation guidelines

1. Start with dripperline insertion (this can be performed at the same time as mainline and head installation, but keep sub-main and flushing manifolds for last).
2. Perform 2 test runs for the dripperline insertion machine: 1 on the surface, to make sure the dripperline is not damaged by the machine in any way, and the other subsurface, to make sure the dripperline depth and position are correct.

3. Start injecting the driplines a few meters before the intended location of the sub-main pipe (a), and finish injecting few meters after passing the intended location of the flushing manifold or the end of the row (b).
This ensures dripperline insertion at the required depth, beginning with the location of the sub-main and the collector.

4. The use of driplines with "flap or AS mechanism is highly recommended- it will prevent clogging and ensure longer longevity of the drip.

5. Face the drippers upward.



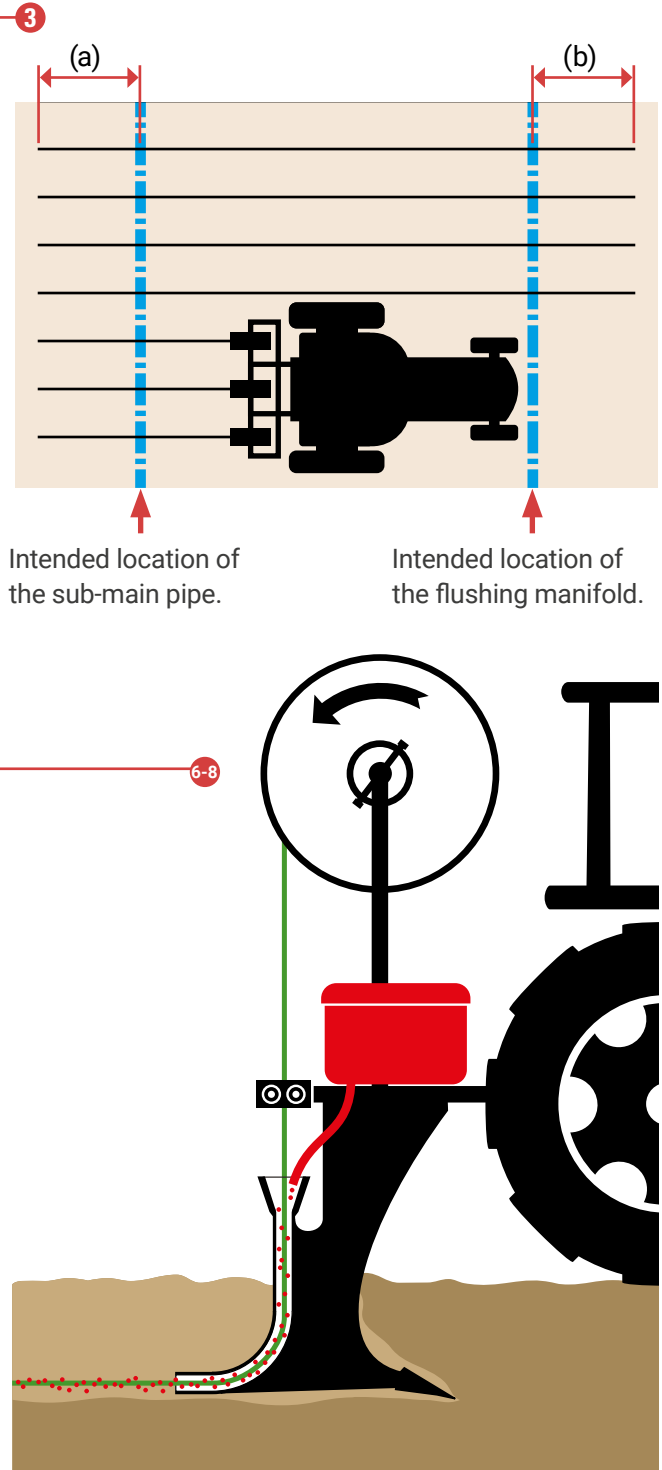
6. The recommended insertion speed is 4km/h; in any case, it should not exceed 6km/h, faster can harm the system.

7. Use a GPS RTK, or clearly mark the track that the insertion machine should follow, to ensure a consistent, aligned progress. This will ensure uniform spacing between the dripperlines.

