



# Green Business Plan

*for establishing an*

## Orchard farm with drip-irrigation system and protected with tree windbreaks

(TEMPLATE)

First and last name: \_\_\_\_\_

Date of birth: \_\_\_\_\_

Address: \_\_\_\_\_

Telephone: \_\_\_\_\_

Email: \_\_\_\_\_

This *Green Business Plan* Template has been produced by the **Global Green Growth Institute (GGGI)** under the '**Green Rehabilitation Investment Project for Karakalpakstan Republic to address impacts of the Aral Sea crisis**' (Aral Sea GRIP Project) funded by the **Korea International Cooperation Agency (KOICA)** and co-funded and implemented by GGGI.



TOGETHER WITH

The **German Sparkassenstiftung (DSIK)** under a Memorandum of Understanding signed between GGGI and DSIK on the 27<sup>th</sup> of June on '*Green Entrepreneurial Education and Development of the Agribusiness Sector in the Republic of Uzbekistan*'.



#### ACKNOWLEDGEMENT:

**Authors:** Juan Jose Robalino and Sarah Appelt

Information provided as example has been collected by the Uzbek consultant company 'A Master Fruit' LLC, registered in Uzbekistan, under a contract between the Global Green Growth Institute and A Master Fruit LLC (100006691).

#### Expert Reviewers:

Mathias Wangler, Country Representative of German Sparkassenstiftung Uzbekistan.

**Illustration Credits:** Azimova Nazokatoy

#### DISCLAIMER:

The Global Green Growth Institute and the German Sparkassenstiftung do not make any warranty, either express or implied, or assume any legal liability or responsibility for the accuracy, completeness, or the use of this document or its information.

# 1. Summary

The proposed business idea is to produce \_\_\_\_\_ (fruit/seed/nut) (e.g., apricot) irrigated with drip-irrigation and protected with tree windbreaks for increasing the productivity of the farm, decreasing water consumption, and for improving environmental conditions including air quality and green areas for beneficial animals and insects, in other words, promoting ecosystem services such as carbon sequestration and pollination.

In Uzbekistan, impact assessments from the implementation of drip-irrigation systems have shown increased yields averaging 40% for all crops, with the greatest positive impact observed in orchards. In addition, plantation of trees for windbreaks have shown an increase in crop yield and quality that has led to higher revenues due to the numerous benefits of wind protection. Different crops respond differently to wind protection with documented yield increases up to 20% under an optimal structure and after the trees in the windbreaks have reached their final height.

I would like to invest in implementing a drip-irrigation system and planting protective trees for improving my \_\_\_\_\_ (fruit/seed/nut) (e.g., apricot) production in \_\_\_\_\_ (e.g., 1 hectare) of my farm. Considering neighboring farms, I estimate a total \_\_\_\_\_ (fruit/seed/nut) production of \_\_\_\_\_ (e.g., average apricot yield 11,250 kg/ha). Following local market's price \_\_\_\_\_ (e.g., Uzbekistan's 2022 apricot price USD 0.66 per kg), the estimated annual revenue is about \_\_\_\_\_ (e.g.,  $11,250 \text{ kg} * 0.66 \text{ USD/kg} = \text{USD } 7,425$ ). After \_\_\_\_\_ (visiting/learning about) (e.g., visiting a neighbor's farm who has implemented drip-irrigation), I am interested in trying the system in my farm. Considering the referential price provided \_\_\_\_\_ (e.g., USD 4,000 per hectare), I am interested in investing in this system.

In addition, for protecting \_\_\_\_\_ (e.g., 1 ha) of my farm, I have decided (or an expert/consultant has suggested me) to plant \_\_\_\_\_ (e.g., 400 meters of linear windbreak protecting the 4 sides of the farm) with \_\_\_\_\_ (e.g., Karatal trees in row-spacings of 2m which will provide, once mature and with a height of 15m, approximately 60m of upwind and 300m of downwind protection against crop damaging considering Karakalpakstan wind velocities of 5m/s during March and April). The investment in trees to be planted is \_\_\_\_\_ (e.g.,  $400\text{m of trees} / 2\text{m spacing} = 200 \text{ trees} * 0.18 \text{ USD/tree} = 36 \text{ USD}$ ).

