

# An Empirical Perspective on the Design and Use of Embedded Systems for Stone Fruits of Meghalaya

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## ABSTRACT:

*Fruit Cultivation in Meghalaya is a prominent business sector for earning a good amount of state's revenue. Meghalaya being a home of wide variety of fruits and vegetables holds a unique position in production figures among other states of North-East. Fruit crops are capable of giving higher tonnage of yield per unit area than other field crops. Meghalaya produces several stone fruits such as plum, peach, apricot in a restricted scale. Pear is widely grown in the Khasi Hills districts of the state. The flesh of pear fruit contains stone cells. This paper focuses on details of components for designing an embedded system for orchard management and also identification of diseases/insects of plum tree and its prevention. It will reduce labour cost, improve tree health, increase fruit production and will surely play an important role in the economic prosperity of Meghalaya.*

**Keywords:** *microcontroller, sensors, HTML pages, codes, constraints.*

## INTRODUCTION:

Meghalaya is a state in north-east India. The name means "the abode of clouds". The capital is Shillong, known as the "Scotland of the East". Nature has blessed her with abundant rainfall, sunshine, virgin forests, high plateaus, tumbling waterfalls, crystal clear rivers, meandering streamlets and above all with sturdy, intelligent and hospitable people. Meghalaya is subject to vagaries of the monsoon. The climate varies with altitude. The climate of Khasi and Jaintia Hills is uniquely pleasant and bracing. It is neither too warm in summer nor too cold in winter, but over the plains of Garo Hills, the climate is warm and humid, except in winter. The Meghalayan sky seldom remains free of clouds. The average annual rainfall is about 2600 mm over western Meghalaya, between 2500 to 3000 mm over northern Meghalaya and about 4000 mm over south-eastern Meghalaya. There is a great variation of rainfall over central and southern Meghalaya. At Sohra (Cherrapunjee), the average annual rainfall is as high as 12000 millimetres, but Shillong located at a distance of about fifty kilometres from Sohra receives an average of 2200 mm of rainfall annually.

Meghalaya has suitable climate for cultivation of wide variety of horticulture crops such as fruits, vegetables, spices, aromatic and ornamental plants, medicinal plants and plantation crops. The key fruits grown in the state are pineapple, citrus fruits, banana, papaya and strawberries. Other potential fruits include plums, peaches, apricot, pear, guava, mango, litchi, lemon, etc. Fruits are found to be a rich source of vitamins and minerals. Fruits crops are capable of giving higher tonnage of yield per unit area than other field crops. As the new technologies and developments have gradually become readily available in the country, the cropping and cultivating systems and production practices have also remained witness to significant metamorphosis. Fresh fruits and vegetables export has steadily increased. In order to make the thriving business, the industrial strategy of India has been expanded beginning from the lower level to the huge markets to deal globally. Fresh fruits and vegetables which are cultivated are sent to the small scale vegetable and fruit suppliers, then these items are dispatched to the fruit and vegetable exporters as well as to the local markets. The last few decades recorded an all time high of number of Indian fruit and vegetable exporters and suppliers. Fruit production and

cultivation in this country has witnessed a growth of near about 3.9 %, while fruit processing units have also grown about 20 % per year.

These fruits can also be processed in several products like canned fruit, concentrates and fruit juices, dehydrated fruit, jellies and jams. Cultivation of fruits chiefly depends upon the quality of soils, harvest, plantation and a perfect ambience of brilliant minds. There are ample investment opportunities for the expansion of export market for fruit cultivation in Meghalaya. But the low level of industrialization and the poor infrastructure base acts as a barrier to the interest of the state's economy. Plums, peaches, pear, apricots can be grown in abundance in Meghalaya. This is because Meghalaya has favourable soil and climatic conditions for stone fruit cultivation and thus holds a huge horticulture potential and also a great scope to augment business prospect.

