Logistics For Agri Supply Chain Through Id3 Decision Trees Algorithm In Krishnagiri District, Tamil Nadu, India.

Venugopal Navaneetha Kumar

Abstract Purpose – The main purpose of this paper is to identify the supply chain and the logistics problem in the agricultural industry. Different products and its issues to be identified and to be sorted out in the agricultural industry and to suggest the manufacturers and the government for the better growth of Indian economy and its future growth in terms of export, technology etc. Design/methodology/approach: Descriptive method was used in the form of interview schedule method to collect the data from the transporters, manufacturers, suppliers, retailers. ID3 decision tree algorithm was used in this paper to identify the major problem in the logistics of agri-based products. Findings: In both the floriculture and horticulture industry the major problem is the technology with the lowest harvest with the high cost. The low harvest because of not having the skilled labours and the facilities like space etc. And the high cost is because the facilities and the number of machineries available in the district other state or the country is very low. Choosing the right logistics with the advanced technology helps both the transporters retailers and the facilitator work easier with the better income. Originality/value: ID3 decision tree algorithm is used identify the problems in both floriculture and horticulture industry in the Krishnagiri district, Tamil Nadu and its logistical activities in the supply chain.

Keywords: Technology, logistics, hectares, financial year, tonnes Paper type : Research paper

1. INTRODUCTION
Agriculture is the primary source of livelihood and plays a vital role in the Indian economy. Over 58% of the rural households depend on the agriculture as their principal means of livelihood. India is the second largest producer of agri products, and also India is among 15 leading exporters of agricultural products in the world. Total agricultural exports from India had grew at a compound annual growth rate (CAGR) of 16.45% over from the year 10-18 to reach US$38.21 billion in financial year 2018. India is an agricultural based country, where more than 50% of population depends on agriculture. This structures the Indians source of income. Its also said that agriculture is the backbone of Indian economy. In agriculture horticulture and floriculture is an intensive subset of agriculture, where it deals with flowers, landscape, vegetables and fruits. Horticulture is socially important because it improves the way we used to plants for food and other human purposes as well as repairing the environment and personal aesthetics, where floriculture is important in all three ways like economic way as fast emerging world venture in the world, especially as a worlds money-spinner, aesthetic point of view in which it is considered as billion dollar earning industry which ultimately adds the monitory value of any building, and finally also by the social point of view which symbolizes the beauty, peace, love etc with its wide varieties. The demand of horticulture produce is increasing from 546.71 crore in 2017 to almost 600 crore till February 2018. The major exporting countries were USA, Pakistan, Netherlands, Germany, Italy, Belgium and UK. There are more than 300 export-oriented units in India. More than 50% of the floriculture units are based in Karnataka, Tamil Nadu and Andhra Pradesh while Tamil Nadu ranks first in flower cultivation. With technical collaborations from foreign companies, the Indian floriculture industry is poised to increase its share in world trade. In Tamil Nadu, out of the total area of cultivation occupy 25610 hectors. Where Krishnagiri, Dindigul, Dharmapuri, Salem, Vellore, Madurai, Tiruvannamalai, Tirunelveli and Erode are the major flowers growing districts in Tamil Nadu. Since, Tamil Nadu has the wider area of agri-products to be grown and in Tamil Nadu Krishnagiri District has its own image for both the flowers and the vegetables which is transported in the wider area.

2. TAMIL NADU, KRISHNAGIRI DISTRICT

2.1 Horticulture industry
Tamil Nadu is nestled in the south-East part of peninsular India and its blessed with varying Agro-climatic zones. The agro-climatic zones are divided as follows The following table shows information about the Climatic conditions of Tamil Nadu District
2.1.1 TABLE NO 2.1

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Agro-climatic zone</th>
<th>Districts</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Western Zone</td>
<td>Coimbatore, Erode, Thiruppur, Dindigul and Theni</td>
</tr>
<tr>
<td>2</td>
<td>Southern Zone</td>
<td>Madurai, Ramanathapuram, Thirunelveli, Sivagangai, Virudhunagar, Thuthukudi, Pudukottai and Karur</td>
</tr>
<tr>
<td>3</td>
<td>North Eastern Zone</td>
<td>Kancheepuram, Thiruvarur, Vellore, Thiruvannamalai, Cuddalore, and Villupuram.</td>
</tr>
<tr>
<td>4</td>
<td>North Western Zone</td>
<td>Dharmapuri, Krishnagiri, Salem, Namakkal, Perambalur, and Ariyalur</td>
</tr>
<tr>
<td>5</td>
<td>Delta Zone</td>
<td>Thanjavur, Thiruvur, Nagapattinam and Trichirapalli</td>
</tr>
<tr>
<td>6</td>
<td>High Rainfall Zone</td>
<td>Kanyakumari</td>
</tr>
<tr>
<td>7</td>
<td>Hilly and Tribal Zone</td>
<td>The Nilgiris</td>
</tr>
</tbody>
</table>

The above table describes the vagarious climatic condition of Tamil Nadu Districts. Since, Tamil Nadu is the largest contributor to India's GDP, 70% of the people in Tamil Nadu are Agrarian and Agricultural allied activities. Last five years Tamil Nadu has made step forward in the agricultural industry. Horticulture is done based on traditional horticulture crops and non-traditional horticultural crops. Besides nowadays traditional horticulture crops have been introduced in non-traditional areas and non-traditional horticulture crops introduced in traditional areas. Horticulture crops grown in Tamil Nadu have been classified into six categories like vegetables, flowers, fruits, spices and condiments, plantation crops, and medicinal aromatic plants. Vegetables are majorly grown are tomato, brinjal, onion, drumstick, potato, carrot and beans in the area of 2,26,502 Ha. Horticulture industry has a new born institutions which provide operational and the financial flexibility for implementing new schemes. TANHODA is the nodal agency for Mission for Integrated Development of Horticulture (MIDH) National Horticulture Mission (NHM), Pradhan Mantri Krishi Sinchayee Yojana (PMKSY)" Per Drop More Crop", Tamil Nadu Irrigated Agriculture Modernization and Water-Bodies Restoration and Management (TN-IAMWARM), Bamboo mission, National Mission on Medicinal plants (NMMP), State Horticulture farms, Gardens & Parks and other schemes. The following chart shows the major crops grown in Districts of Tamil Nadu

2.2 Floriculture industry

In Tamil Nadu loose flowers are produced in an area of about 42,400 hectares with the production of 3,53,535 MT jasmine, chrysanthemum, marigold, rose, crossandra and nerium)and cut flowers are produced in an area of 800 ha with a production of 15,900 MT. Tamil Nadu occupies 25% of country’s flower production. Cut flowers are majorly cultivated in Hosur, Nilgiris, Kodai kanal (both upper and lower the hills) and the Yercaud of shevroyan hills.