As a farmer situated in \_\_\_\_\_ (e.g., Kegeyli district) I have seen an increase in the occurrence of (wind/dust) storms and reduction in water availability for irrigation which have affected my farm as well as my neighbors' farms. I have been a farmer for \_\_\_\_\_ (e.g., the last 15 years) and I am looking for options to improve my farm's production as well as to have a positive impact in my farm's surroundings.

## 2. The Business Idea

### 2.1. The Green Business Model

The green business model consists in the production of \_\_\_\_\_ (fruit/seed/nut) (e.g., apricot) with drip-irrigation system and protected with tree windbreaks for creating ecosystems services that will positively impact my farm's productivity and my farm's surroundings. For this, my responsibilities will be to source raw materials and produce agricultural products by leveraging labor and equipment, while taking care of and proper manage the drip-irrigation system and the trees planted as windbreaks.

As part of these responsibilities, an estimate of water consumption with and without drip-irrigation system, as well as carbon sequestration from mature trees, will be calculated. The estimated reduction in water consumption and carbon sequestration will serve for communicating my customers and relevant government institutions on the farm's contribution for adapting to and mitigating climate change.

Implementing drip-irrigation and planting trees for windbreaks will also bring advantages to my customers by improving the yield and quality of the products, securing the supply and overall supporting food security efforts in the region. Additionally, windbreaks and coordinated irrigation serve as a good way to reduce soil erosion and improve soil quality.

Furthermore, I will also register my full-time and seasonal employees as staff on my farm as part of my sustainable business activities, contributing to environmental, social, and governance criteria. The official registration procedure for staff gives my employees access to social security services and will have a positive impact on the social structures and security system in my neighborhood. It is very important for me that my activities reflect environmental as well as social responsibility.

## 3. Personal qualification

### 3.1. Professional qualification

(EXAMPLE) After graduating from high-school I attended agricultural vocational studies for 2 years. While exercising my profession as a farmer during the past 15 years, I have attended technical agriculture seminars for improving the management of my farm as well as for keeping records of my business practices for improving decision making. The last seminar I attended was provided by DSJK where I learned about how to conduct my business, develop a business plan and how to talk with banks.

### 3.2. Entrepreneurial qualification

(EXAMPLE) My continuous seek for doing things better responds to my desire to improve the productivity of my farm, to support my family, as well as to create a favorable environment for me and my neighbors which can allow us to continue our production practices in the long-term.

While helping my parents with the production of cotton I got good insights of everyday farm business life from an early age. Following my technical learning and my work for the last 15 years, I have looked for solutions that can help me improve my farm's production while not having a negative impact in the environment and while improving the welfare of my employees.

As main manager of the farm, I have been responsible year after year for the production of apricot, the purchase of inputs like for example seeds and fertilizers, as well as for preparing the land and securing a proper production process. This experience has allowed me to understand the proper management of the farm and the need for seeking solutions that can further improve the productivity of it.

### **3.3. Motivation to implement a green business model.**

(EXAMPLE) I have recently attended a training session in which I acquired knowledge of the additional benefits of water saving technologies and planting trees for production as well as for wind protection and for improving the environment in my region. In addition, I was able to understand my farm's vulnerability to climate change and the need to take action now in order to improve the adaptive capacity of my farm to keep producing crops in the long-term. It also made me aware of the responsibility that I bear as a local employer for nature as well as for my staff and their families.

It is important to me to be able to secure a long-term production of my farm and achieve profitable returns. Therefore, I have been looking for actions that I can take on my farm in order to improve the yield of my inputs and secure the farm's long-term productivity. While seeking for solutions for my farm, I got to understand that some solutions will not only positively impact to my farm, but they will also have a positive impact in my neighbor's farm as well as in our community. Therefore, I am eager to implement actions that can help me and the people around me to have a better future.

