

## Appendix 1 – Vegetable production guidelines for 12 common aquaponic plants

The information below provides technical advice on 12 of the most popular vegetables to grow in aquaponics. Information on optimal growing conditions, including specific growing instructions and harvesting techniques for each vegetable, is included. The guidelines below are based on the experience gathered from long-standing aquaponic farming, from horticulture manuals on soil/soil-less cropping, extension papers, and the professional experience of farmers and researchers. This list is by no means exhaustive. Rather, it should be used as an example of the types of information needed for any crop grown and help readers target their research when growing crops that are not listed here. Other common crops, not included in this appendix are: okra, pak choy, bok choy, ong choy, tatsoi, kale, mint, thyme, dill, scallions, chives, cilantro, taro, watercress, salad rocket, edible flowers, ornamental flowers, and even small fruit trees. Root vegetables such as onion, carrot, beets, radish and taro should be grown in wicking beds attached to media beds.

### BASIL

**pH:** 5.5–6.5

**Plant spacing:** 15–25 cm (8–40 plants/m<sup>2</sup>)

**Germination time and temperature:** 6–7 days with temperatures at 20–25 °C

**Growth time:** 5–6 weeks (start harvesting when plant is 15 cm)

**Temperature:** 18–30 °C, optimal 20–25 °C

**Light exposure:** Sunny or slightly sheltered

**Plant height and width:** 30–70 cm; 30 cm

**Recommended aquaponic method:** media beds, NFT and DWC



**Growing basil in aquaponic units:** Basil is one of the most popular herbs to grow in aquaponic units, particularly in large-scale commercial monoculture units because of its high value and the high demand in urban or peri-urban zones. Many cultivars of basil have been tried and tested in aquaponic units including the Italian Genovese basil (sweet basil), lemon basil, and purple passion basil. Owing to the higher nitrogen

uptake, basil is an ideal plant for aquaponics; however, care should be used to avoid excessive nutrient depletion of the water.

**Growing conditions:** Basil seeds need a reasonably high and stable temperature to initiate germination (20–25 °C). Once transplanted in the units, basil grows best in warm to very warm conditions and full exposure to sun. However, better quality leaves are obtained through slight shading. With daily temperatures higher than 27 °C plants should be ventilated or covered with shading nets (20 percent) during strong solar radiation seasons to prevent tip burn.

**Growing instructions:** Transplant new seedlings into the aquaponic unit when the seedlings have 4–5 true leaves. Basil can be affected by various fungal diseases, including *Fusarium* wilt, grey mould, and black spot, particularly under suboptimal temperatures and high humidity conditions. Air ventilation and water temperatures higher than 21 °C, day and night, help to reduce plant stress and incidence of diseases.

**Harvesting:** The harvest of leaves starts when plants reach 15 cm in height and continues for 30–50 days. Care should be used when handling leaves at harvest to avoid leaf bruising and blackening. It is advisable to remove flowering tips during plant growth to avoid bitter tastes in leaves and encourage branching. However, basil flowers are attractive to pollinators and beneficial insects, so leaving a few flowering plants can improve the overall garden and ensure a constant supply of basil seeds. Basil seeds are a speciality product in some locations.

### CAULIFLOWER

**pH:** 6.0–6.5

**Plant spacing:** 45–60 cm (3–5 plants/m<sup>2</sup>)

**Germination time and temperature:** 4–7 days with temperature 8–20 °C

**Growth time:** 2–3 months (spring crops), 3–4 months (autumn crops)

**Temperature:** 20–25 °C for initial vegetative growth, 10–15 °C for head setting (autumn crop)

**Light exposure:** full sun

**Plant height and width:** 40–60 cm; 60–70 cm

**Recommended aquaponic method:** media beds



**Growing cauliflower in aquaponic units:** Cauliflower is a high-value, nutritious winter crop that will grow and thrive in media bed units with adequate plant spacing. Cauliflower has a relatively high nutrient demand, and the plants react positively to high concentrations of nitrogen and phosphorus. Among other nutrients, potassium

and calcium are important for the production of heads. The plant is particularly sensitive to climatic conditions, and the heads do not develop properly in hot, very cold or very dry conditions; therefore, selecting the suitable variety and the timing to transplant are crucial.

