Bayesian Network for Greenhouse Management

Abstract:
The techniques for climate control in greenhouse are to tune the crop needs and avoid unnecessary energy consumption. A greenhouse environment is an incredibly complex and dynamic environment.
The use of automated controllers represents a powerful way to minimize and facilitate management of climate conditions, irrigation and nutrient levels of the modern greenhouse.
The major factors that are to be taken care in a greenhouse are

- Temperature and humidity
- Water drain system
- pH levels
- Co2 supply
- Nutrient levels

Each system (Co2, fertilizer, temp/humidity, pH) equally contributes for the plant growth.

Temperature and Humidity:

In the grow room, lighting is a major source of heat buildup, and often removal of excess heat becomes more important than warming the environment. External temperatures and shade play a major role in providing sufficient warmth for the plant to grow.

Humidity is the measure of water vapor contained within the air. Low humidity indicates a dry atmosphere with little water vapor and causes rapid water loss from plants whereas high humidity results in precipitation.

To maintain balanced temperature and humidity levels we rely on artificial cooling and heating system using fans and heaters so that despite changes in outside atmosphere , the inside atmosphere will always be preserved.

Soil pH levels: Soil pH is important because it influences several soil factors affecting plant growth, such as (1) soil bacteria, (2) nutrient leaching, (3) nutrient availability, (4) toxic elements, and (5) soil structure. Soil itself will have its own alkaline values and fertilizers we use for plants produce ions which contributes to increase or decrease in pH values of the soil.

Irrigation System: Soil texture greatly influences water availability. The sandy soil can quickly be recharged with soil moisture but is unable to hold as much water as the soils with heavier textures. So we can say water drain capacity of sandy soil will be more comparative to the clay soil whose drain capacity is exactly the opposite. Soil texture, soil structure, and slope have the largest impact on drain rate.

Water infiltration is the movement of water from the soil surface into the soil profile which is mainly dependent on the soil texture. Both determine the surface water level which is one

more parameter to be maintained at an optimal rate for the plant growth. Too much of water leads to loosening of soil and in turn affects the capacity of plants to absorb the nutrients. And in addition it results in crop damage too.

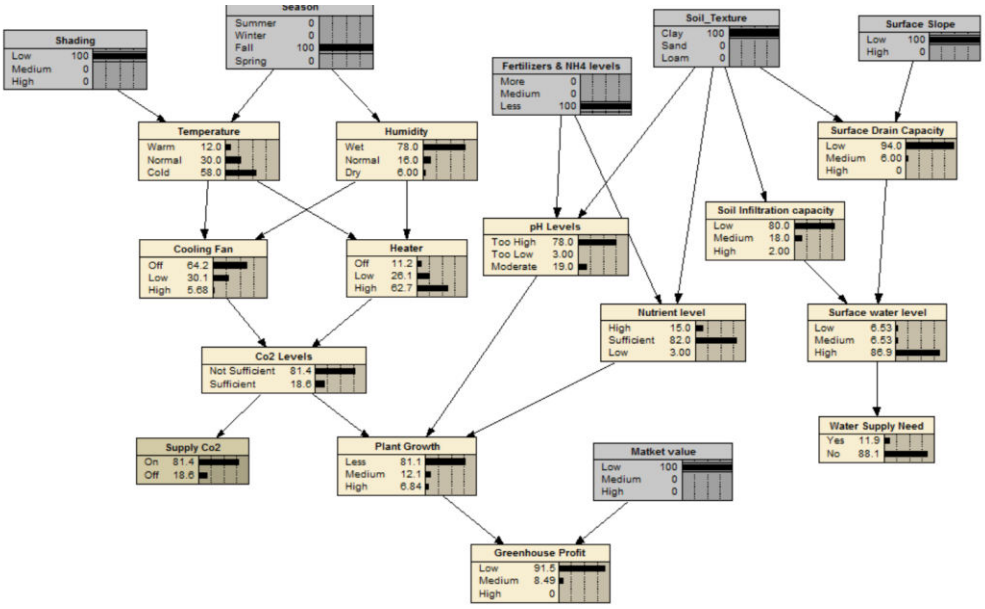
Based upon the above parameters the system estimates the level of each factor to be preserved in a greenhouse for plant growth and in turn tells us the estimated production capacity in the greenhouse. In the network, shading, season, Fertilizers, soil texture, surface slope and predicted market values are taken as parent nodes, based on which other node values are estimated.

Test case 1: In fall, the weather is usually rainy/snowy which indicates cool temperatures and wet air. Shade could be removed to allow as much sunlight as possible to enter the greenhouse.