## LITERATURE REVIEW:

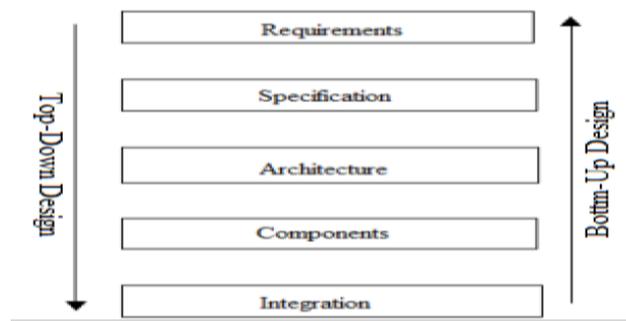
V. Ramya, B. Palaniappan, Bobby George [13] proposed an embedded system for automatic mist irrigation for cardamom field, which has a wireless sensor network for real time infield sensing and control of an irrigation system. This wireless system supports the cardamom field which has both plain and slope areas. The irrigation system updates solenoid valves for specified location of mist emitters automatically according to the set point of temperature, humidity and soil moisture. This system also senses the water level of the tank and whenever the water level is too low then the system immediately provides a visual and sound alarm and then it automatically switches ON the motor. When the water level reaches 90% of the tank then the motor is switched OFF through the remote system. Communication signals from the sensor network and irrigation controller to the base station is interfaced using XbeePRO communication. C. Arun, K. Lakshmi Sudha [1] discussed remote monitoring in agricultural greenhouse using wireless sensor and short message service (SMS); here they are sending data via sms. S. R. Kumbhar, Arjun P. Ghatule [11] presented a wireless application of drip irrigation system where irrigation is carried out using soil moisture values. Zhang Feng [18] discussed the design of wireless sensor network and Internet technology of farmland automatic irrigation control method. Emphasis on an analysis of the routing protocol of sensor network nodes to achieve the system hardware and software design ,middleware, and applications such as mobile phone or wireless PDA of internet of things, will constitute a variety of sensors intelligent network, thus enhancing the overall automation system and monitoring levels. The final analysis of the network in the Internet based on the agricultural plants of farmland water-saving irrigation system integrated approach. User use mobile phones or wireless PDA can easily soil moisture content of online monitoring and control to realize the irrigation automation. Application results show that system through the embedded control technology complete intelligent irrigation, improve the agricultural irrigation water use efficiency and irrigation system automatization is generally low status, can well realize water saving. Vitthal S Saptasagare, Basappa B Kodada [12] proposed a system that has several types of sensors deployed in the crop field area. It captures the physical phenomena of soil moisture, temperature, water level of the tank and ph of soil. The sensed data from various sensors goes to the central Global System for Mobile communication (GSM) node. From that the sensed data is given to the personal computer, which is used by a farmer.

There are many other microcontrollers and microcontroller platforms available for physical computing. In this paper, the proposed embedded system is designed with Arduino .Arduino boards are relatively inexpensive compared to other microcontroller platforms. Arduino is available as an open-source on electronics platform and has a software package used to program the hardware part. It is developed to make easily accessible for designers and hobbyists and student to create an interactive and live environment to implement many objects based on electronics and automobiles. The concept of Arduino is developed by Massimo Banzi which is easily programmable and simple to deploy. The Arduino software runs on Windows, Macintosh OSX, and Linux. It has simple, clear programming environment. The microcontroller on the board is programmed using the Arduino programming language (based on Wiring) and the Arduino development environment (based on Processing). Arduino projects can be stand-alone or they can communicate with software on running on a computer (e.g. Flash, Processing, MaxMSP). Once we have downloaded/unzipped the arduino IDE,

we can Plug the Arduino to our PC via USB cable. It is easy to implement in analog components, automatic engines, sensors, and other automobile and electronic automation devices. In the proposed system, sensors measure temperature and humidity, soil moisture, pH, rainfall. Also ultrasonic sensor, waterflow sensor, solenoid valve, water/fertilizer tank, motor, L293D IC, IN4007, TIP 120 are interfaced with Arduino. This is because Arduino can be deployed easily to establish many online functions that require many sensors. Also, for identification of diseases/insects of plum tree, the HTML pages and their codes are described in this paper.