**Growing conditions:** Optimal air temperature for the initial vegetative growth of the plant is 15–25 °C. For the formation of the heads, the plants require colder temperatures of 10–15 °C (autumn crop) or 15–20 °C (spring crop) providing that a good percentage of relative humidity and full sun conditions are met to develop good heads. Plants can tolerate cold temperatures; however, heads can be damaged by frost. Light shade can be beneficial in warmer temperatures (above 23 °C).

**Growing instructions:** Germinate seeds in propagation trays at 20–25 °C. Provide direct sun from early seedling stages so plants do not become leggy. When plants are 3–5 weeks old and have 4–5 true leaves, begin transplanting into the aquaponic system about 50 cm apart. To preserve the white colour of the heads, use string or rubber bands to secure outside leaves over the head when it is about 6–10 cm in diameter. Once this stage is reached, harvest may take less than a week in ideal temperatures or as long as a month in cooler conditions. Too much sun, heat or nitrogen uptake can cause “ricey” heads where the main flower separates into small, rice-like grains. Temperatures below 12 °C could instead produce “buttoning”. Cauliflower is susceptible to some pests including cabbageworms, flea beetle, white maggots (larvae) and cabbage aphids, which can be removed manually or by using other pest management techniques.

**Harvesting:** Harvest when the heads are compact, white and firm. Cut the heads off the plant with a large knife, and remove the remaining plant and roots from the bed pipe and place into a compost bin.

#### **LETTUCE (MIXED SALAD LEAVES):**

**pH:** 6.0–7.0

**Plant spacing:** 18–30 cm (20–25 heads/m<sup>2</sup>)

**Germination time and temperature:** 3–7 days; 13–21 °C

**Growth time:** 24–32 days (longer for some varieties)

**Temperature:** 15–22 °C (flowering over 24 °C)

**Light exposure:** full sun (light shading in warm temperatures)

**Plant height and width:** 20–30 cm; 25–35 cm

**Recommended aquaponic method:** media bed, NFT and DWC





**Growing lettuce in aquaponic units:** Lettuce grows particularly well in aquaponics owing to the optimal nutrient concentrations in the water. Many varieties can be grown in aquaponics, but four main types are included here: crisphead lettuce (iceberg), which has tight head with crispy leaves, ideal for cooler conditions; butterhead lettuce, which show leaves that are loosely piled one on another and have no bitter taste; Romaine lettuce, which has upright and tightly folded leaves that are slow to bolt and are sweet in taste; and loose leaf lettuce, which comes out in a variety of colours and shapes with no head and can be directly sowed on media beds and harvested by picking single leaves without collecting the whole plant. Lettuce is in high demand and has a high value in urban and peri-urban zones, which makes it a very suitable crop for large-scale commercial production.

**Growing conditions:** Lettuce is a winter crop. For head growth, the night air temperature should be 3–12 °C, with a day temperature of 17–28 °C. The generative growth is affected by photoperiod and temperature – extended daylight and warm conditions (> 18 °C) at night cause bolting. Water temperature > 26 °C may also favour bolting and leaf bitterness. The plant has low nutrient demand; however, higher calcium concentrations in water help to prevent tip burn in leaf in summer crops. The ideal pH is 5.8–6.2, but lettuce still grows well with a pH as high as 7, although some iron deficiencies might appear owing to reduced bio-availability of this nutrient above neutrality.

**Growing instructions:** Seedlings can be transplanted in aquaponic units at three weeks when plants have at least 2–3 true leaves. Supplemental fertilization with phosphorus to the seedlings in the second and third weeks favours root growth and avoids plant stress at transplant. Moreover, plant hardening, through exposing of seedlings to colder temperatures and direct sunlight, for 3–5 days before transplanting results in higher survival rates. When transplanting lettuce in warm weather, place light sunshade over the plants for 2–3 days to avoid water stress. To achieve crisp, sweet lettuce, grow plants at a fast pace by maintaining high nitrate levels in the unit. When air and water temperatures increase during the season, use bolt-resistant (summer) varieties. If growing in media beds, plant new lettuces where they will be partially shaded by taller nearby plants.

**Harvesting:** Harvesting can begin as soon as heads or leaves are large enough to eat. If selling to markets, remove the full plants and roots when harvesting as soon as they reach market weight (250–400 g). Cut the roots out and place them in a compost bin. Harvest early in the morning when leaves are crisp and full of moisture and chill quickly.