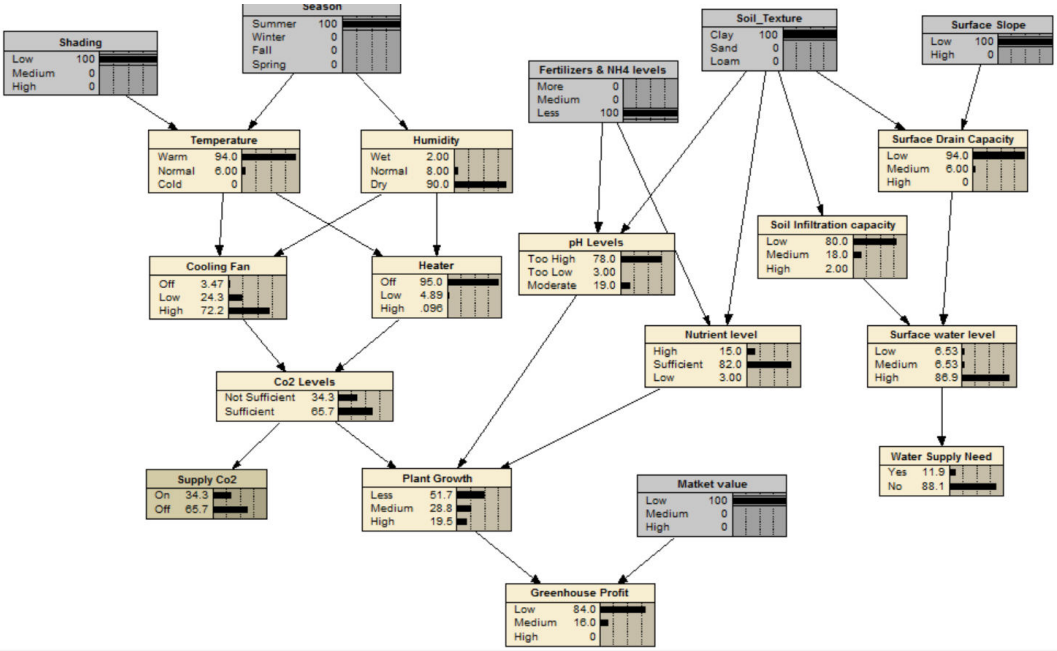
To maintain the warmth, we turn off the fan/vent to not to allow the outer cool and wet air to enter inside. This results in a drop in Co2 levels as we prevented the circulation of air. Usually we use Co2 generators to maximize production.

Fertilizers, as stated before release ions which changes the pH levels and based upon the pH values of the soil the resulting pH levels vary. We maintain a slope in the slope on the surface to see the water won't stagnate. Based on the soil texture, water drain capacity varies. If it is sand a low slope will drain the water easily. Soil infiltration is the penetration capacity of the soil. All this affects the surface water levels. We can put an automated drip system which provides adequate water to the plants when water levels go down.

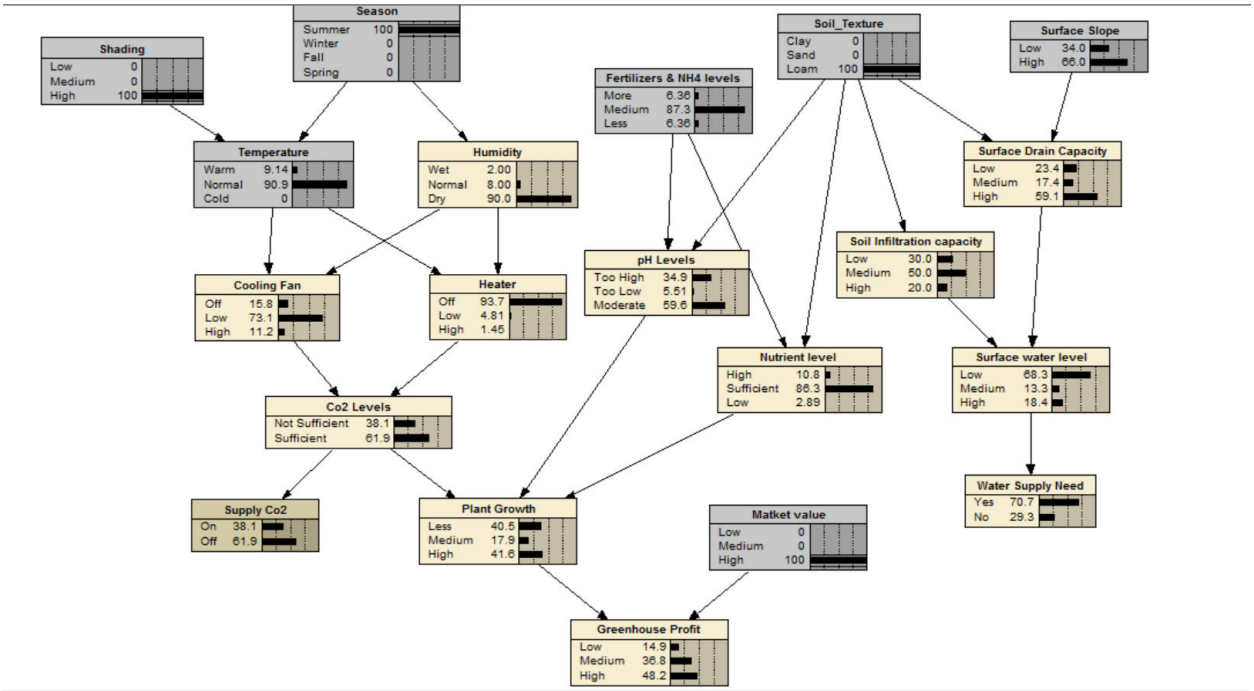
More pH levels make the plants absorb more than required nutrients and vice versa. And insufficient Co2 levels decrease the photosynthetic activity of plants which affects plant growth which in turn affects the greenhouse profits.



Test Case 2: Summer weather and plant growth



Test case 3: In a promising greenhouse condition



Sources for information :

http://thehealingcanna.com/temperature-humidity/

http://extension.uga.edu/publications/detail.cfm?number=B792