### METHODOLOGY:

There are two types of designing methods, one is Top-down method and the other is Bottom-up method. This work adopts the Top-down method. The design is a solution, the translation of requirements into the way of meeting them. The design will determine the success of the system. Based on the proposed system objectives, the major modules are identified and the operations to be carried out are determined. In the design phase of the system the data flow diagrams, flowcharts, data base tables, inputs, outputs and screen are designed by using all the necessary fields in a compact manner. Major levels of abstraction in design process is shown below:



**COMPONENT LEVEL:** The Component level involves in designing the hardware and software components.

### COMPONENTS USED:

If we buy the components then the design time will be reduced and also the implementation speed will increase. The following components are used for designing an all-purpose embedded system for stone fruits of Meghalaya:

**Arduino mega 2560:** The Arduino mega 2560 board [2] is shown below:



**Rain Sensor Module:** The rain sensor module [7] is an easy tool for rain detection. It can be used as a switch when raindrop falls through the raining board and also for measuring rainfall intensity. The rain sensor module is shown below:



**Soil Moisture Sensor:** The soil moisture sensor [5] is shown below:



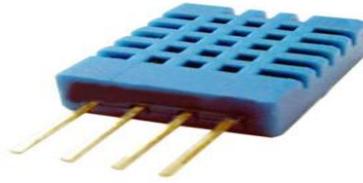
There are two types of soil moisture sensor. One is frequency domain sensor, which has an oscillating circuit. It measures the soil water content by measuring the soil's dielectric constant, which determines the velocity of an electromagnetic wave or pulse through the soil. When the soil's water content increases, the dielectric also increases, which can be used to estimate how much water the soil holds. The other one is neutron moisture gauge which utilizes the moderator properties of water for neutrons. The principle is that fast neutrons are emitted from a decaying radioactive source, and when they collide with particles having the same mass as a neutron (i.e., protons, H<sup>+</sup>), they slow down. As the main source of hydrogen in soil is water, so by measuring the density of slowed-down neutrons around the probe can estimate the volume fraction of water content the soil holds.

### **LM393 Driver:**

It consists of two independent low voltage comparators [4] designed to operate from a single supply over a wide range of voltages. Operation from split power supplies is also possible. These comparators also have a unique characteristic in that the input common-mode voltage range includes ground even though operated from a single power supply voltage. Input offset voltage specifications as low as 2.0 mV make this device an excellent selection for many applications in consumer automotive and industrial electronics.

### **DHT11 Humidity & Temperature Sensor:**

This DFRobot DHT11 Temperature & Humidity Sensor [3] features a temperature & humidity sensor complex with a calibrated digital signal output. By using the exclusive digital-signal-acquisition technique and temperature & humidity sensing technology, it ensures high reliability and excellent long-term stability. This sensor includes a resistive-type humidity measurement component and an NTC temperature measurement component, and connects to a high-performance 8-bit microcontroller, offering excellent quality, fast response, anti-interference ability and cost-effectiveness. The DHT11 sensor is shown below:



### Ultra sonic Sensor:

This is a low cost Ultrasonic Distance Sensor [8] provides a non-contact distance measurement with a fine accuracy of 3mm. The module is capable of measuring distance from obstacles in range of 2 cm to 400 cm or 1" to 3 Ft. Unlike IR sensors, the performance of this sensor is not dependent on the sunlight or color of the object. The module comes in a compact form factor with a ultrasonic transmitter, receiver and signal conditioning circuit on-board.

The ultrasonic sensor is shown below:



### pH Sensor:

“pH stands for power of hydrogen, which is a measurement of the hydrogen ion concentration in the body. The total pH scale ranges from 1 to 14, with 7 considered to be neutral. A pH less than 7 is said to be acidic and solutions with a pH greater than 7 are basic or alkaline”. The analog pH sensor/meter kit [6] is specially designed for Arduino controllers and has built-in simple, convenient and practical connection and features. It has an LED which works as the Power Indicator, a BNC connector and PH2.0 sensor interface. To use it, just connect the pH sensor with BNC connector, and plug the PH2.0 interface into the analog input port of any Arduino controller. The pH sensor kit is shown below:



**Water flow sensor:** The YF-S201 Hall Effect Water Flow Meter / Sensor sits in line with our water line and contains a pinwheel sensor to measure how much liquid has moved through it. There's an integrated magnetic hall effect sensor that outputs an electrical pulse with every revolution. By counting the pulses from the output of the sensor, the water flow can be easily calculated. The connection details are : Red wire : +5V ; Black wire : GND ; Yellow wire : PWM output.

The water flow sensor is shown below:



**Solenoid Valve:** The 12V Solenoid Valve - 3/4" is a controlled fluid valve. Simply connect a fluid source to the 3/4" threaded inlet and it will interrupt the flow until 12V is applied to the fast-on connectors on the solenoid.