The following table shows the major flower crops grown in Tamil Nadu

2.2.1 TABLE NO 2.2

<table>
<thead>
<tr>
<th>Crops</th>
<th>Area (ha)</th>
<th>Production (MT)</th>
<th>Productivity (MT/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rose</td>
<td>1,837</td>
<td>1,070</td>
<td>9.15</td>
</tr>
<tr>
<td>Acacetunam oblong</td>
<td>1,190</td>
<td>1,022</td>
<td>8.8</td>
</tr>
<tr>
<td>Acacetunam auriculata</td>
<td>2,817</td>
<td>2,534</td>
<td>9.00</td>
</tr>
<tr>
<td>Acacetunam grandiflorum</td>
<td>867</td>
<td>780</td>
<td>9.00</td>
</tr>
<tr>
<td>Crossandra</td>
<td>1,177</td>
<td>3,531</td>
<td>3.00</td>
</tr>
<tr>
<td>Chrysanthemum</td>
<td>2,538</td>
<td>3,401</td>
<td>14.30</td>
</tr>
<tr>
<td>Marigold</td>
<td>6,735</td>
<td>109,895</td>
<td>16.00</td>
</tr>
<tr>
<td>Nerium</td>
<td>1,408</td>
<td>3,378</td>
<td>24.00</td>
</tr>
<tr>
<td>Tuberoses</td>
<td>2,156</td>
<td>363</td>
<td>16.80</td>
</tr>
<tr>
<td>Other flowers</td>
<td>2,177</td>
<td>374</td>
<td>17.20</td>
</tr>
<tr>
<td>Total</td>
<td>52,400</td>
<td>315,355</td>
<td>9.60</td>
</tr>
</tbody>
</table>

The above table describes the major flower crops grown in Tamil Nadu
The following table shows the traditional flowers of Tamil Nadu

2.2.2 TABLE NUMBER 2.3

<table>
<thead>
<tr>
<th>Traditional Flowers of Tamil Nadu</th>
<th>Less known traditional flowers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jasmine</td>
<td>Gongylaea</td>
</tr>
<tr>
<td>Scented Rose</td>
<td>Hibiscus</td>
</tr>
<tr>
<td>Chrysanthemum</td>
<td>Nerium</td>
</tr>
<tr>
<td>Tuberose</td>
<td>Barleria</td>
</tr>
<tr>
<td>Marigold</td>
<td>Celosia</td>
</tr>
<tr>
<td>Crossandra</td>
<td>Tabernae montana coriaria</td>
</tr>
<tr>
<td></td>
<td>Chrysargam</td>
</tr>
<tr>
<td></td>
<td>Arthrobys (Manoranjitham)</td>
</tr>
<tr>
<td></td>
<td>Ixora</td>
</tr>
</tbody>
</table>

The above table describes about the traditional flowers grown in Tamil Nadu

The following table shows the major zones of flowers grown in Tamil Nadu Districts

2.2.3 TABLE NO 2.4

<table>
<thead>
<tr>
<th>Seven floriculture zones of Tamil Nadu</th>
<th>Loose Flowers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Hosur zone</td>
<td>Jasmine, Marigold, Chrysanthemum, Tuberose, Gongylaea</td>
</tr>
<tr>
<td>2. Hill area zone</td>
<td>Chrysanthemum, Marigold</td>
</tr>
<tr>
<td>3. Coimbatore zone</td>
<td>Jasmine, Scented rose, Tuberose, Chrysanthemum, Crossandra, Marigold, Gongylaea, Celosia</td>
</tr>
<tr>
<td>4. Madurai zone</td>
<td>Jasmine, Scented rose, Tuberose, Crossandra, Marigold, Gongylaea, Nerium</td>
</tr>
<tr>
<td>5. Chengai zone</td>
<td>Jasmine, Crossandra, Marigold, Tuberose</td>
</tr>
<tr>
<td>6. Kanyakumari zone</td>
<td>Jasmine, Scented rose</td>
</tr>
<tr>
<td>7. Trichy zone</td>
<td>Crossandra, Tuberose</td>
</tr>
</tbody>
</table>

The above table describes about the major zones of flowers grown in Tamil Nadu Districts

The following table shows major districts of loose and cut flower production in the state Tamil Nadu

2.2.4 TABLE NO 2.5

<table>
<thead>
<tr>
<th>Flower</th>
<th>Potential districts for loose flower production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loose flowers</td>
<td></td>
</tr>
<tr>
<td>Jasmine</td>
<td>Coimbatore, Madurai, Salem, Erode, Dindigul, Virudhunagar, Tumseveli, Trichy, and Kanyakumari</td>
</tr>
<tr>
<td>Marigold</td>
<td>Erode, Dindigul, Krishnagiri</td>
</tr>
<tr>
<td>Rose</td>
<td>Krishnagiri, Dindigul, Madurai</td>
</tr>
<tr>
<td>Chrysanthemum</td>
<td>Krishnagiri, Dindigul</td>
</tr>
<tr>
<td>Cut Flowers</td>
<td></td>
</tr>
<tr>
<td>Rose</td>
<td>Krishnagiri (Hosur)</td>
</tr>
<tr>
<td>Chrysanthemum</td>
<td>Veyvand and Nilgiri</td>
</tr>
<tr>
<td>Carnation</td>
<td>Nilghis and Kodakanal</td>
</tr>
<tr>
<td>Lilium</td>
<td>Nilghis</td>
</tr>
</tbody>
</table>

The above table describes the major districts of loose and cut flowers production in the state of Tamil Nadu

The following table shows the major cut flower zones in Tamil Nadu
3. MAJOR INDUSTRIES OF FLOWER PRODUCTION

3.1 TANFLORA

TANFLORA is the India’s first project in the agri-zone it is jointly run by TIDCO (tamil nadu industries corporation) and MNA & associates. The infrastructure has been developed owned and maintained by the TANFLORA with other facilities of rain water harvesting of 20 tanks (150 million litres can be stored only 3 ponds which can store only 70 million litres of water), water storage of steel tanks are imported from Holland having capacity of 7.33 lakhs litres per tank. This project is one of the largest production facilities of cut flowers in the world and also its the country’s first Agri-export zone for cut flowers. Government of Tamil Nadu had supported the project by providing the funds under ASIDE scheme for developing the infrastructure which is around 700 hectares. APEDA, ministry of commerce provided financial assistance for establishment of post harvest facilities. National Horticulture Board provided capital subsidy to the growers. It produces around 67.5 million of cut flowers per annum. This is also a cooperative farming concept developed on the lines of Aggrexco of Israel. The roses grown by the growers are collect and processed in the post harvest facilities of TANFLORA packed and marketed under the brand name of TANFLORA, primarily exported to Europe, Australia, Middle East, Far East and Japan.