## **4. Market**

### **4.1. Market volume**

(EXAMPLE) Fruit production plays a small but important role in Karakalpakstan's agricultural sector. According to data from the Ministry of Agriculture, the allocation of land for fruit production is only 4.5% of the total agricultural land in Karakalpakstan. Considering a recommended daily intake of 400 grams of fruit and vegetables for a healthy diet, and comparing it with my household, my family, and my neighbors fruit intake, I have found that we only consume 32% of the recommended dietary fruit needs.

In terms of market demand, I have observed that large, juicy, and colorful fruits tend to command the highest prices in the markets; however, due to the lack of access to local fruits, lower quality fruit sells at high prices as well. The Karakalpakstan fruit and berry market is somewhat isolated from the national market. Yet, improvements in quality and quantity, and the presence of supermarket chains such as Korzinka in Nukus is changing this situation.

### **4.2. Market development/trend**

(EXAMPLE) I have observed that the rapid development of selling channels through supermarkets for high quality fruits, compared to direct sales at traditional markets, represent a big opportunity of market growth and development. The steadily growing population of Uzbekistan as well as the increase in average income leads step by step to a rise in local demand for higher quality fruits, which is the opportunity that I am planning to tap into. I have seen in the news also that the export opportunity for apricots for Uzbekistan is attractive. According to the figures shared, in 2022 there was an export potential for fresh apricots of USD 131 million.

From the production side, according to local government, I have heard that there is the plan to establish 20,280 hectares of fruit orchard between 2022 and 2025, which is a good indicative of the potential and attractiveness of producing fruits in the region.

### 4.3. Risks in the market

(EXAMPLE) In order to improve productivity, my neighbors are resorting to short-term measures to increase production like an excessive use of synthetic fertilizers. Yet, I have opted to apply different measures following the Good Agriculture Practice Manual for Uzbekistan, implementing water efficient irrigation technologies, as well as planting trees that will have a long-term positive impact in my farm. Therefore, in the short-term, I may face a competitive disadvantage against my neighbors in terms of economic performance.

Another risk is the possible disinterest of my buyers and government institutions in the positive impact of my practices in the long-term, especially in terms of water conservation and carbon sequestration. However, considering the Global and Uzbekistan's agenda for the development of the agriculture sector and for adapting to and mitigating climate change, taking actions now as well as reporting on the benefits of these actions will take high relevance in the near future. Additionally, aligning my business activities with environmental, social, and governance criteria, can attract free funding, technical assistance, and other benefits through international donor organizations.

#### SECTION 4 NOTE – Potential Source of Information:

##### For Uzbekistan

- Agriculture Statistics – <https://stat.uz/en/official-statistics/agriculture>
- Product prices and news - <https://agromart.uz/en> (APP - Agromart)

##### For Karakalpakstan

- Agriculture Statistics – <https://stat.uz/en/official-statistics/agriculture>
- Regional Statistics - <https://karakalpakstan.uz/en/page/show/1>
- Product prices, knowledge materials, and news - <https://greenaral.uz/en> (APP - Jasilawil)

## 5. Customers

### 5.1. Operating radius

(EXAMPLE) My farm is located in Kegeyli District, northwest of Kazanketken township, in the Republic of Karakalpakstan. The total farm size is 2.3 ha, it has access to a primary canal for irrigation purposes, and it is exposed to winds of 5 m/s.

### 5.2. Target group

(EXAMPLE) In Karakalpakstan, fruit production is mostly handled by aggregators and large farm enterprises who collect, process (cleaning and sorting), and distribute or sell the products in markets. Most of local production is sold through local markets for household consumption.