## CUCUMBERS

**pH:** 5.5–6.5

**Plant spacing:** 30–60 cm (depending on variety; 2–5 plants/m<sup>2</sup>)

**Germination time and temperature:** 3–7 days; 20–30 °C

**Growth time:** 55–65 days

**Temperature:** 22–28 °C day, 18–20 °C night; highly susceptible to frost.

**Light exposure:** full sun

**Plant height and width:** 20–200 cm; 20–80 cm

**Recommended aquaponic method:** media beds; DWC



**Growing cucumbers in aquaponic units:** Cucumbers, along with other members of the Cucurbitaceae family including squash, zucchini and melons, are excellent high-value summer vegetables. They are ideal plants to grow in media bed units as they have a large root structure. Cucumbers can also be grown on floating rafts, although in grow pipes there could be the risk of clogging owing to excessive root growth. Cucumbers require large quantities of nitrogen and potassium, thus the choice for the number of plants should take into account the nutrients available in the water and the fish stocking biomass.

**Growing conditions:** Cucumbers grow best with long hot humid days with ample sunshine and warm nights. Optimal growth temperatures are 24–27 °C during the day with 70–90 percent of relative humidity. A temperature of the substrate of about 21 °C is also optimal for production. Plants stop their growth and production at 10–13 °C. It is recommended to have higher potassium concentration to favour higher fruit settings and yields.

**Growing instructions:** Cucumbers seedlings can be transplanted at 2–3 weeks at the 4–5 leaf stage. Plants grow very quickly and it is a good practice to limit their vegetative vigour and divert nutrients to fruits by cutting their apical tips when the stem is two metres long; removing the lateral branches also favours ventilation. Further plant elongation can be successively secured by leaving only the two farthest buds coming out from the main stem. Plants are encouraged to further production by regular harvesting of fruits of marketable size (> 180 g for slicing varieties). The presence of pollinating insects is necessary for good fecundation and fruit set. Cucumber plants need support for their growth, which will also provide plants with adequate aeration to prevent foliar diseases (powdery mildew, grey mould). Owing to the high incidence of pest occurrences in cucumber plants, it is important to plan appropriate integrated pest management strategies (see Chapter 6) and to intercrop the plant unit with plants that are less affected by the possible treatments used.

**Harvesting:** Once transplanted, cucumbers can start production after 2–3 weeks. In optimal conditions, plants can be harvested 10–15 times. Harvest every few days to prevent the fruits from becoming overly large and to favour the growth of the following ones.

**EGGPLANT****pH:** 5.5–7.0**Plant spacing:** 40–60 cm (3–5 plants/m<sup>2</sup>)**Germination time and temperature:** 8–10 days; 25–30 °C**Growth time:** 90–120 days**Temperature:** 15–18 °C night, 22–26 °C day; highly susceptible to frost**Light exposure:** full sun**Plant height and width:** 60–120 cm; 60–80 cm**Recommended aquaponic method:** media beds

**Growing eggplant in aquaponic units:** Eggplant is a summer fruiting vegetable that grows well in media beds owing to the deep growth of the root systems. Plants can produce 10–15 fruits for a total yield of 3–7 kg. Eggplants have high nitrogen and potassium requirements, which indicates the need for careful management choices in the number of plants to grow in each aquaponic unit in order to avoid nutrient imbalances.

**Growing conditions:** Eggplants enjoy warm temperatures with full sun exposure. Plants perform best with daily temperatures in the range of 22–26 °C and relative humidity of 60–70 percent, both of which favour strong fruit set. Temperatures < 9–10 °C and > 30–32 °C are very limiting.

**Growing instructions:** Seeds germinate in 8–10 days in warm temperatures (26–30 °C). Seedlings can be transplanted at 4–5 leaves. Plants can be transplanted when temperatures rise in spring. Towards the end of the summer season, begin pinching off new blossoms to favour the ripening of the existing fruit. At the end of the season, plants can be drastically pruned at 20–30 cm by leaving just three branches. This method interrupts the crop without removing the plants during the unfavourable season (winter, summer) and lets the crop restart the production afterwards. Plants can be grown without pruning; however, in limited spaces or in greenhouses, management of the branches can be facilitated with stakes or vertical strings.