3.2 IIAP

IIAP will become self-sustaining and supply cut flowers to market across the country said Gil Haskel. Indo-Israel Agriculture project has been setup in Thally near Hosur, Krishnagiri district. This is the country’s first centre of excellence (COE) for cut flowers it is also the setup under the Indo-Israel’s agency for International Development Cooperation. It was the 29th centre for excellence established across the country under the Indo-Israel partnership. IIAP cultivated both the flowers and vegetables where exports from Israel often visits to share the knowledge and techniques of both the industries. It also aims to train the entrepreneurs and extension officers on high-tech cultivation of commercial cut flowers suitable for Tamil Nadu based on its barriers. It also helps in creating the hub for the supply chain management.

4. SUPPLY CHAIN MANAGEMENT AND ITS ISSUES IN AGRI PRODUCTS

Supply chain plays the major important role in the agricultural products with the flow of products and information in the supply chain management. The links of procurement of materials, transformation if materials into finished products and the distribution of products to end customers is the entire process in the supply chain. Today’s supply chain are enabling organizations to reduce the cost of inventory, extend the resources, add value to the product, time management and to retain the customers. Most of the agri products are highly perishable and few products are perishable within certain period of time. So the Proper flow of supply chain is the major important problem in both the horticulture and the floriculture industry in which the product has to reach the customers on time. The major issues in the supply chain of agri products are the technological factors where the maximum growers cannot use the latest technology of packaging, fragmentation issues, integration issues, infrastructural issues, linkage and integration issues, cold chain issues, post-harvest awareness, financial issues, network of logistics, vehicle capacity, technical and non-technical labors, farmers knowledge and their awareness, quality and safety issues. So the main aim of this paper is to solve the major problems in the supply chain.

4.1 OBJECTIVES

a. To study about the logistics of the agri products in India and to promote it in the best possible ways.

b. To analyze the major problems in the logistics of agri products and to make agri industry best in its possible opportunities.

c. To identify the major reason which makes agri industry lack behind other industries.

d. To conduct the detailed study of logistics in the agri industry and the strategies its strategies used in every stage of agri products.
5. METHODOLOGY
Descriptive research methods adopted here the interview schedule method was used to collect the data from the logistics operators, transporters, manufacturers, suppliers, retailers. ID3 decision tree algorithm was used in this paper to identify the major problem in the logistics of agri-based products.

6. TOOLS USED
In decision tree learning, ID3 algorithm (Iterative Dichotomiser 3) was invented by Ross Quinlan. This algorithm attempts to create the possible decision tree and which can also be used typically in machine learning and natural learning domains. The resulting tree is used to classify the future. In this paper ID3 was used to identify the major problems faced in the logistics of the agri products.

7. AGRI LOGISTICS SUPPLY CHAIN THROUGH ID3 ALGORITHM
Generally, decision tree was not used in the logistics of agri products. Since the agri products are perishable and few products are highly perishable, so the attempt has been made using ID3 algorithm because selecting the right agri logistics plays the major important after post harvesting of the crop. So this decision tree helps you to make a decision for selecting the logistics with the right techniques.

7.1 As A MATTER OF CREATING DECISION TREE THE ATEMPT DERIVEF THROUGH ID3 ALGORITHM
STEP 1: Create root node for the tree

```
Agri-products
  `--- flowers
        `--- Highly perishable
                      `--- perishable
                  `--- Vegetables
                                `--- Highly perishable
                                                      `--- perishable
```

STEP 2: If all examples are positive, return leaf node ‘positive’
No leaf nodes seems to be positive so the next step has to be followed
STEP 3: In agri-logistics the flowers are highly perishable so it seems to be negative because of highly perishable

<table>
<thead>
<tr>
<th>SL_NO</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FLOWERS</td>
<td>VEGETABLES</td>
</tr>
<tr>
<td><strong>1</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>TIME</strong></td>
<td></td>
</tr>
<tr>
<td>1.1</td>
<td>Low time</td>
<td></td>
</tr>
<tr>
<td>1.2</td>
<td>Medium time</td>
<td></td>
</tr>
<tr>
<td>1.3</td>
<td>Maximum time</td>
<td></td>
</tr>
<tr>
<td>1.4</td>
<td>Worst condition</td>
<td></td>
</tr>
<tr>
<td><strong>2</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>TEMPERATURE</strong></td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td>High temperature</td>
<td></td>
</tr>
<tr>
<td>2.2</td>
<td>Medium temperature</td>
<td></td>
</tr>
<tr>
<td>2.3</td>
<td>Low temperature</td>
<td></td>
</tr>
<tr>
<td><strong>3</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>QUANTITY</strong></td>
<td></td>
</tr>
<tr>
<td>3.1</td>
<td>High quantity</td>
<td></td>
</tr>
<tr>
<td>3.2</td>
<td>Medium quantity</td>
<td></td>
</tr>
<tr>
<td>3.3</td>
<td>Low quantity</td>
<td></td>
</tr>
<tr>
<td><strong>4</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>LABOURS</strong></td>
<td></td>
</tr>
<tr>
<td>4.1</td>
<td>Technical labours</td>
<td></td>
</tr>
<tr>
<td>4.2</td>
<td>Non-technical labours</td>
<td></td>
</tr>
<tr>
<td><strong>5</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>HARVESTING COST</strong></td>
<td></td>
</tr>
<tr>
<td>5.1</td>
<td>Pre-harvest cost</td>
<td></td>
</tr>
<tr>
<td>5.2</td>
<td>Post-harvest cost</td>
<td></td>
</tr>
<tr>
<td><strong>6</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>TECHNOLOGY</strong></td>
<td></td>
</tr>
<tr>
<td>6.1</td>
<td>High harvest low cost</td>
<td></td>
</tr>
<tr>
<td>6.2</td>
<td>High harvest high cost</td>
<td></td>
</tr>
<tr>
<td>6.3</td>
<td>Low harvest high cost</td>
<td></td>
</tr>
<tr>
<td>6.4</td>
<td>Low harvest low cost</td>
<td></td>
</tr>
<tr>
<td><strong>7</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>VEHICLE CAPACITY</strong></td>
<td></td>
</tr>
<tr>
<td>7.1</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>7.2</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>7.3</td>
<td>Low</td>
<td></td>
</tr>
</tbody>
</table>
ID3 FOR FLOWERS