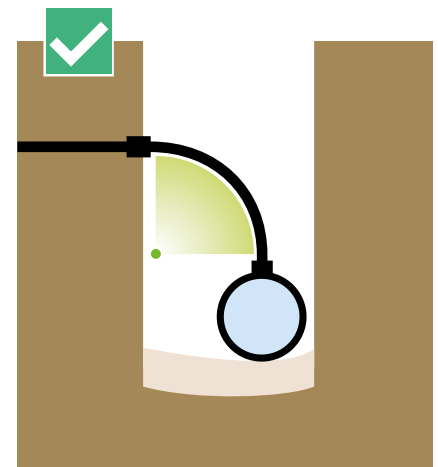
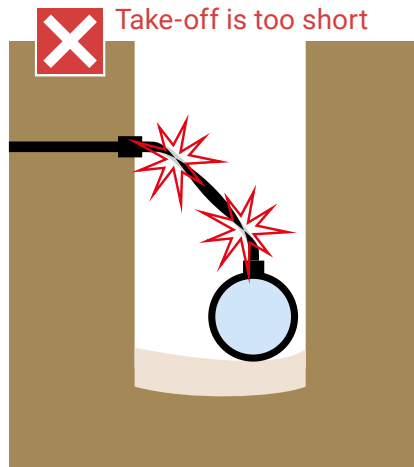
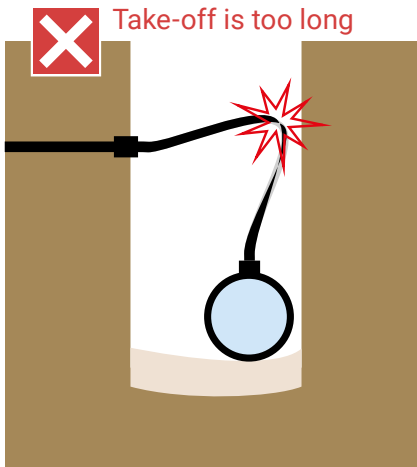
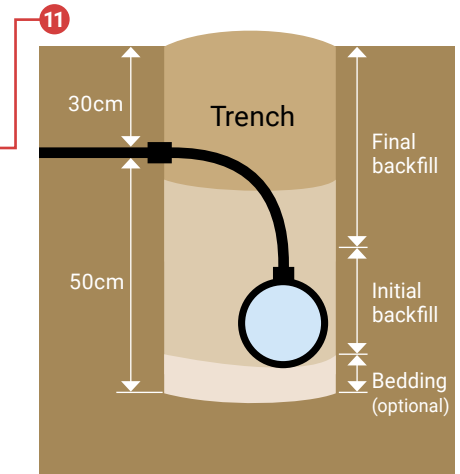
8. When replacing a coil and joining two dripperlines, use ring-type or wire-tie connectors. Make sure the connector can comfortably pass through the insertion tube. The worker should manually assist the entry of the connector into the conic inlet of the insertion tube. Drive very slowly for a few meters until the connector safely exits the insertion tube, and increase the speed gradually.

9. After the dripperline insertion, pack the soil with a heavy tractor. Drive over the shank burrows.

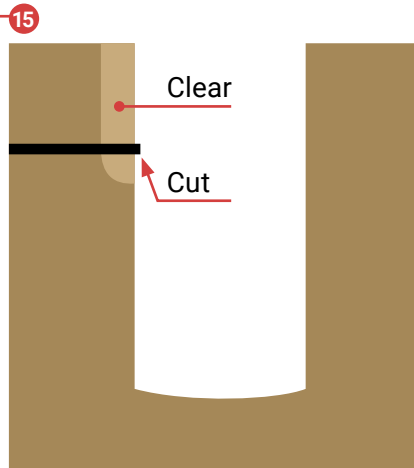
10. After the dripperlines are in the soil, trench the sub-main and mainlines with a trencher (preferable to a backhoe). This will result in cutting off the pre-inserted dripperline at the sub-main location.



