

Aurora Del Camp

Crop Planner

A small farm plans big

by

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Application Description

Problem description

Aurora Del Camp is a 4 hectare (10 acre) organic farm located on the Mediterranean coast about 30km north of Barcelona. We serve about 150 families with a wide variety of vegetables (and some ground fruits such as melons and strawberries) throughout the year. As we are an all season farm, we must plant a large variety of crops and have a constant supply for our customers. With almost forty (40) different crop varieties and a full year schedule, this means planning is paramount. Even small planning mistakes could mean thousands of Euros in lost revenue.

We would like to have a scheduling tool that could help us in the various different tasks involved in growing and harvesting. Since crops grow differently during different periods of the year (a head of lettuce might take three months to grow in the winter, but only three weeks during the summer months), timing our plantings and tasks (including soil preparation, seed planting, transplanting, weeding, etc.) is essential.

If we had tool that allowed us to plan by working backwards in time, a great deal of grief could be spared as far as planning goes. Working backwards means inputting quantity needs (projected demand) for a given period of time and having a scheduling application indicate when we need to start working towards that goal. For instance, if we wanted 300 heads of lettuce per week in September, we would need to transplant in August (just one month growth time). However, if we wanted the same amount of lettuce in January, we would need to plant in October (three months of growth time).

In addition to resolving the timing and task issues, we would like to incorporate space management into our crops. Since space is limited and crop rotation is essential, knowing what to plant where and when is also important.

This document hopes to define the specifics of the planning issues, including a definition of crop types, cycles and tasks involved in the growing of most common types of vegetables. More exhaustive definitions of these concepts may be needed before work can begin on a real world tool and serious analysis should not be overlooked.

Crops and growth cycles

Different crops grow differently and are harvested differently.

*Before crops are even set in the ground, different types of **preparation** may take place in and out of the*

field including:

- Tilling
- Rotovating
- Green manure planting
- Fertilizing (manure, or mineral fertilizer, or some other type of fertilizer)
- Bed building
- Setting up of irrigation
- Setting rows
- Buying seed
- Soaking seeds
- Cutting or separating cloned seeds (potatoes and garlic)
- Setting weed-control mesh or paper
- False germination and cleaning – removing weed pressure, by watering the beds and then cleaning the emerging weeds either manually, mechanically or thermally (flame) before planting the desired crop.

*Beginning with seed, we can separate crops into the following different **seeding types**:*

- Seed planted into a seedling tray and grown there to prepare for transplant.
- Seed planted directly into the ground.
- Seeds that can be planted either directly, or transplanted as a seedling.
- Seeds that are not really seeds, but rather “clones”, such as potatoes, garlic and some types of onions.

*Following seeds, the growth period of a crop may require different sorts of **growing tasks** including:*

- Transplanting (we may skip the seed to seedling stage when we buy seedlings from a nursery)
- Weeding
- Fumigating (sometimes, or as needed, as climatic or plague conditions exist)
- Thinning (usually after direct seeding, to give plants space to grow)
- Trimming (to promote better plant grow. This is common in tomatoes for instance)
- Covering (as with potatoes or leeks)

*Once the crop is ready to harvest, we should keep in mind that different crops have different **harvest types**. We could define them in the following terms:*

- *Cut and gone* – a head of lettuce, for instance, is planted once, cut once, and has only a single unit of crop value.
- *Cut and regrow* – some crops may be cut once and regrow again. This happens with Swiss Chard for instance. Once it gets cut, it can usually grow back and be ready to harvest again in a few weeks (three weeks in the summer, four to eight weeks in the winter). Celery and broccoli may also be categorized as cut and regrow crops, although we may not choose to regrow them (for spacial, seasonal or
- *Harvest and reharvest* – Fruit bearing crops are including in this type of crop. This includes tomatoes that produce many different tomatoes that might become ripe for harvest during the plant’s fertile period (when nutrients are available and weather is cooperative). Usually these types of crops have a production curve that includes lower production at the beginning and end of the ripeness period and a height of production in the middle of the same period.

Crop production units

In order to be able to estimate production, we must define units of measure for each crop. For

instance, the productivity of a tomato plant might be expressed in kilograms or grams during different stages of its ripeness period. So for instance, during week 1 of plant ripeness, we might get 100g of fruit per plant, but during week 5 we might get 400g of fruit. We can express week 1 either as a quantifiable weight, or as a percentage of the "full production" week (25%).

Sample Tomato production during ripeness:

	Week1	Week2	Week3	Week4	Week5	Week6	Week7	Week8
Grams	100	125	200	400	600	500	300	150
Percentage of maximum week	16%	20%	33%	66%	100%	83%	50%	25%

Other crops, such as lettuce, are simpler. Lettuce produces one unit, once during its cycle. However, its ripeness period is varying, meaning it can last in the ground for a while even though it is ready for harvest. In the winter, for instance, a ready-to-eat head of lettuce can stay in the ground for up to two months. In the summer, the same head of lettuce might bolt (go to seed) in a week if not harvested.

Different factors influence ripeness and productivity, namely fertility and harvest schedules. When a fruit plant is not harvested frequently enough, it may stop producing more fruit or might produce smaller fruit subsequently.

These issues are seen on a day to day basis in the field.

End of season clean-up

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Planning

Given crop schedules (season) and productivity – basically, each crop's specific "configuration" – we can work backwards and plan ahead of time. For instance, if we know that a tomato plant produces 500g per week of tomatoes during its peak ripeness period, and we know we want 100kg of tomatoes during a certain period (say, week23), we need to make sure we have at least 200 tomato plants in the ground reaching that level of ripeness during that period. This requires us to think months ahead. From buying the seed or ordering seedlings, prepping the ground, fertilizing, etc. Multiply this problem by thirty to forty varieties of crops and four seasons of planting (including multiple varieties of the same crop) and the problem gets bigger and bigger...

Expectations, accounting for crop delays and planning projections

- rain and climatic influences...
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Crop Rotation

Crop rotation is the practice of conserving and rejuvenating soil mineral content and general health by not repeating similar crops in a given field or sub-field. Since the same family of crops usually use up the somewhat equal quantities of the certain minerals found in the soil, it is common practice in non-intensive agriculture to rotate crops.

Spatial considerations

- Beds and Rows
- Crop real estate requirements (linear and square)

Task Velocity

- Rotovating
- Hand Weeding
- ETc....