STEP 4: calculate Entropy H(s)

1.4.1 Profit

Assuming for 1 acres in one yeild

<table>
<thead>
<tr>
<th>VERY HIGH PROFIT</th>
<th>HIGH PROFIT</th>
<th>MEDIUM PROFIT</th>
<th>LOW PROFIT</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>6Lakhs</td>
<td>4 lakhs</td>
<td>3 lakhs</td>
<td>2 lakhs</td>
<td>15 lakhs</td>
</tr>
</tbody>
</table>

\[
H(s) = \sum_{x} p(x) \log_2 \frac{1}{p(x)}
\]

\[
H(s) = -\left(\frac{6}{15}\right) \log_2 \left(\frac{6}{15}\right) - \left(\frac{4}{15}\right) \log_2 \left(\frac{4}{15}\right) - \left(\frac{3}{15}\right) \log_2 \left(\frac{3}{15}\right) - \left(\frac{2}{15}\right) \log_2 \left(\frac{2}{15}\right)
\]

\[
H(s) = 1.8891
\]

STEP 5 : For each attribute, calculate the entropy with respect to the attribute ‘x’ denoted by H(S, x)

1.5.1 TIME

Number of vehicles reached the destination in correct duration

<table>
<thead>
<tr>
<th>LOW TIME</th>
<th>MEDIUM TIME</th>
<th>MAXIMUM TIME</th>
<th>WORST CONDITION</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>15 VEHICLES</td>
</tr>
</tbody>
</table>

\[
P(S_{LT}) = \frac{6}{15}
\]

\[
P(S_{MET}) = \frac{4}{15}
\]

\[
P(S_{MXT}) = \frac{3}{15}
\]

\[
P(S_{WC}) = \frac{2}{15}
\]

\[
H(s) = \sum_{x} p(x) \log_2 \frac{1}{p(x)}
\]

\[
H(S_{LT}) = -\left(\frac{6}{15}\right) \log_2 \left(\frac{6}{15}\right) - \left(\frac{4}{15}\right) \log_2 \left(\frac{4}{15}\right) = 0.9703
\]

\[
H(S_{WC}) = -\left(\frac{2}{15}\right) \log_2 \left(\frac{2}{15}\right) - \left(\frac{3}{15}\right) \log_2 \left(\frac{3}{15}\right) = 0.5664
\]

\[
H(S_{MXT}) = -\left(\frac{3}{15}\right) \log_2 \left(\frac{3}{15}\right) - \left(\frac{4}{15}\right) \log_2 \left(\frac{4}{15}\right) = 0.7219
\]

\[
H(S_{MET}) = -\left(\frac{2}{15}\right) \log_2 \left(\frac{2}{15}\right) - \left(\frac{11}{15}\right) \log_2 \left(\frac{11}{15}\right) = 0.83657
\]

Therefore

\[
IG(S_{TIME}) = H(s) - \sum_{x} p(x) \times H(x)
\]

\[
IG(S_{TIME}) = H(s) - p(S_{LT})\times H(S_{LT}) - p(S_{WC})\times H(S_{WC}) - p(S_{MXT})\times H(S_{MXT}) - p(S_{MET})\times H(S_{MET})
\]

\[
IG(S_{TIME}) = 1.8891 - \left(\frac{6}{15}\right) \times (0.9703) - \left(\frac{4}{15}\right) \times (0.5664) - \left(\frac{3}{15}\right) \times (0.7219) - \left(\frac{2}{15}\right) \times (0.83657)
\]

\[
IG(S_{TIME}) = 0.6120
\]

1.5.2 TEMPERATURE

Temperature maintained by the number of vehicles.
<table>
<thead>
<tr>
<th>HIGH TEMPERATURE VEHICLES</th>
<th>MEDIUM TEMPERATURE VEHICLES</th>
<th>LOW TEMPERATURE VEHICLES</th>
<th>TOTAL VEHICLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>8</td>
<td>3</td>
<td>15</td>
</tr>
</tbody>
</table>

\[
P(S_{HT}) = \frac{4}{15}\\
P(S_{MET}) = \frac{9}{15}\\
P(S_{LT}) = \frac{2}{15}
\]

\[
H(s) = \sum_{x} p(x) \log_{2} \frac{1}{p(x)}
\]

\[
H(S_{HT}) = -(\frac{4}{15}) \log_{2} (\frac{4}{15}) - (\frac{11}{15}) \log_{2} (\frac{11}{15}) = 0.8365
\]

\[
H(S_{MET}) = -(\frac{9}{15}) \log_{2} (\frac{9}{15}) - (\frac{7}{15}) \log_{2} (\frac{7}{15}) = 0.9967
\]

\[
H(S_{LT}) = -(\frac{2}{15}) \log_{2} (\frac{2}{15}) - (\frac{11}{15}) \log_{2} (\frac{11}{15}) = 0.7219
\]

Therefore

\[
IG(S_{TEMPERATURE}) = H(s) - \sum_{x} p(x) \times H(x)
\]

\[
IG(S_{TEMPERATURE}) = H(s) - p(S_{HT}) \times H(S_{HT}) - p(S_{MET}) \times H(S_{MET}) - p(S_{LT}) \times H(S_{LT})
\]

1.5.3 QUANTITY

Maximum production of one yield

<table>
<thead>
<tr>
<th>HIGH QUANTITY VEHICLES</th>
<th>MEDIUM QUANTITY VEHICLES</th>
<th>LOW QUANTITY VEHICLES</th>
<th>TOTAL VEHICLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>5</td>
<td>4</td>
<td>15</td>
</tr>
</tbody>
</table>

\[
P(S_{HQ}) = \frac{6}{15}\\
P(S_{MQ}) = \frac{5}{15}\\
P(S_{LQ}) = \frac{4}{15}
\]

\[
H(s) = \sum_{x} p(x) \log_{2} \frac{1}{p(x)}
\]

\[
H(S_{HQ}) = -(\frac{6}{15}) \log_{2} (\frac{6}{15}) - (\frac{5}{15}) \log_{2} (\frac{5}{15}) = 0.9703
\]

\[
H(S_{MQ}) = -(\frac{5}{15}) \log_{2} (\frac{5}{15}) - (\frac{10}{15}) \log_{2} (\frac{10}{15}) = 0.9182
\]

\[
H(S_{LQ}) = -(\frac{4}{15}) \log_{2} (\frac{4}{15}) - (\frac{11}{15}) \log_{2} (\frac{11}{15}) = 0.8365
\]