The solenoid coil is used to translate the electric pulses into hydraulic pulses that enables opening and closing of specific solenoid valves. Solenoid coil, when mounted on the valve are connected to the controller by an electric cable. The solenoid valves are power operated devices which are used to modify the fluid flow or pressure rate in a process system. It is normally closed if there is no flow across the valve in its resting position with no current on the solenoid contacts. The quick opening of the valves, consisting of a metallic circular disc at right angles to the direction of flow in the pipe, which when rotated on a shaft, seals against the seats in the valve body. Solenoids offer fast and safe switching, high reliability, long service life, good medium compatibility of the materials used, low control power and compact design.

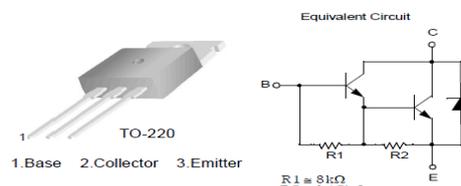
**DC motor:** Here a 6V DC motor is used. The operating temperature:  $-10^{\circ}\text{C} \sim +60^{\circ}\text{C}$  and rated voltage: 6.0VDC.



#### **IN4007:**

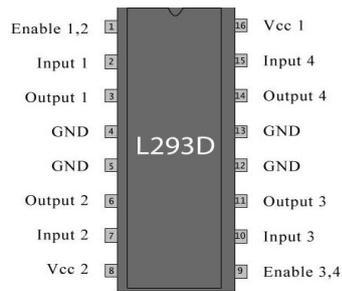
A rectifier diode is used as a one-way check valve. Since these diodes only allow electrical current to flow in one direction, they are used to convert AC power into DC power. When constructing a rectifier, it is important to choose the correct diode for the job; otherwise, the circuit may become damaged. A 1N4007 diode is electrically compatible with other rectifier diodes, and can be used as a replacement for any diode in the 1N400x family. The 1N4007 can sustain a peak repetitive reverse voltage of 1000 volts. When the maximum allowable consistent current amount is flowing through the diode, the voltage differential between the anode and the cathode is 1.1 volts. Under these conditions, a 1N4007 diode will dissipate 3 watts of power (about half of which is waste heat).

**TIP120 NPN Epitaxial Darlington Transistor:** TIP120 and its equivalent circuit is shown below:



#### **L293D IC :**

L293D is a dual H-bridge motor driver integrated circuit (IC). Motor drivers act as current amplifiers since they take a low-current control signal and provide a higher-current signal. This higher current signal is used to drive the motors. L293D contains two inbuilt H-bridge driver circuits. In its common mode of operation, two DC motors can be driven simultaneously, both in forward and reverse direction. The L293D IC is shown below:



The motors are rotated on the basis of the inputs provided across the input pins as LOGIC 0 or LOGIC 1. In simple words we need to provide Logic 0 or 1 across the input pins for rotating the motor. Lets consider a Motor connected on left side output pins (pin 3,6). For rotating the motor in clockwise direction the input pins has to be provided with Logic 1 and Logic 0.

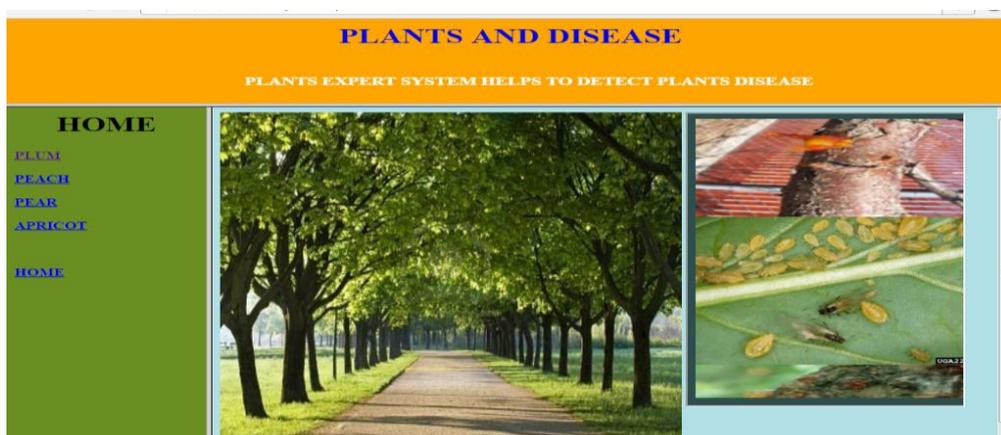
**Water Tank:** The same tank is used for supplying water to the field and for fertiliser application when required. Organic fertilisers such as bird and animal manures, blood meal, fish meal, feather meal, ecto and endo mycorrhizae etc can also be used. Organic-based ingredients promote stable consistent plant growth with no growth spikes.