### 5.3. Customer needs and customer benefits

(EXAMPLE) Local requirements are not that strict in terms of quality and quantity. However, this has a direct impact in terms of lower sales and income. Yet, I have observed that some aggregators have started to work with national customers and have upgraded their facilities for aggregation. These aggregators are demanding higher quality and to meet safety standards. There are some who are even asking for certification in order to access international markets.

## 6. Competitive Analysis

### 6.1. Preliminary remarks

(EXAMPLE) In the following section I have identified local competitors producing apricots within a radius of 50 km. In addition to the 3 farms described below, there are some fruit production farms in the region. Most of them follow the same type of activities with little differentiation among them.

### 6.2. Competitor 1

(EXAMPLE) Fruit orchard producing apricot, apple, and quince with a farm size of 3.4 ha and access to primary canal with limited water for irrigation.

### 6.3. Competitor 2

(EXAMPLE) Apricot orchard in 0.2 ha in a total farm size of 1.6 ha and access to secondary canal with limited water for irrigation.

### 6.4. Competitor 3

(EXAMPLE) Fruit orchard including apricot in a total area of 0.1 ha.

## 7. Sales and Communication

(EXAMPLE) There is little differentiation between orchard farms in the region. Therefore, I find the implementation of drip-irrigation and trees for windbreaks, as well as the reporting of water conservation and carbon sequestration as a good differentiation strategy to showcase my commitment to improve my farm practices with a positive impact to my surroundings. Currently, there are online platforms in Karakalpakstan, like for example Jasilawil, where I can showcase my farm's experience in order to motivate other farmers to take action, as well as to capture the attention of programs that are supporting farmers to further improve the productivity of their farms. By showcasing my commitment to contribute to a positive change, it may provide me with the opportunity to access additional green technologies and financing to keep improving my farm practices.

## 8. Procedures and Organization

### 8.1. Core processes

(EXAMPLE) As the responsible and representative for my farm, I would like to set up a mutual agreed contract with XXX aggregator in Kegeyli. My differentiation with other farmers will be the annual monitoring of product quality and reporting on water conservation, trees' status, and carbon sequestration as a mechanism to support an environmental improvement.

I will be responsible to acquire the needed production inputs, as well as negotiating and registering contracts for additional labor required. I will also be in charge of managing the soil preparation, planting, caring, controlling for pest and diseases, and harvesting, trying to follow the Good Agriculture Practice Manual for Uzbekistan.

### 8.2. Supporting processes

(EXAMPLE) I am supported by my partner in accounting. My partner has very good knowledge in this area following the education received and previous work experience. For more complex questions or for the annual accounts and tax payment, I will consult with a tax consultant.

In addition, I will make use of the pool of consultants available in the platform Jasilawil (e.g., Agromart for Uzbekistan) for any additional technical or farm management question that I need to clarify.

#### SUB-SECTION 8.2. NOTE – Potential Platform for Accessing Support:

##### For Uzbekistan

- Consultation Services - <https://agromart.uz/en> (APP - Agromart)
- Chamber of Commerce and Industry of Uzbekistan - <https://chamber.uz/en/index>

##### For Karakalpakstan

- Consultation Services - <https://greenaral.uz/en> (APP - Jasilawil)
- Chamber of Commerce and Industry of Uzbekistan - <https://chamber.uz/en/index>



### 8.3. Staff planning

(EXAMPLE) In addition to my own and my partners' labor force, my farm regularly employs 4 seasonal staff. The staff seasonally employed is and will continue to be formally registered keeping their employment record books open. This allows and will allow to keep contributing as employer to the Social Tax and secure their social benefits.

### 8.4. Infrastructure and Equipment

(EXAMPLE) No major infrastructure is needed for operating the farm. In terms of equipment, I have hired a consultant to support me designing the implementation of drip-irrigation as well as where and how to plant the trees. In addition, I will lease a truck and a sprayer from local service providers when harvesting or when necessary.