Therefore

\[
IG(S_{QUANTITY}) = H(s) - \sum_{x} p(x) \times H(x)
\]

\[
IG(S_{QUANTITY}) = H(s) - p(S_{HQ}) \times H(S_{HQ}) - p(S_{MQ}) \times H(S_{MQ}) - p(S_{LQ}) \times H(S_{LQ})
\]

1.5.4 LABOURS
Labours required for one acre of production

<table>
<thead>
<tr>
<th>TECHNICAL</th>
<th>NON-TECHNICAL</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>11</td>
<td>15</td>
</tr>
</tbody>
</table>

\[
P(S_{\text{TECHNICAL}}) = \frac{4}{15}
\]

\[
P(S_{\text{NON-TECHNICAL}}) = \frac{11}{15}
\]

\[
H(s) = \sum_{x \in X} p(x) \log_2 \frac{1}{p(x)}
\]

\[
H(S_{\text{TECHNICAL}}) = - \left( \frac{4}{15} \right) \log_2 \left( \frac{4}{15} \right) - \left( \frac{11}{15} \right) \log_2 \left( \frac{11}{15} \right) = 0.8365
\]

\[
H(S_{\text{NON-TECHNICAL}}) = - \left( \frac{11}{15} \right) \log_2 \left( \frac{11}{15} \right) - \left( \frac{4}{15} \right) \log_2 \left( \frac{4}{15} \right) = 0.8365
\]

Therefore

\[
IG(S_{\text{LABOURS}}) = H(s) - \sum_{i=0}^{n} p(x_i) \times H(x_i)
\]

\[
IG(S_{\text{LABOURS}}) = H(s) - p(S_{\text{TECHNICAL}}) \times H(S_{\text{NON-TECHNICAL}}) - p(S_{\text{TECHNICAL}}) \times H(S_{\text{NON-TECHNICAL}})
\]

\[
IG(S_{\text{LABOURS}}) = 1.8891 - \left( \frac{4}{15} \right) \times (0.8365) - \left( \frac{11}{15} \right) \times (0.8365)
\]

\[
IG(S_{\text{LABOURS}}) = 1.0525
\]

**1.5.5 HARVESTING COST**

Cost required to harvest a crop in pre and post harvest.

<table>
<thead>
<tr>
<th>PRE HARVEST</th>
<th>POST HARVEST</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>7</td>
<td>15</td>
</tr>
</tbody>
</table>

\[
P(S_{\text{PRE-HARVEST}}) = \frac{8}{15}
\]

\[
P(S_{\text{POST-HARVEST}}) = \frac{7}{15}
\]

\[
H(s) = \sum_{x \in X} p(x) \log_2 \frac{1}{p(x)}
\]

\[
H(S_{\text{PRE-HARVEST}}) = - \left( \frac{8}{15} \right) \log_2 \left( \frac{8}{15} \right) - \left( \frac{7}{15} \right) \log_2 \left( \frac{7}{15} \right) = 0.9967
\]

\[
H(S_{\text{POST-HARVEST}}) = - \left( \frac{7}{15} \right) \log_2 \left( \frac{7}{15} \right) - \left( \frac{8}{15} \right) \log_2 \left( \frac{8}{15} \right) = 0.9967
\]

Therefore

\[
IG(S_{\text{HARVESTING COST}}) = H(s) - \sum_{i=0}^{n} p(x_i) \times H(x_i)
\]

\[
IG(S_{\text{HARVESTING COST}}) = H(s) - p(S_{\text{PRE-HARVEST}}) \times H(S_{\text{PRE-HARVEST}}) - p(S_{\text{POST-HARVEST}}) \times H(S_{\text{POST-HARVEST}})
\]

\[
IG(S_{\text{HARVESTING COST}}) = 1.8891 - \left( \frac{8}{15} \right) \times (0.9967) - \left( \frac{7}{15} \right) \times (0.9967)
\]

\[
IG(S_{\text{HARVESTING COST}}) = 0.8924
\]

**1.5.6 TECHNOLOGY**

Using technology the harvest and the cost of production is calculated.

<table>
<thead>
<tr>
<th>HIGH HARVEST LOW COST</th>
<th>LOW HARVEST HIGH COST</th>
<th>HIGH HARVEST HIGH COST</th>
<th>LOW HARVEST LOW COST</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>2</td>
<td>5</td>
<td>2</td>
<td>15 RESPONDENTS</td>
</tr>
</tbody>
</table>
\[ P(S_{HH,LC}) = \frac{6}{15} \]
\[ P(S_{LH,HC}) = \frac{2}{15} \]
\[ P(S_{HH,HC}) = \frac{5}{15} \]
\[ P(S_{LL,LC}) = \frac{2}{15} \]

\[ H(s) = \sum_{x \in \mathcal{X}} p(x) \log_2 \left( \frac{1}{p(x)} \right) \]
\[ H(S_{HH,LC}) = - \left( \frac{6}{15} \right) \log_2 \left( \frac{6}{15} \right) - \left( \frac{9}{15} \right) \log_2 \left( \frac{9}{15} \right) = 0.9703 \]
\[ H(S_{LH,HC}) = - \left( \frac{2}{15} \right) \log_2 \left( \frac{2}{15} \right) - \left( \frac{10}{15} \right) \log_2 \left( \frac{10}{15} \right) = 0.5664 \]
\[ H(S_{HH,HC}) = - \left( \frac{5}{15} \right) \log_2 \left( \frac{5}{15} \right) - \left( \frac{10}{15} \right) \log_2 \left( \frac{10}{15} \right) = 0.9182 \]
\[ H(S_{LL,LC}) = - \left( \frac{2}{15} \right) \log_2 \left( \frac{2}{15} \right) - \left( \frac{10}{15} \right) \log_2 \left( \frac{10}{15} \right) = 0.5664 \]
Therefore
\[ IG(S_{TECHNOLOGY}) = H(s) - \sum_{x \in \mathcal{X}} p(x) \times H(x) \]
\[ IG(S_{TECHNOLOGY}) = H(S_{HH,LC}) + H(S_{LH,HC}) + H(S_{HH,HC}) + H(S_{LL,LC}) \]
\[ IG(S_{TECHNOLOGY}) = 1.8891 - \left( \frac{6}{15} \right) \times (0.9703) - \left( \frac{2}{15} \right) \times (0.5664) - \left( \frac{5}{15} \right) \times (0.9182) - \left( \frac{2}{15} \right) \times (0.5664) \]
\[ IG(S_{TECHNOLOGY}) = 1.4028 \]