**Harvesting:** Start harvesting when the eggplants are 10–15 cm long. The skin should be shiny; dull and yellow skin is a sign that the eggplant is overripe. Delayed harvest makes the fruits unmarketable owing to the presence of seeds inside. Use a sharp knife and cut the eggplant from the plant, leaving at least 3 cm of the stem attached to the fruit.



## PEPPERS

**pH:** 5.5–6.5

**Plant spacing:** 30–60 cm (3–4 plants/m<sup>2</sup>, or more for small-sized plant varieties)

**Germination time and temperature:** 8–12 days; 22–30 °C (seeds will not germinate below 13 °C)

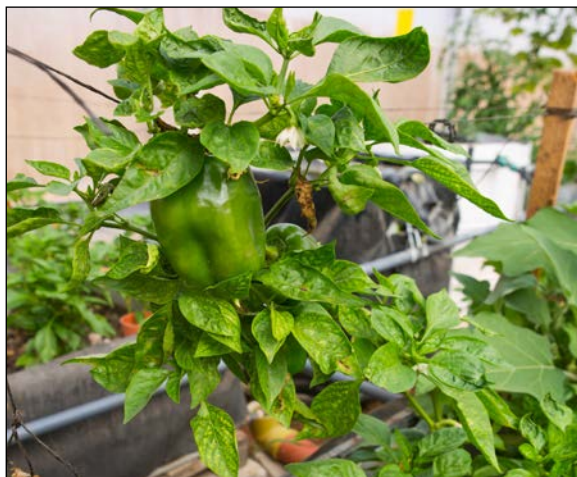
**Growth time:** 60–95 days

**Temperature:** 14–16 °C night time, 22–30 °C daytime

**Light exposure:** full sun

**Plant height and width:** 30–90 cm; 30–80 cm

**Recommended aquaponics method:** media beds



**Growing peppers in aquaponic units:** There are many varieties of peppers, all varying in colour and degree of spice, yet from the sweet bell pepper to the hot chili peppers (jalapeño or cayenne peppers) they can all be grown with aquaponics. Peppers are more suited to the media bed method but they might also grow in 11 cm diameter NFT pipes if given extra physical support.

**Growing conditions:** Peppers are a summer fruiting vegetable that prefers warm conditions and full sun exposure. Seed germination temperatures are high: 22–34 °C. Seeds will not germinate well in temperatures < 15 °C. Daytime temperatures of 22–28 °C and night-time temperatures of 14–16 °C favour best fruiting conditions under a relative humidity of 65–60 percent. Optimal temperatures at root level are 15–20 °C. In general, air temperatures below 10–12 °C stop plant growth and cause abnormal deformation of the fruits, making them unmarketable. Temperatures > 30–35 °C lead to floral abortion or fallout. In general, spicier peppers can be obtained at higher temperatures. The top leaves of the plant protect the fruit hanging below from sun exposure. As with other fruiting plants, nitrate supports the initial vegetative growth (optimum range: 20–120 mg/litre) but higher concentrations of potassium and phosphorus are needed for flowering and fruiting.

**Growing instructions:** Transplant seedlings with 6–8 true leaves to the unit as soon as night temperatures settle above 10 °C. Support bushy, heavy-yielding plants with stakes or vertical strings hanging from iron wires pulled horizontally above the units. For red sweet peppers, leave the green fruits on the plants until they ripen and turn red. Pick the first few flowers that appear on the plant in order to encourage further plant growth. Reduce the number of flowers in the event of excessive fruit setting to favour the growing fruits to reach adequate size.

**Harvesting:** Begin harvesting when peppers reach a marketable size. Leave peppers on the plants until they ripen fully by changing colour and improve their levels of vitamin C. Harvest continually through the season to favour blossoming, fruit setting and growth. Peppers can be easily stored fresh for 10 days at 10 °C with 90–95 percent humidity, or they can be dehydrated for long-term storage.

### TOMATO

**pH:** 5.5–6.5

**Plant spacing:** 40–60 cm (3–5 plants/m<sup>2</sup>)

**Germination time and temperature:** 4–6 days; 20–30 °C

**Growth time:** 50–70 days till first harvest; fruiting 90–120 days up to 8–10 months (indeterminate varieties)

**Optimal temperatures:** 13–16 °C night, 22–26 °C day

**Light exposure:** full sun

**Plant height and width:** 60–180 cm; 60–80 cm

**Recommended aquaponic method:** media beds and DWC



**Growing tomatoes in aquaponic units:** Tomatoes are an excellent summer fruiting vegetable to grow using all methods of aquaponics, although physical support is necessary. Given the high nutrient demand of tomatoes, especially potassium, the number of plants per unit should be planned according to the fish biomass, in order to avoid nutrient deficiencies. A higher nitrogen concentration is preferable during early stages to favour plants' vegetative growth; however, potassium should be present from the flowering stage to favour fruit settings and growth.