**SUB-SECTION 8.4. NOTE – Potential Platform for Accessing Technology Support:**

**For Uzbekistan**

- Consultation Services - <https://agromart.uz/en> (APP - Agromart)
- Innovation and Tech Support - <http://akis.agro.uz/uz>
- Water Management Equipment and Consultancy – APP - TOMЧИ

**For Karakalpakstan**

- Consultation Services - <https://greenaral.uz/en> (APP - Jasilawil)
- Water Management Equipment and Consultancy – APP - TOMЧИ

## 9. Explanation of target figures.

(EXAMPLE) The revenue planning is based on 200 field workdays and considering a farm size of 1 hectare for apricot production. The estimated annual revenue of USD 7,425 considers an annual yield of 11,250 kg/ha, and a market price of 0.66 USD/kg. On the other hand, the operational expenses consider those related to planting, cultivation costs, labor costs, harvest costs, and profit and other taxes. The total operational expenses are estimated at 60% based on current operations.

In terms of additional investment for the farm, the drip-irrigation system that I am interested in installing in one hectare has a value of USD 4,000 including the installation costs. I am planning to acquire a credit of 4 years for covering the USD 4,000. In addition, an expert/consultant has suggested me to plant 400 meters of linear windbreak protecting the 4 sides of the farm with Karatal trees in row-spacings of 2m which will provide, once mature and with a height of 15m, approximately 60m of upwind and 300m of downwind protection against crop damaging considering Karakalpakstan wind velocities of 5m/s during March and April. The investment in trees to be planted is  $(400\text{m of trees} / 2\text{m spacing} = 200 \text{ trees} * 0.18 \text{ USD/tree})$  36 USD. The expert has suggested me to plant Karatal considering its potential future source of income by selling Karatal cuttings or lumber if proper tree management practices are applied. As potential source of income, a conservative price of USD 0.15 per Karatal cutting has been considered after reaching the maturity of the trees (after 4 years), according to the opinion of the expert/consultant (10 lumber per tree per year).

## 10. Revenue and Profitability forecast

(EXAMPLE)

Years	1	2	3	4	5	6
A) Income (1+2)	7,425	7,425	7,425	7,425	7,725	7,725
1) Orchard (apricot) Income (a x b)	7,425	7,425	7,425	7,425	7,425	7,425
a) Yield (farm yield, kg/ha)	11,250	11,250	11,250	11,250	11,250	11,250
b) Price per unit (USD/kg)	0.66	0.66	0.66	0.66	0.66	0.66
2) Tree Income (c x d)	0	0	0	0	300	300
c) Product (cutting, lumber, fruit)					2,000	2,000
d) Price per unit (USD/ton)					0.15	0.15
B) Operational Expenses (3+4+5+6+7)	4,381	4,381	4,381	4,381	4,422	3,622
3) Orchard Op. Expenses (e+f+g)	1,644	1,644	1,644	1,644	1,644	1,644
e) Tree care						
Weed control	85	85	85	85	85	85
Fruit thinning	300	300	300	300	300	300
Girdling	50	50	50	50	50	50
Tree topping	90	90	90	90	90	90
Tree pruning	100	100	100	100	100	100
Chop brush	80	80	80	80	80	80
Leaf analysis	6	6	6	6	6	6
f) Inputs						
Fertilizers (through sprinklers)	50	50	50	50	50	50
Pesticides	249	249	249	249	249	249
Water (irrigation)	100	100	100	100	100	100
Equipment maintenance	120	120	120	120	120	120
Diesel	65	65	65	65	65	65
g) Harvest						
Pick (e.g., fruit)	225	225	225	225	225	225
Pack (e.g., fruit)	113	113	113	113	113	113
Haul	11	11	11	11	11	11
4) Windbreak Operational Expenses (h+i)	150	150	150	150	185	185
h) Inputs & Caring						
Weed control	30	30	30	30	30	30
Tree pruning	30	30	30	30	30	30
Pest management	40	40	40	40	40	40
Fertilization	50	50	50	50	50	50
i) Harvest					35	35
Collecting (e.g., lumber)					35	35
5) Labor (j+k)	1,454	1,454	1,454	1,454	1,454	1,454
j) Personnel	1,440	1,440	1,440	1,440	1,440	1,440
k) Taxes on salaries* (12%)**	14	14	14	14	14	14
6) Depreciation (l)	800	800	800	800	800	0
l) Equipment	800	800	800	800	800	0