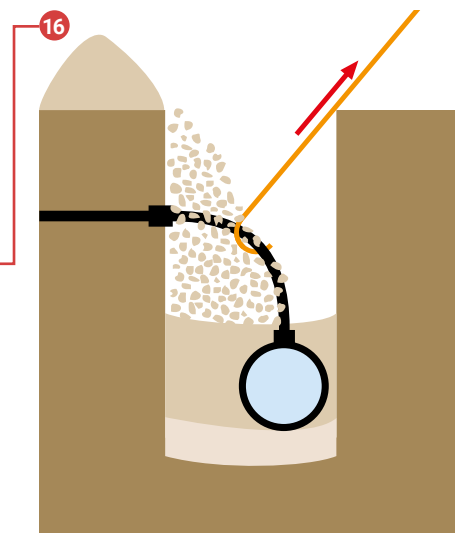
11. Recommended trench dimensions: _____
12. Position the sub-mains and connect the take-offs. If the trench is very narrow, connect the take-offs to the sub-main outside of the trench, and then push the sub-main into the trench.
13. It is recommended to use Netafim Q Flex riser for simply the connection between the submain and the driplines.
14. To avoid kinks, the take-offs should be of the right length to form a regular curve between the dripperlines and the sub-main line.



15. Clear the soil around the dripperline ends with a shovel, cut the exposed end straight, and make the connection to the take-off. _____



16. Backfill halfway while securing the take-off with a metal rod and with a hook at its end to avoid kinking. _____
17. Water-pack the backfill by flooding the trench. The complete backfill should be done only after commissioning of the system.
18. Flush the mains, sub-mains and dripperlines before pressurizing and running the system.
19. For your first installation, make sure you are accompanied by a Netafim supervisor at all critical stages.



After we set the SDI system following the previous pages instructions now its time for the reccomendation on how to grow alfalfa efficiently using Netaim SDI system.

/ Alfalfa - Irrigation and fertigation recommendations

Germination and Establishment:

- Soil profile must be at field capacity, meter deep, during planting (seeding).
- Main germination irrigation (in case of no rain), should be done by an overhead system, 20-30mm should be applied.
- In the case of a dry climate during the first two-four weeks after germination irrigation, it's recommended to provide two irrigations of 10mm every week with an overhead irrigation system, to ensure moist topsoil for better germination and established root system.
- Routine irrigation schedule by SDI system can start after full germination and plant development to 15-20cm tall.
- On the first and second cut, the SDI irrigation event should not be more frequent than twice a week, to spread the moisture up to the undeveloped rootzone to achieve uniformity.

Refer to the table below for a suggested routine irrigation timetable:

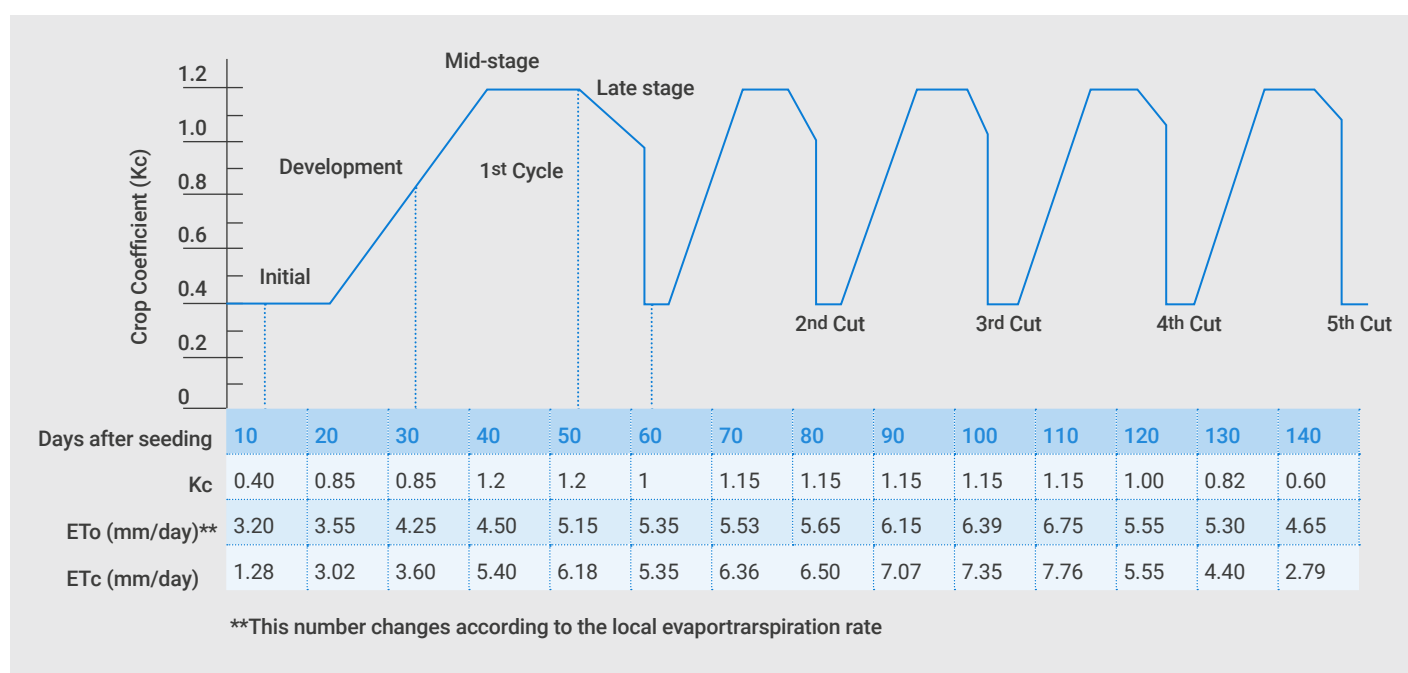
Routine Irrigation Scheduling:

KC	First cycle (days from germination)	Other cycles (Days from harvesting)	Recommended interval
0.6	0-10	0-7	3-4 Days
0.8-1	10-30	7-15	3-4 Days
1.2	30-45	15-20	2-3 Days
1.0	45-50	20-35	2-3 Days
Total (days)	50*	30**	

* Range 45-60 days according the local climate

** Typical range 25-40 days doing spring/summer time according to the local climate.

Example - Irrigation Cycle



- It is recommended to start the irrigation schedule within 24H after harvesting (cutting). In case of humid soil, it is recommended to irrigate only after the bales have been collected.
- To prevent compaction or damage, it is recommended to stop irrigation 2-4 days before harvesting, depending on the soil structure.
- Irrigation quantities change according to the expected ET (evapotranspiration) and weekly KC (crop factor).
- For monitoring the level of humidity in the soil, use tensiometers or other sensors, a soil drill or a shovel to see if the soil profile is properly wet
- In case of an effective rain event, skip irrigation.
- An effective rain event is one with over 10mm. Rainfall of less than 10 mm is not effective and is not calculated as part of irrigation.
- Rain efficiency should be calculated at an 80% rate (e.g. reduce 8mm of the irrigation application amount in the event of 10mm of rain).



Fertilization Recommendation:

- Most fertilizers improve yields of alfalfa when the elements contained in the fertilizer are in short supply in the soil. Thus, if P, K, S, or micronutrients are low in soil or tissue tests, yields of alfalfa will improve with application of those fertilizers.
- Alfalfa (legumes) have symbiotic relationships with bacteria that gives nitrogen-fixing abilities, few weeks after planting.
- For quick and better establishment, it is recommended to apply 20-30Kg/N per hectare as base dressing or by fertigation.
- If soil test shows low P values (lower than 12PPM in Olsen method) it is recommended to apply 15kg/P2O5 per Hectare per one additional PPM.



Weed Management Guidelines:

- Alfalfa is stressed by weed interference mainly during its establishment and in thinning stands. Alfalfa does not occupy all of the ground area at these two stages, so weeds are able to establish and compete with alfalfa for soil nutrients, water, light, and space.
- It is highly recommended to follow all the management steps and apply the needed herbicide in the right time according to the weed situation.
- It is recommended to apply pre-planting, pre-emergence and post-emergence herbicide.
- Calculate the chemical and dose according to the local regulation, timing and weeds situation.
- In case of high weed distribution potential, it is suggested to irrigate before planting let the weed germinate, and apply the herbicide without risk of damaging the crop.

Specific Recommendations for RO-80

System configuration:

- SDI, 30Ha.
- Dripnet PC AS, 22250, 1L/H. 0.5M.
- One meter spacing between laterals.
- 35cm deep.
- Application rate- 2mm/H.
- Germination and establishment was done by overhead irrigation
- System capacity- 8mm/day
- Soil type- heavy soil

Monthly max ET:

- April 4mm/D.
- May 4mm/D.
- June, July, August- 6-7-mm/D
- September- 4-5mm/d
- October- 3mm/D

Irrigation table:

Kc	First cycle (days from emerge)	Irrigation recommendation (base on 5mm ETmax/D)	Other cycles (days from harvesting)	Irrigation recommendation (base on 5mm ETmax/D)
0.6	0-10	Rain or Overhead irrigation	0-7	10H/shift every 4 days
0.8-1	10-30	Frequent overhead irrigations	7-15	10H/shift every 4 days
1.2	30-45	10h/shift every 4 days	15-30	7.5H/shift every 3 days
1.0	45-50	10h/shift every 4 days	30-35	7.5H/shift every 3 days
Total (days)	50		30-40	Start the next cycle in about 24H after harvest

Scheduling guidelines:

- The recommended time is per shift, each shift should receive the same irrigation time.
- The calculated irrigation time is according to the climate condition (ET), crop canopy cover (Kc) system application rate (mm/H) and the recommended interval.
- For example- $5\text{mm (ET)} \times 1 \text{ (Kc)} \times 4\text{days (interval)} / 2\text{mm/H} = 10\text{H}$
- The recommendations are based on the average ET.
- The actual ET can be different than the average.
- Soil monitoring and following real time ET from your local climate station and on Netafim's GrowSphere platform is highly recommended.



/ SDI system maintenance

For optimal performance, drip irrigation systems require routine system maintenance. Correct preventative maintenance ensures long-term use of a durable and efficient SDI system.

Maintenance consists of two categories:

Preventive maintenance, aimed at preventing clogging of the drippers, can be divided into three categories:

- Flushing the system
- Chemical injection
- Irrigation scheduling*(technical irrigation)



NOTE

Irrigation scheduling (technical irrigation) is not a distinct maintenance practice, and therefore it is not discussed in this book. However, the application of an orderly irrigation plan is of utmost importance to the prevention of clogging of the drippers.

Corrective maintenance consists mainly of removal of obstructions already present in the drippers:

- Flushing the system
And one or more of the following practices according to the nature of the obstruction:
- Organic formation - treated with hydrogen peroxide.
- Mineral sedimentation - treated with acids (or a combination of acid and hydrogen peroxide).
- Organic formation and mineral sedimentation - treated with a combination of acid and hydrogen peroxide.

/ Maintenance timetable guide

Additionally, to routine system maintenance, the SDI system requires unique maintenance on these occasions:

When operating a new system for the first time

Once a week

Once a month

Once a growing season

At the end of the growing season

For the success of your alfalfa cultivation using SDI, find out the right maintenance guide for each.



When operating a new system for the first time

- Flush the piping - main line, sub-mains and distribution pipes.
- Flush the driplines.
- Check actual flow rate and working pressure for each irrigation shift (when the system is active for at least half an hour).
- Compare the data collected to the data supplied with the system (planned). The tolerance should not be greater than $\pm 5\%$.
- Write down the newly acquired data and keep it as a benchmark for future reference.
- If the flow rate and/or the working pressure at any point in the system differ by more than 5% from the data supplied with the system, have the installer check the system for faults.



Once a week

- Check actual flow rate and working pressure for each irrigation shift under regular operating conditions (i.e., when the system is active for at least half an hour and stabilized).
Compare the data collected to the benchmark data.
- Check that the water reaches the ends of all the driplines.
- Check the pressure differential across the filters. A well-planned filtration system should lose 0.2 - 0.3 bar (when the filtration system is clean).
- If the pressure differential exceeds 0.8 bar, check the filter/s and their controller for faults.



Once a month

- Check the pump's flow rate and pressure at its outlet.
- Flush the driplines. (A higher or lower frequency may be required, depending on the type and quality of the water.)
- If the filtration system is automatic, initiate manually flushing of the filter/s and check that all components work as planned.
- If pressure-regulating valves are installed, check the pressure at the outlet of each one of them and compare these figures with the benchmark data.



Once a growing season

In some cases, the following need to be performed twice or three times in a growing season, depending on the type and quality of the water used.

- Check all the valves in the system.
- Check the level of dirt in the system (carbonates, algae and salt sedimentation).
- Check for occurrence of dripper clogging.
- Flush the piping - main line, sub-mains and distribution pipes.
- If necessary, inject hydrogen peroxide and/or acids as required.



At the end of the growing season

- Inject chemicals for the maintenance and flushing of the main line, the sub-main lines, the distribution pipes and the driplines.
- Flush the driplines.
- Prepare the system for the inactive period between the growing seasons.
- Perform winterization of the system in regions where the temperature might drop below 0°C.



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