**Growing conditions:** Tomatoes prefer warm temperatures with full sun exposure. Below 8–10 °C the plants stop growing, and night temperatures of 13–14 °C encourage fruit set. Temperatures above 40 °C cause floral abortion and poor fruit setting. There are two major types of tomato plants: determinate (seasonal production) and indeterminate (continuous production of floral branches). In the first type, plants can be left to grow as bushes by leaving 3–4 main branches and removing all the auxiliary suckers to divert nutrients to fruits. Both determinate and indeterminate varieties should be grown with a single stem (double in case of high plant vigour) by removing all the auxiliary suckers. However, in determinate varieties, the apical tip of the single stem has to be cut as soon as the plant reaches 7–8 floral branches in order to favour fruiting. Tomatoes rely on supports that can be either made of stakes (bush plants) or bound to vertical plastic/nylon strings that are attached to iron wires pulled horizontally above the plant units.



Tomatoes have a moderate tolerance to salinity, which makes them suitable for areas where pure freshwater is not available. Higher salinity at fruiting stage improves quality of the products.

**Planting instructions:** Set stakes or plant support structures before transplanting to prevent root damage. Transplant the seedlings into units 3–6 weeks after germination when the seedling is 10–15 cm and when night-time temperatures are constantly above 10 °C. In transplanting the seedlings, avoid waterlogged conditions around the plant collar to reduce any risks of diseases. Once the tomato plants are about 60 cm tall, start to determine the growing method (bush or single stem) by pruning the unnecessary upper branches. Remove the leaves from the bottom 30 cm of the main stem to favour a better air circulation and reduce fungal incidence. Prune all the auxiliary suckers to favour fruit growth. Remove the leaves covering each fruit branch soon before ripening to favour nutrition flow to the fruits and to accelerate maturation.

**Harvesting:** For best flavour, harvest tomatoes when they are firm and fully coloured. Fruits will continue to ripen if picked half ripe and brought indoors. Fruits can be easily maintained for 2–4 weeks at 5–7 °C under 85–90 percent relative humidity.

## BEANS AND PEAS

**pH:** 5.5–7.0

**Plant spacing:** 10–30 cm dependent on variety (bush varieties 20–40 plants/m<sup>2</sup>, climbing varieties 10–12 plants/m<sup>2</sup>)

**Germination time and temperature:** 8–10 days; 21–26 °C

**Growth time:** 50–110 days to reach maturity depending on variety

**Temperature:** 16–18 °C night, 22–26 °C day

**Light exposure:** full sun

**Plant height and width:** 60–250 cm (climbing); 60–80 cm (bush)

**Recommended aquaponic method:** media bed

**Growing beans in aquaponic units:** Both climbing and bush bean varieties grow well in aquaponic units, but the former are recommended for less use of space, which maximizes aquaponic bed use. Climbing varieties can also yield 2–3 times more pods than bush varieties. Beans have low nitrate needs, but have a moderate demand in terms of phosphorus and potassium. Such nutrient requirements make beans an ideal choice for aquaponic production, although excess nitrate may delay flowering. Beans are recommended for newly established units as they may fix atmospheric nitrogen on their own.



**Growing conditions for pole beans:** Climbing varieties enjoy full sun, but will tolerate partial shade in warm conditions. Plants do not grow at < 12–14 °C. Temperatures > 35 °C cause floral abortion and poor fruit set. Optimal relative humidity for plants is 70–80 percent. Beans are sensitive to the photoperiod; thus, it is important to choose the right varieties according to the location and season. In general, climbing varieties are cultivated in summer while dwarf varieties are adapted to short-day conditions (spring or autumn).

**Growing instructions for pole beans:** For media bed units, seed directly into the grow bed 3–4 cm deep (making sure the bell siphon is out so the water level is high during germination). Beans do not transplant well, which makes them hard to grow in NFT pipes. Any supporting pole should be placed before seed germination in order to avoid root damage. In sowing, care should be taken to avoid future cross-shading with other plants. Beans are susceptible to aphids and spider mites. Although low occurrences of such pests could be controlled with mechanical remedies, attention should be paid to the choice of companion plants to avoid cross-contamination if any treatment has to be carried out.