7) Input & Turnover Taxes** (m+n+o)	333	333	333	333	339	339
m) Turnover (4% or 12%)***	149	149	149	149	155	155
n) Water (4 USD/m <sup>3</sup> )***	182	182	182	182	182	182
o) Land (4 USD/ha)***	2	2	2	2	2	2
C) Earnings Before Interest and Taxes (A - B)	3,044	3,044	3,044	3,044	3,303	4,103
D) Interest and Loan Repayment (8+9)	1,680	1,510	1,340	1,170	0	0
8) Loan Repayment	1,000	1,000	1,000	1,000		
9) Interests (17%)	680	510	340	170		
E) Taxes (10)	165	172	178	184	248	308
10) Income Tax (15%)*** [(C-D)*Tax]	165	172	178	184	248	308
F) Net Income (C - D - E)	1,199	1,362	1,526	1,690	3,055	3,795

\***Social Tax** – 12%

\*\* **Turnover Tax** – 4% from total sales when entities annual turnover does not exceed USD 100,000. 12% when annual turnover exceeds USD 100,000. **Water Tax** for agriculture lands – estimated at USD 4 per m<sup>3</sup>. **Land Tax** is based on soil fertility and the type of land (irrigated or dry-land) – estimated at USD 4 per hectare.

\*\*\* According to Presidential Decree No. 213 (August 31, 2022) 'On additional measures to improve the welfare of the population of the Republic of Karakalpakstan through the accelerated development of entrepreneurship, innovative technologies and infrastructures', enterprises in Karakalpakstan, including farming entities, will pay 50% of all 'Input & Turnover Taxes', as well as of 'Income Tax', and 1% of 'Social Taxes' from January 1<sup>st</sup>, 2023, until January 1<sup>st</sup>, 2028.

## 11. Capital Requirements and Financing

(EXAMPLE)

	Total Cost	Financing costs per year
G) Long-term investments	4,276	
11) Property		
12) Structure		
p) Greenhouse/hotbed		
13) Machinery		
q) Trellis system (inc. installation)		
r) Tractor		
s) Tractor equipment		
t) Irrigation system (inc. installation)	4,000	17% Interest (4 years)
14) Tree planting		
u) Land preparation	170	
v) Analyses (soil, layout)	70	
w) Trees	36	
H) Medium- and Short-Term Investments		
15) Equipment		
I) Upfront Costs		
16) Registration		
17) Legalization		
18) Education and Training		
J) Total Capital Required	4,276	
K) Expenditures per year		4,276

## 12. Environmental Benefits

(EXAMPLE)

Years	1	2	3	4	5	6
L) Carbon Sequestration (tCO <sub>2</sub> )	3.35	3.35	3.35	3.35	5.35	5.35
19) Number of mature trees	335	335	335	335	535	535
Orchard trees (e.g., apricot)	335	335	335	335	335	335
Windbreak trees	200	200	200	200	200	200
20) Carbon sequestration per tree*	0.01	0.01	0.01	0.01	0.01	0.01

\*Carbon sequestration per year estimated once the tree reaches maturity after the 4<sup>th</sup> year and before it has reached 30 years.