1.5.7 VEHICLE CAPACITY

Capacity of vehicles to carry the product

<table>
<thead>
<tr>
<th>HIGH CAPACITY</th>
<th>MEDIUM CAPACITY</th>
<th>LOW CAPACITY</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>4</td>
<td>3</td>
<td>15 TONNES</td>
</tr>
</tbody>
</table>

\[ P(S_{HC}) = \frac{8}{15} \]
\[ P(S_{MC}) = \frac{4}{15} \]
\[ P(S_{LC}) = \frac{3}{15} \]

\[ H(s) = \sum_{x \in \mathcal{X}} p(x) \log_2 \left( \frac{1}{p(x)} \right) \]
\[ H(S_{HC}) = - \left( \frac{8}{15} \right) \log_2 \left( \frac{8}{15} \right) - \left( \frac{7}{15} \right) \log_2 \left( \frac{7}{15} \right) = 0.9967 \]
\[ H(S_{MC}) = - \left( \frac{4}{15} \right) \log_2 \left( \frac{4}{15} \right) - \left( \frac{11}{15} \right) \log_2 \left( \frac{11}{15} \right) = 0.8365 \]
\[ H(S_{LC}) = - \left( \frac{2}{15} \right) \log_2 \left( \frac{2}{15} \right) - \left( \frac{12}{15} \right) \log_2 \left( \frac{12}{15} \right) = 0.7219 \]
Therefore
\[ IG(S_{VEHICLE CAPACITY}) = H(s) - \sum_{x \in \mathcal{X}} p(x) \times H(x) \]
\[ IG(S_{VEHICLE CAPACITY}) = H(S_{HC}) + H(S_{MC}) + H(S_{LC}) \]
\[ IG(S_{VEHICLE CAPACITY}) = 1.8891 - \left( \frac{8}{15} \right) \times (0.9967) - \left( \frac{4}{15} \right) \times (0.8365) - \left( \frac{2}{15} \right) \times (0.7219) \]
\[ IG(S_{VEHICLE CAPACITY}) = 0.99008 \]

STEP6:
\[ IG(S_{TECHNOLOGY}) = \text{HIGHEST INFORMATION GAIN} \]
STEP 7:
Repeat until we run out of all attributes, or the decision tree has all leaf nodes.

1.7.1 TECHNOLOGY

1.7.1.1 HIGH HARVEST LOW COST
Using technology, the production which is done at the high harvest with low cost

<table>
<thead>
<tr>
<th>YES</th>
<th>NO</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>2</td>
<td>10</td>
</tr>
</tbody>
</table>

\[ H(S_{HHLC}) = - \left( \frac{8}{10} \right) \log_2 \left( \frac{8}{10} \right) - \left( \frac{2}{10} \right) \log_2 \left( \frac{2}{10} \right) \]

\[ H(S_{HHLC}) = 0.7219 \]

1.7.1.2 HIGH HARVEST HIGH COST
Using the technology the production which is done with the high harvest and high cost

<table>
<thead>
<tr>
<th>YES</th>
<th>NO</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>8</td>
<td>10</td>
</tr>
</tbody>
</table>

\[ H(S_{HHHC}) = - \left( \frac{2}{10} \right) \log_2 \left( \frac{2}{10} \right) - \left( \frac{8}{10} \right) \log_2 \left( \frac{8}{10} \right) \]

\[ H(S_{HHHC}) = 0.7219 \]

1.7.1.3 LOW HARVEST HIGH COST
Using technology the production which is done with low harvest and high cost

<table>
<thead>
<tr>
<th>YES</th>
<th>NO</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>3</td>
<td>10</td>
</tr>
</tbody>
</table>

\[ H(S_{LHHC}) = - \left( \frac{7}{10} \right) \log_2 \left( \frac{7}{10} \right) - \left( \frac{3}{10} \right) \log_2 \left( \frac{3}{10} \right) \]

\[ H(S_{LHHC}) = 0.8812 \]

1.7.1.4 LOW HARVEST LOW COST
Using the technology he production which is done with low harvest low cost
YES | NO | TOTAL
---|---|---
1 | 9 | 10

\[ H(S_{LHLC}) = - \left( \frac{1}{10} \right) \log_2 \left( \frac{1}{10} \right) - \left( \frac{9}{10} \right) \log_2 \left( \frac{9}{10} \right) \]

\[ H(S_{LHLC}) = 0.4689 \]

**ID3 FOR VEGETABLES**

**STEP 4: calculate Entropy H(s)**

2.4.1 profit

Assuming for 1 acres in one yield

| VERY HIGH PROFIT | HIGH PROFIT | MEDIUM PROFIT | LOW PROFIT | TOTAL |
---|---|---|---|---|
2 Lakhs | 1.5 lakhs | 1 lakhs | 0.5 lakhs | 5 lakhs |

\[ H(s) = \sum_{x \in X} p(x) \log_2 \frac{1}{p(x)} \]

\[ H(s) = - \left( \frac{2}{5} \right) \log_2 \left( \frac{2}{5} \right) - \left( \frac{1.5}{5} \right) \log_2 \left( \frac{1.5}{5} \right) - \left( \frac{1}{5} \right) \log_2 \left( \frac{1}{5} \right) - \left( \frac{0.5}{5} \right) \log_2 \left( \frac{0.5}{5} \right) \]

\[ H(s) = 1.8463 \]

**STEP 5 : For each attribute, calculate the entropy with respect to the attribute 'x' denoted by H(S, x)**

1.5.1 **TIME**

Number of vehicles reached the destination in correct duration

| LOW TIME | MEDIUM TIME | MAXIMUM TIME | WORST CONDITION | TOTAL |
---|---|---|---|---|
8 | 6 | 4 | 2 | 20 VEHICLES |

\[ P(S_{LT}) = \frac{8}{20} \]

\[ P(S_{MET}) = \frac{6}{20} \]

\[ P(S_{MXT}) = \frac{4}{20} \]

\[ P(S_{WC}) = \frac{2}{20} \]

\[ H(s) = \sum_{x \in X} p(x) \log_2 \frac{1}{p(x)} \]

\[ H(S_{LT}) = - \left( \frac{8}{20} \right) \log_2 \left( \frac{8}{20} \right) - \left( \frac{12}{20} \right) \log_2 \left( \frac{12}{20} \right) = 0.9709 \]

\[ H(S_{WC}) = - \left( \frac{6}{20} \right) \log_2 \left( \frac{6}{20} \right) - \left( \frac{14}{20} \right) \log_2 \left( \frac{14}{20} \right) = 0.8812 \]
\[ H(S_{\text{MXT}}) = -\left(\frac{4}{20}\right) \log_2 \left(\frac{4}{20}\right) - \left(\frac{16}{20}\right) \log_2 \left(\frac{16}{20}\right) = 0.7219 \]
\[ H(S_{\text{MET}}) = -\left(\frac{2}{20}\right) \log_2 \left(\frac{2}{20}\right) - \left(\frac{18}{20}\right) \log_2 \left(\frac{18}{20}\right) = 0.4689 \]