#### **Harvesting:**

**Snap bean varieties (green or yellow wax beans)** - Pods should be firm and crisp at harvest; the seeds inside should be undeveloped or small. Hold stem with one hand and pod with the other to avoid pulling off branches that will produce later pickings. Pick all pods to keep plants productive.

**Shell beans (black, broad or fava beans)** - Pick these varieties when the pods change colour and the beans inside are fully formed but not dried out. Pods should be plump, firm. Quality declines if they are left on the plant for too long.

**Dried beans (kidney beans and soybeans)** - Let the pods become as dry as possible before cooler weather sets in or when plants have turned brown and lost most of their leaves. Pods will easily split when very dry, making seed removal an easy process.

#### **HEAD CABBAGE**

**pH:** 6–7.2

**Plant spacing:** 60–80 cm (4–8 plants/m<sup>2</sup>)

**Germination time and temperature:** 4–7 days; 8–29 °C

**Growth time:** 45–70 days from transplanting (depending on varieties and season)

**Ideal temperature:** 15–20 °C (growth stops at > 25 °C)

**Light exposure:** full sun

**Plant height and width:** 30–60 cm; 30–60 cm

**Recommended aquaponic method:** media beds (not suitable for newly established aquaponic units)



**Growing cabbage in aquaponic units:** Cabbage is a highly nutritious winter crop. The plants grow best in media beds because they reach significant dimensions at harvest and may be too large and heavy for rafts or grow pipes. Cabbage is a nutrient-demanding plant, which makes it unsuitable for newly established units (less than four months old). Nevertheless, owing to the large space required, cabbage crops take up fewer

nutrients per square metre than other winter leafy vegetables (lettuce, spinach, rocket, etc.). Although cabbage can tolerate temperatures as low as 5 °C, the low temperatures may not be suitable for culturing fish.

**Growing conditions:** Cabbage is a winter crop with ideal growing temperatures of 15–20 °C; Cabbage grows best when the heads mature in cooler temperatures, so plan to harvest before daytime temperatures reach 23–25 °C. High concentrations of phosphorus and potassium are essential when the heads begin to grow. Integration with organic fertilizers delivered either on leaves or substrates may be necessary in order to supply plants with adequate levels of nutrients.

**Growing instructions:** Transplant seedlings at 4–6 leaves and a height of 15 cm. Position seedlings with an optimal planting density according to the chosen variety. In the event of day temperatures > 25 °C, use a shading net of 20 percent light shading to prevent the plant from bolting (growing to produce seeds). Given the high incidence of cabbage worms and other pests such as aphids, root maggots and cabbage loopers, it is important to carry out careful monitoring and use organic (aquaponic safe) pesticides when necessary.

**Harvesting:** Start harvesting when cabbage heads are firm with a diameter of about 10–15 cm (depending on variety grown). Cut the head from the stem with a sharp knife, and place the outer leaves into the compost bin. If cabbage heads tend to break, it indicates they are over-ripe and should have been harvested earlier.

## BROCCOLI

**pH:** 6–7

**Plant spacing:** 40–70 cm (3–5 plants/m<sup>2</sup>)

**Germination time and temperature:** 4–6 days; 25 °C

**Growth time:** 60–100 days from transplant

**Average daily temperature:** 13–18 °C

**Light exposure:** full sun; can tolerate partial shade but will mature slowly

**Plant height and width:** 30–60 cm; 30–60 cm

**Recommended aquaponic method:** media beds



**Growing broccoli in aquaponic units:** Broccoli is a nutritious winter vegetable. The media bed method is the recommended option as broccoli is a large and heavy plant at harvest. Broccoli is moderately difficult to grow because it is a nutrient-demanding plant. It is also highly susceptible to warm temperatures; therefore, select a variety that is bolt-resistant.



**Growing conditions:** Broccoli grows best when daytime temperatures are 14–17 °C. For head formation, winter varieties require temperatures of 10–15 °C. Higher temperatures are possible, providing that a higher humidity is present. Hot temperatures cause premature bolting.