M) Water Conservation (m <sup>3</sup> /day/ha) (21 - 22)	45.33
21) Under surface irrigation [(x/y) * (1 + z) * φ]	136
x) Daily crop evapotranspiration~	6.0
y) Irrigation system application efficiency~	60%
z) Leaching requirement~	36%
φ) Multiplier for conversion of mm/day to m <sup>3</sup> /ha	10
22) Under drip-irrigation [(x/y) * (1 + z) * φ]	90.67
x) Daily crop evapotranspiration~	6.0
y) Irrigation system application efficiency~	90%
z) Leaching requirement~	36%
φ) Multiplier for conversion of mm/day to m <sup>3</sup> /ha	10
N) Total water conservation (M * # of ha under drip-irrigation - m <sup>3</sup> /day)	45.33

~Referential information is provided in Annex 1.

### 13. Profit to cover living expenses.

	Per month	Per year
O) Living expenses		
23) Food		
24) Clothing		
25) Health		
26) Education		
27) Others		
P) House expenses		
Q) Social Security		
28) Insurance		
29) Pension		
R) Interests and Taxes		
30) Loan repayment and interests		
31) Taxes		
S) Total household expenses (O+P+Q+R)		

# ANNEX 1: Water Conservation Referential Information

## 1. Crop's maximum daily evapotranspiration (ET<sub>c</sub>)

Evapotranspiration is the loss of water from the soil both by evaporation and by transpiration from the plants growing thereon. Evapotranspiration is not the same for different plants and it also varies with the season. The maximum evapotranspiration during the season is used for designing irrigation systems. The maximum crop evapotranspiration rates have been calculated based on research conducted in the Amu Darya River Basin and shown in the Table 1 below for reference.

Crop	ET <sub>c</sub> (mm/day)
Cotton	8.5
Wheat	6.9
Rice	7.3
Alfalfa	6.7
Maize	8.5
Vegetables	6.3
Melon	7.4
Fruits	6.0
Sorghum	7.1
Potato	8.1

## 2. Irrigation System Application Efficiency

Irrigation application efficiency expresses how much of the irrigated water is actually available to the plant. The lower the efficiency, expressed as a percentage, the more water must be irrigated to satisfy the crop's needs. Table 2 summarizes the application efficiencies of different irrigation methods for reference.

Irrigation methods	Field Application Efficiency
Surface irrigation (border, furrow, basin)	60%
Sprinkler irrigation	75%
Drip irrigation	90%

## 3. Leaching Requirement

All irrigation water contains salt. Plant roots extract nutrients from the soil solution leaving most salts behind. If the salts are not leached out of the plant's rootzone, the accumulation of salts will create a lower osmotic pressure in the soil thereby hindering the roots' ability to function normally. The plant expends extra energy to extract nutrients leading to stress, physiological damage, and lower yields. Additionally, sodium and chloride are toxic to many plants. The Leaching Requirement, or Leaching Fraction, refers to the amount of additional water required to leach salts out of the

rootzone of your crop. The higher the salt content of your irrigation water, the higher the leaching requirement.

Table 3 shows the estimated Leaching Requirement as a percentage where the **irrigation water salinity (ECw)** and the **maximum soil salinity threshold for crops (ECe)** intersect.

**Table 3                      Irrigation Water Salinity (Electrical Conductivity) (ECw)**

	dS/m	0.2	0.5	0.7	1.0	1.3	1.5	2.0	2.5	3.0	4.0	5.0	6.0	7.0
<b>Maximum Soil Salinity Threshold (ECe)</b>	0.5	9	25	39	67	108	-	-	-	-	-	-	-	-
	1.0	4	11	16	25	35	43	67	100	-	-	-	-	-
	1.5	3	7	10	15	21	25	36	50	67	114	-	-	-
	2.0	2	5	8	11	15	18	25	33	43	67	100	-	-
	2.5	2	4	6	9	12	14	19	25	32	47	67	92	-
	3.0	1	3	5	7	9	11	15	20	25	36	50	67	88
	3.5	1	3	4	6	8	9	13	17	21	30	40	52	67
	4.0	1	3	4	5	7	8	11	14	18	25	33	43	54
	4.5	1	2	3	5	6	7	10	13	15	22	29	36	45
	5.0	1	2	3	4	5	6	9	11	14	19	25	32	39
	5.5	1	2	3	4	5	6	8	10	12	17	22	28	34
	6.0	1	2	2	3	5	5	7	9	11	15	20	25	30
	6.5	1	2	2	3	4	5	7	8	10	14	18	23	27
	7.0	1	1	2	3	4	4	6	8	9	13	17	21	25

These two pieces of information will allow you to calculate your leaching requirement which will directly affect the volume of water your irrigation system needs to deliver.