Also connecting wire, resistors, pipe ,M Seal, breadboard etc are used.

**Pest control:** For pest control, traditional pest control method and electronic pest repellent are preferred.

### Identification of diseases/insects of plum tree and its prevention:

HTML is the abbreviation for Hyper Text Markup Language, and is the code, or language that is used for the creation of basic website layouts.It is the standard markup language for creating web pages and web applications. HTML is used to create electronic documents (called pages) that are displayed on the World Wide Web. Each page contains a series of connections to other pages called hyperlinks. Every web page that we see on the Internet is written using one version of HTML code or another.HTML code ensures the proper formatting of text and images so that our internet browser may display them as they are intended to look. Without HTML, a browser would not know how to display text as elements or load images or other elements. HTML also provides a basic structure of the page, upon which Cascading Style Sheets(CSS) are overlaid to change its appearance. One could think of HTML as the bones (structure) of a web page, and CSS as its skin (appearance). For Identification of diseases/insects of plum tree, the HTML pages and their codes used in this paper are described below:



**Codes:** The coding for the above page is as follows

```
MAIN - Notepad
File Edit Format View Help
<html>
<frameset rows="20%,80%">
<frame src=TOP.HTML scrolling="no">
<frameset cols="20%, 80%">
<frame src=TOPICS.HTML>
<frame src=WELCOME.HTML name="main">
</frameset>
</frameset>
</html>
```

```
<html>
<body bgcolor="#2f4f4f">
<div><marquee                                bgcolor="#556b2f"
onMouseOver="this.scrollAmount=0"onMouseOut="this.scrollAmount=4"scrollamount="4"
direction="up" loop="true"width="290" height="430"><center>


















```

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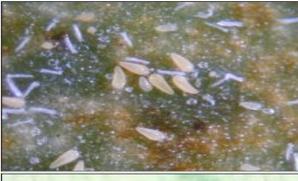