Therefore
\[
IG(S_{\text{TIME}}) = H(s) - \sum_{i=0}^{n} p(x) \times H(x)
\]
\[
IG(S_{\text{TIME}}) = H(s) - p(S_{\text{LT}}) \times H(S_{\text{LT}}) - p(S_{\text{MXT}}) \times H(S_{\text{MXT}}) - p(S_{\text{MET}}) \times H(S_{\text{MET}}) - p(S_{\text{WC}}) \times H(S_{\text{WC}})
\]
\[
IG(S_{\text{TIME}}) = 1.8463 - \left(\frac{8}{20}\right) \times (0.9709) - \left(\frac{6}{20}\right) \times (0.8812) - \left(\frac{4}{20}\right) \times (0.7219) - \left(\frac{2}{20}\right) \times (0.4689)
\]
\[
IG(S_{\text{TIME}}) = 0.96667
\]

1.5.2 TEMPERATURE

Temperature maintained by the number of vehicles.

<table>
<thead>
<tr>
<th>HIGH TEMPERATURE VEHICLES</th>
<th>MEDIUM TEMPERATURE VEHICLES</th>
<th>LOW TEMPERATURE VEHICLES</th>
<th>TOTAL VEHICLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>4</td>
<td>6</td>
<td>15</td>
</tr>
</tbody>
</table>

\[ P(S_{\text{HT}}) = \frac{5}{15} \]
\[ P(S_{\text{MET}}) = \frac{4}{15} \]
\[ P(S_{\text{LT}}) = \frac{6}{15} \]

\[ H(s) = \sum_{x \in x} p(x) \log_2 \frac{1}{p(x)} \]
\[ H(S_{\text{HT}}) = -\left(\frac{5}{15}\right) \log_2 \left(\frac{5}{15}\right) - \left(\frac{10}{15}\right) \log_2 \left(\frac{10}{15}\right) = 0.9182 \]
\[ H(S_{\text{MET}}) = -\left(\frac{4}{15}\right) \log_2 \left(\frac{4}{15}\right) - \left(\frac{11}{15}\right) \log_2 \left(\frac{11}{15}\right) = 0.8366 \]
\[ H(S_{\text{LT}}) = -\left(\frac{6}{15}\right) \log_2 \left(\frac{6}{15}\right) - \left(\frac{9}{15}\right) \log_2 \left(\frac{9}{15}\right) = 0.9709 \]

Therefore
\[
IG(S_{\text{TEMPERATURE}}) = H(s) - \sum_{i=0}^{n} p(x) \times H(x)
\]
\[
IG(S_{\text{TEMPERATURE}}) = H(s) - p(S_{\text{HT}}) \times H(S_{\text{HT}}) - p(S_{\text{MET}}) \times H(S_{\text{MET}}) - p(S_{\text{LT}}) \times H(S_{\text{LT}})
\]
\[
IG(S_{\text{TEMPERATURE}}) = 1.8463 - \left(\frac{5}{15}\right) \times (0.9182) - \left(\frac{4}{15}\right) \times (0.8366) - \left(\frac{6}{15}\right) \times (0.9709)
\]
\[
IG(S_{\text{TEMPERATURE}}) = 0.92878
\]

1.5.3 QUANTITY

Maximum production of one yield

<table>
<thead>
<tr>
<th>HIGH QUANTITY VEHICLES</th>
<th>MEDIUM QUANTITY VEHICLES</th>
<th>LOW QUANTITY VEHICLES</th>
<th>TOTAL VEHICLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>3</td>
<td>5</td>
<td>15</td>
</tr>
</tbody>
</table>

\[ P(S_{\text{HQ}}) = \frac{7}{15} \]
\[ P(S_{\text{MEQ}}) = \frac{3}{15} \]
\[ P(S_{\text{LO}}) = \frac{5}{15} \]

\[ H(s) = \sum_{x \in x} p(x) \log_2 \frac{1}{p(x)} \]
\[ H(S_{\text{HQ}}) = -\left(\frac{7}{15}\right) \log_2 \left(\frac{7}{15}\right) - \left(\frac{8}{15}\right) \log_2 \left(\frac{8}{15}\right) = 0.99967 \]
\[ H(S_{\text{MEQ}}) = -\left(\frac{4}{15}\right) \log_2 \left(\frac{4}{15}\right) - \left(\frac{12}{15}\right) \log_2 \left(\frac{12}{15}\right) = 0.7219 \]
\[ H(S_{\text{LOW}}) = -\left(\frac{3}{15}\right) \log_2 \left(\frac{3}{15}\right) - \left(\frac{10}{15}\right) \log_2 \left(\frac{10}{15}\right) = 0.9182 \]

Therefore
IG(S_{QUANTITY}) = H(s) - \sum_{i=0}^{n} p(x) \times H(x)

IG(S_{QUANTITY}) = H(s) - p(S_{HQ}) \times H(S_{HQ}) - p(S_{MEQ}) \times H(S_{MEQ}) - p(S_{LO}) \times H(S_{LO})

IG(S_{QUANTITY}) = 1.8463 - \left( \frac{1}{15} \right) \times (0.9967) - \left( \frac{1}{15} \right) \times (0.7219) - \left( \frac{3}{15} \right) \times (0.9182)

IG(S_{QUANTITY}) = 0.9307

1.5.4 LABOURS

Labours required for one acre of production

<table>
<thead>
<tr>
<th>TECHNICAL</th>
<th>NON-TECHNICAL</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>12</td>
<td>20</td>
</tr>
</tbody>
</table>

P(S_{TECHNICAL}) = \frac{8}{20}
P(S_{NON-TECHNICAL}) = \frac{12}{20}

H(s) = \sum_{x\in X} p(x) \log_2 \frac{1}{p(x)}

H(S_{TECHNICAL}) = - \left( \frac{8}{20} \right) \log_2 \left( \frac{8}{20} \right) - \left( \frac{12}{20} \right) \log_2 \left( \frac{12}{20} \right) = 0.9709

H(S_{NON-TECHNICAL}) = - \left( \frac{12}{20} \right) \log_2 \left( \frac{12}{20} \right) - \left( \frac{8}{20} \right) \log_2 \left( \frac{8}{20} \right) = 0.9709

Therefore

IG(S_{LABOURS}) = H(s) - \sum_{i=0}^{n} p(x) \times H(x)

IG(S_{LABOURS}) = H(s) - p(S_{TECHNICAL}) \times H(S_{NON-TECHNICAL}) - p(S_{TECHNICAL}) \times H(S_{NON-TECHNICAL})

IG(S_{LABOURS}) = 1.8463 - \left( \frac{8}{20} \right) \times (0.9709) - \left( \frac{12}{20} \right) \times (0.9709)

IG(S_{LABOURS}) = 0.8754

1.5.5 HARVESTING COST

Cost required to harvest a crop in pre and post harvest.