**Growing instructions:** Transplant seedlings into media beds once 4–5 true leaves are present and the plants are 15–20 cm high. Seedlings should be positioned 40–50 cm apart as closer spacing will produce smaller central heads. Broccoli, as well as cabbage, is susceptible to cabbage worms and other persistent pests. While some mechanical removal can have marginal effect, treatment with biological pesticides and repellents can control the infestations.

**Harvesting:** For best quality, begin harvesting broccoli when the buds of the head are firm and tight. Harvest immediately if the buds start to separate and begin flowering (yellow flowers).

### SWISS CHARD / MANGOLD

**pH:** 6–7.5

**Plant spacing:** 30–30 cm (15–20 plants/m<sup>2</sup>)

**Germination time and temperature:** 4–5 days; 25–30 °C optimal

**Growth time:** 25–35 days

**Temperature:** 16–24 °C

**Light exposure:** full sun (partial shade for temperatures > 26 °C)

**Plant height and width:** 30–60 cm; 30–40 cm

**Recommended aquaponic method:** media beds, NFT pipes and DWC



**Growing Swiss chard in aquaponic units:** Swiss chard is an extremely popular leafy green vegetable to grow using aquaponics and it thrives with all three aquaponic methods. It is a moderate nitrate feeder and requires lower concentrations of potassium and phosphorus than fruiting vegetables, which makes it an ideal plant for aquaponics. Owing to its high market value, its fast growth rate and its nutritional content, Swiss chard is frequently grown in commercial aquaponic systems. Foliage is green to dark green, but the stems can have striking and attractive colours of yellow, purple or red.

**Growing conditions:** Swiss chard optimal temperatures are 16–24 °C, while the minimum temperature for growth is 5 °C. Although traditionally a late-winter/spring crop (tolerating moderate frosts), Swiss chard may also grow well in full sun during mild summer seasons. A shading net is suggested at higher temperatures. Swiss chard has a moderate tolerance to salinity, which makes it an ideal plant for saline water.

**Growing instructions:** Swiss chard seeds produce more than one seedling; therefore, thinning is required as the seedlings begin to grow. As plants become senescent during the season, older leaves can be removed to encourage new growth.

**Harvesting:** Swiss chard leaves can be continuously cut whenever they reach harvestable sizes. The removal of larger leaves favours the growth of new ones. Avoid damaging the growing point in the centre of the plant at harvest.

## PARSLEY

**pH:** 6–7

**Plant spacing:** 15–30 cm (10–15 plants/m<sup>2</sup>)

**Germination time and temperature:** 8–10 days; 20–25 °C

**Growth time:** 20–30 days after transplant

**Temperature:** 15–25 °C

**Light exposure:** full sun; partial shade at > 25 °C

**Plant height and width:** 30–60 cm; 30–40 cm

**Recommended aquaponic method:** media beds, NFT and DWC

**Growing parsley in aquaponic units:** Parsley is a very common herb grown in both domestic and commercial aquaponic units owing to its nutritional content (rich in vitamins A and C, calcium and iron) and its high market value. Parsley is an easy herb to grow as the nutrient requirements are relatively low compared with other vegetables.

**Growing conditions:** Parsley is a biennial herb but it is traditionally grown as an annual; most varieties will grow over a two-year period if the winter season is mild with minimal to moderate frost. Although the plant can resist temperatures of 0 °C, the minimum temperature for growth is 8 °C. In the first year, the plants produce leaves while in the second the plants will begin sending up flower stalks for seed production. Parsley enjoys full sun for up to eight hours a day. Partial shading is required for temperatures > 25 °C.

**Growing instructions:** The main difficulty when growing parsley is the initial germination, which can take 2–5 weeks, depending on how fresh the seeds are. To accelerate germination, seeds can be soaked in warm water (20–23 °C) for 24–48 hours to soften the seed husks. Afterwards, drain the water and sow the seeds into propagations trays. Emerging seedlings will have the appearance of grass, with two narrow seed leaves opposite each other. After 5–6 weeks, transplant the seedlings into the aquaponic unit during early spring.

**Harvesting:** Harvesting begins once the individual stalks of the plant are at least 15 cm long. Harvest the outer stems from the plant first as this will encourage growth throughout the season. If only the top leaves are cut, the stalks will remain and the plant will be less productive. Parsley dries and freezes well. If dried, plants can be crushed by hand and stored in an airtight container.