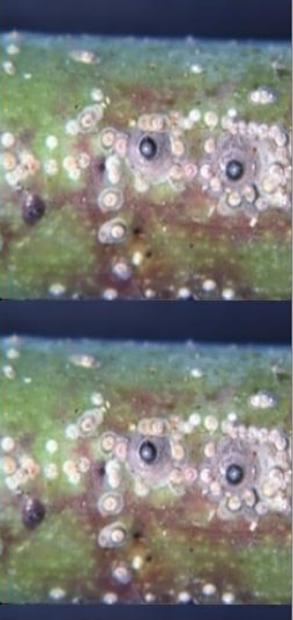



</marquee>
</body>
</html>
    
```

**PLUM:**

PLUM			
PLUM TREE DISEASE			
NAME OF INSECT	NAME OF DISEASE	PREVENTION	IMAGES OF INSECT/DISEASE
Japanese Beetles	It infects leaves.	Many of the pests can be eliminated with a pesticide spray. Control Japanese beetles by shaking the branches of the tree so that they fall to the ground. Place the beetles in	
Plum Aphid	It infects leaves.	Spray the tree with neem oil when you spy an infection of aphids.	
Plum Curculio	It infects Fruits.	A Petal-fall pesticide applied in fall will prevent plum curculio.	
Rust Mites	It infects leaves.	Control rust mites with a sulfur spray applied in early spring.	

<p>Western Flower Thrips</p>	<p>It infects Fruits.</p>	<p>Only an insecticide will prevent this injury. Spinosad can be applied during bloom when bees are not flying (at dawn or dusk), or at petal fall.</p>	
<p>A soil-borne, fungus-like organism (Phytophthora)</p>	<p>Crown Rot and Root Rot It infects Fruits.</p>	<p>Plant only in well-drained areas. Do not replant in areas where root or crown rot occurred previously. Phosphorus acid (Agri-fos) can help protect healthy trees growing next to infected trees, as this disease can spread by root-to-root contact.</p>	
<p>A fungus</p>	<p>Perennial Canker (It infects bark, stem, limbs, twigs).</p>	<p>Prune out diseased tissue, prevent wounding, and keep trees healthy. There are no fungicides for managing cankers. Prune dead branches by cutting at least 4 inches below diseased wood. Avoid injury to trees. Control twig and tree borers since their damage may allow entrance of the fungus. Prevent wounding by sun scald.</p>	
		<p>Preventive trunk sprays (permethrin,</p>	
<p>Greater Peachtree(Crown) Borer</p>	<p>It infects trunk, bark, roots.</p>	<p>Preventive trunk sprays (permethrin, carbaryl) are the main control tactic, from early July through September on the lower 12-18" of trunk and exposed roots.</p>	
<p>Flatheaded Borer (Pacific Flatheaded Borer and Flatheaded Apple-tree Borer)</p>	<p>It infects trunk, bark.</p>	<p>Apply protective trunk sprays to prevent larvae from entering trees, such as products containing permethrin. Keep trees healthy with optimal watering, fertilization, pruning, and remove</p>	

		remove infested trees.	
San Jose Scale	It infects bark, twigs.	A 2% oil application during leaf expansion will kill overwintering immature scales (but not adults). Adults are difficult to kill, but die after their offspring (crawlers) emerge. To kill crawlers, apply bifenthrin or carbaryl in early June.	
		A single application of a	
San Jose Scale	It infects bark, twigs.	are difficult to kill, but die after their offspring (crawlers) emerge. To kill crawlers, apply bifenthrin or carbaryl in early June.	
Speckled Green Fruitworm	It infects leaves, flowers, fruits.	A single application of a relatively benign insecticide such as Bt ( <i>Bacillus thuringiensis</i> ) or spinosad, in spring after fruit starts forming, is very effective.	

Codes: The coding for the above page is as follows:

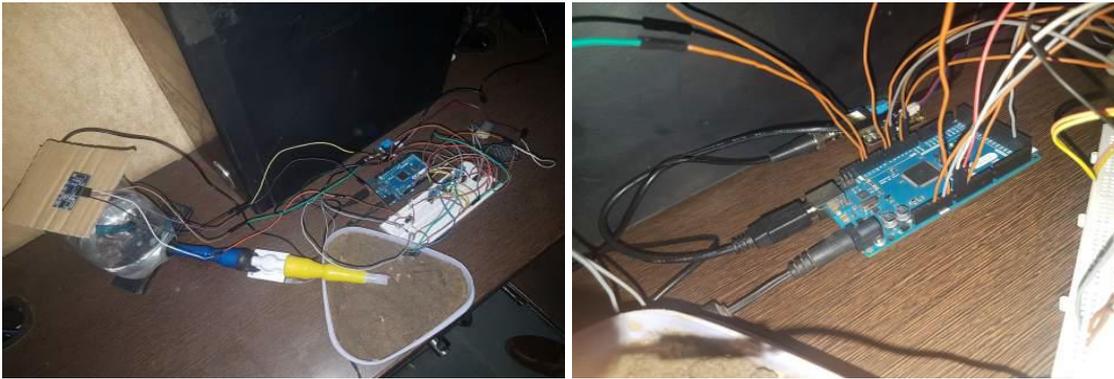
```
<html>
<body>
<table border="3" cellpadding="20" cellspacing="2" width="90">
<caption> <b><u>PLUM</u></b> </caption>
<tr>
<th bgcolor = "#FFD700" colspan="3"> PLUM TREE DESEASE </th>
```