### 3.1. Irrigation Water Salinity (ECw)

First, you must know the salinity of the water you are using for irrigation. Both water and soil salinity are usually measured by its electrical conductivity, either dS/m or uS/cm. Water salinity may be measured easily by a handheld meter.

### 3.2. Maximum Soil Salinity Threshold (ECe)

The table below shows the maximum documented salinity thresholds for plants at which there will be no expected reductions in yields. The table has been compiled from several sources and serves for referential purposes.



Plant (Common Name)	Maximum Soil Salinity Threshold at Which Growth and Yield Reductions Begin (ECe dS/m)
<b>Small Vegetables</b>	
Broccoli	2.8
Brussel sprouts	1.8
Cabbage	1.8
Carrots	1.0
Cauliflower	1.8
Celery	2.5
Lettuce	1.7
Onions	1.2
Spinach	3.2
Radishes	2.0
<b>Vegetables (Solanum Family)</b>	
Egg Plant	1.5
Peppers	1.7
Tomato	2.5
<b>Vegetables (Cucumber Family)</b>	
Cucumber	2.5
Cantaloupe melon	2.2
Musk melon	1.0
Pumpkin, winter squash	3.9
Squash, Zucchini	4.7
Squash (Scallop)	3.2
Watermelon	2.0
<b>Roots and Tubers</b>	
Beets, red	4.0
Garlic	3.9
Parsnip	0.8
Potato	1.7
Sweet potato	1.5
Turnip	0.9
Sugar beet	7.0
<b>Legumes</b>	
Beans	1.0
Broadbean (faba bean)	1.6
Cowpea	4.9
Peanut	3.2
Peas	1.5
Soybeans	5.0
Chickpeas	3.0
<b>Perennial Vegetables</b>	
Aritchokes	6.1
Asparagus	4.1
Mint	
Strawberries	1.5
<b>Fibre Crops</b>	
Cotton	7.7
Flax	1.7

Plant (Common Name)	Maximum Soil Salinity Threshold at Which Growth and Yield Reductions Begin (ECe dS/m)
<b>Oil Crops</b>	
Safflower	5.3
Sunflower	2.3
Caster bean	7.1
<b>Cereals</b>	
Barley	8.0
Oats	5.2
Corn	1.7
Sweet corn	1.7
Millet	6.0
Sorghum	6.8
Rice	3.0
Wheat	6.0
Wheat (semidwarf)	8.6
Wheat (durum)	5.9
<b>Forage Crops</b>	
Alfalfa	2.0
Barley	6.0
Bermuda	6.9
Clover	1.5
Cowpea (forage)	2.5
Fescue	3.9
Foxtail	1.5
Hardinggrass	4.6
Lovegrass	2.0
Maize (forage)	1.8
Wheatgrass, tall and fairway crested	7.5
Wheatgrass, standard crested	3.5
<b>Grapes and berries</b>	
Raspberries	1.0
Blackberry	1.5
Boysenberry	1.5
Grapes	1.5
<b>Fruit Trees</b>	
Almonds	1.5
Apples	1.7
Peaches	1.7
Nectarines	1.6
Cherries	0.9
Pear	1.7
Apricot	1.6
Plum, prune	1.5
Pomegranate	2.7
Walnut	1.7
Persimmon	2.0
Chinese Date	4.0
Figs	6.0
<b>Deciduous Trees</b>	
Poplars	4.0
Willow	4.0