```

</tr>
<tr>
<th bgcolor = "#ADFF2F"> NAME OF INSECT </th>
<th bgcolor = "#ADFF2F"> NAME OF DISEASE </th>
<th bgcolor = "#ADFF2F"> PREVENTION </th>
</tr>
<tr align="center">
<th bgcolor = "#ADFF2F"> Japanese Beetles </th>
<th bgcolor = "#ADFF2F"> It infects leaves. </th>
<th bgcolor = "#ADFF2F"> Many of the pests can be eliminated with a pesticide spray. Control Japanese
beetles by shaking the branches of the tree so that they fall to the ground. Place the beetles in soapy water to kill
them. </th>
</tr>
<tr align="center">
<th bgcolor = "#ADFF2F"> Plum Aphid </th>
<th bgcolor = "#ADFF2F"> It infects leaves. </th>
<th bgcolor = "#ADFF2F"> Spray the tree with neem oil when you spy an infection of aphids. </th>
</tr>
<tr align="center">
<th bgcolor = "#ADFF2F"> Plum Curculio </th>
<th bgcolor = "#ADFF2F"> It infects Fruits. </th>
<th bgcolor = "#ADFF2F"> A Petal-fall pesticide applied in fall will prevent plum curculio. </th>
</tr>
<tr align="center">
<th bgcolor = "#ADFF2F"> Rust Mites </th>
<th bgcolor = "#ADFF2F"> It infects leaves. </th>
<th bgcolor = "#ADFF2F"> Control rust mites with a sulfur spray applied in early spring. </th>
</tr>
<tr align="center">
<th bgcolor = "#ADFF2F"> Western Flower Thrips </th>
<th bgcolor = "#ADFF2F"> It infects Fruits. </th>
<th bgcolor = "#ADFF2F"> Only an insecticide will prevent this injury. Spinosad can be applied during bloom
when bees are not flying (at dawn or dusk), or at petal fall. </th>
</tr>
<tr align="center">
<th bgcolor = "#ADFF2F"> A soil-borne, fungus-like organism (Phytophthora) </th>
<th bgcolor = "#ADFF2F"> Crown Rot and Root Rot It infects Fruits. </th>
<th bgcolor = "#ADFF2F"> Plant only in well-drained areas. Do not replant in areas where root or crown rot
occurred previously. Phosphorus acid (Agri-fos) can help protect healthy trees growing next to infected trees, as
this disease can spread by root-to-root contact. </th>
</tr>
<tr align="center">
<th bgcolor = "#ADFF2F"> A fungus </th>
<th bgcolor = "#ADFF2F"> Perennial Canker (It infects bark,stem, limbs, twigs). </th>
<th bgcolor = "#ADFF2F"> Prune out diseased tissue, prevent wounding, and keep trees healthy. There are no
fungicides for managing cankers.
Prune dead branches by cutting at least 4 inches below diseased wood. Avoid injury to trees. Control twig and
tree borers since their damage may allow entrance of the fungus. Prevent wounding by sun scald.
</th>
</tr>
<tr align="center">
<th bgcolor = "#ADFF2F"> Greater Peachtree(Crown) Borer </th>
<th bgcolor = "#ADFF2F"> It infects trunk, bark, roots. </th>
<th bgcolor = "#ADFF2F"> Preventive trunk sprays (permethrin, carbaryl) are the main control tactic, from
early July through September on the lower 12 -18” of trunk and exposed roots. </th>
</tr>
<tr align="center">
<th bgcolor = "#ADFF2F"> Flatheaded Borer (Pacific Flatheaded Borer and Flatheaded Apple-tree Borer)
</th>

```





### Constraints:

However, the state of Meghalaya is facing some of the constraints in development of this fruit sector. These include:

- Inadequate infrastructure for post-harvest management
- Land use and tenure system
- Poor transport infrastructure
- Lack of a robust distribution and marketing infrastructure for horticulture produce
- Lack of well-established processing infrastructure to manage the horticultural produce, etc.
- Supply chain and branding issue.
- Credit availability is also a serious concern.

### CONCLUSION:

Meghalaya is basically an agricultural state with about 80% of its total population depending entirely on agriculture for their livelihood.

Stone fruits like plum, peach, apricot are found in the central plateau of East and West Khasi Hills and Jaintia Hills. *Pear containing stone cells is widely grown in the Khasi Hills districts of the state.* These fruits have good commercial value. Now by implementing technology, stone fruits can also be grown in other parts of the state. Cultivation of fruits will surely play a vital role in the prosperity of Meghalaya as generally stated that the standard of living of the people can be judged by per capita production and consumption of fruits. Though the initial cost of establishment of an orchard is high, it is compensated by higher productivity or due to high value of produce. In the long term, the technological innovations as envisioned are revolutionary and they will dramatically alter the way tree fruit is produced, handled, and utilized.

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- [6] Datasheet of ph sensor: SEN0161.pdf.
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