<table>
<thead>
<tr>
<th>PRE HARVEST</th>
<th>POST HARVEST</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

P(S_{PRE-HARVEST}) = \frac{1}{2}
P(S_{POST-HARVEST}) = \frac{1}{2}

H(s) = \sum_{x\in X} p(x) \log_2 \frac{1}{p(x)}

H(S_{PRE-HARVEST}) = - \left( \frac{1}{2} \right) \log_2 \left( \frac{1}{2} \right) - \left( \frac{1}{2} \right) \log_2 \left( \frac{1}{2} \right) = 1

H(S_{POST-HARVEST}) = - \left( \frac{1}{2} \right) \log_2 \left( \frac{1}{2} \right) - \left( \frac{1}{2} \right) \log_2 \left( \frac{1}{2} \right) = 1

Therefore

IG(S_{HARVESTING COST}) = H(s) - \sum_{i=0}^{n} p(x) \times H(x)

IG(S_{HARVESTING COST}) = H(s) - p(S_{PRE-HARVEST}) \times H(S_{PRE-HARVEST}) - p(S_{POST-HARVEST}) \times H(S_{POST-HARVEST})

IG(S_{HARVESTING COST}) = 1.8463 - \left( \frac{1}{2} \right) \times (1) - \left( \frac{1}{2} \right) \times (1)

IG(S_{HARVESTING COST}) = 0.8463
1.5.6 TECHNOLOGY

Using technology the harvest and the cost of production is calculated.

<table>
<thead>
<tr>
<th>HIGH HARVEST</th>
<th>LOW HARVEST</th>
<th>HIGH HARVEST</th>
<th>LOW HARVEST</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOW COST</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>HIGH HARVEST</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>8</td>
</tr>
</tbody>
</table>

P(S_{HH, LC}) = \frac{2}{8}

P(S_{LH, HC}) = \frac{2}{8}

P(S_{HH, HC}) = \frac{3}{8}

P(S_{LH, LC}) = \frac{1}{8}

H(s) = \sum_{x} p(x) \log_e \frac{1}{p(x)}

H(S_{HH, LC}) = -\left(\frac{2}{8}\right) \log_2 \left(\frac{2}{8}\right) - \left(\frac{3}{8}\right) \log_2 \left(\frac{3}{8}\right) = 0.8112

H(S_{LH, HC}) = -\left(\frac{2}{8}\right) \log_2 \left(\frac{2}{8}\right) - \left(\frac{3}{8}\right) \log_2 \left(\frac{3}{8}\right) = 0.8112

H(S_{HH, HC}) = -\left(\frac{3}{8}\right) \log_2 \left(\frac{3}{8}\right) - \left(\frac{2}{8}\right) \log_2 \left(\frac{2}{8}\right) = 0.9544

H(S_{LH, LC}) = -\left(\frac{1}{8}\right) \log_2 \left(\frac{1}{8}\right) - \left(\frac{2}{8}\right) \log_2 \left(\frac{2}{8}\right) = 0.5435

\therefore \text{IG(S}_\text{TECHNOLOGY} = H(s) - \sum_{x} p(x) \times H(x)

IG(S_{TECHNOLOGY}) = 1.0148

1.5.7 VEHICLE CAPACITY

Capacity of vehicles to carry the product

<table>
<thead>
<tr>
<th>HIGH CAPACITY</th>
<th>MEDIUM CAPACITY</th>
<th>LOW CAPACITY</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>4</td>
<td>3</td>
<td>15</td>
</tr>
</tbody>
</table>

P(S_{HC}) = \frac{8}{15}

P(S_{MC}) = \frac{4}{15}

P(S_{LC}) = \frac{1}{15}

H(s) = \sum_{x} p(x) \log_e \frac{1}{p(x)}

H(S_{HC}) = -\left(\frac{8}{15}\right) \log_2 \left(\frac{8}{15}\right) - \left(\frac{7}{15}\right) \log_2 \left(\frac{7}{15}\right) = 0.9967

H(S_{MC}) = -\left(\frac{4}{15}\right) \log_2 \left(\frac{4}{15}\right) - \left(\frac{12}{15}\right) \log_2 \left(\frac{12}{15}\right) = 0.8365

H(S_{LC}) = -\left(\frac{1}{15}\right) \log_2 \left(\frac{1}{15}\right) - \left(\frac{12}{15}\right) \log_2 \left(\frac{12}{15}\right) = 0.7219

IG(S_{VEHICLE \ CAPACITY}) = H(s) - \sum_{x} p(x) \times H(x)

IG(S_{VEHICLE \ CAPACITY}) = H(s) - p(s_{HC}) \times H(S_{HC}) - p(s_{MC}) \times H(S_{MC}) - p(s_{LC}) \times H(S_{LC})
IG(S\text{VEHICLE CAPACITY}) = 1.8463 - \left( \frac{8}{15} \right) \times (0.9967) - \left( \frac{4}{15} \right) \times (0.8365) - \left( \frac{3}{15} \right) \times (0.7219)

IG(S\text{VEHICLE CAPACITY}) = 0.94728

STEP 6:
IG(S, \text{TECHNOLOGY}) = HIGHEST INFORMATION GAIN

STEP 7:
Repeat until we run out of all attributes, or the decision tree has all leaf nodes.

1.7.1 TECHNOLOGY

HIGH HARVEST, LOW COST
YES NO
LOW HARVEST, HIGH COST
YES NO
HIGH HARVEST, HIGH COST
YES NO
LOW HARVEST, LOW COST
YES NO

1.7.1.1 HIGH HARVEST LOW COST

Using technology, the production which is done at the high harvest with low cost

<table>
<thead>
<tr>
<th>YES</th>
<th>NO</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>2</td>
<td>10</td>
</tr>
</tbody>
</table>

H(S_{HHLC}) = - \left( \frac{8}{10} \right) \log_2 \left( \frac{8}{10} \right) - \left( \frac{2}{10} \right) \log_2 \left( \frac{2}{10} \right)

H(S_{HHLC}) = 0.7219

1.7.1.2 HIGH HARVEST HIGH COST

Using the technology the production which is done with the high harvest and high cost

<table>
<thead>
<tr>
<th>YES</th>
<th>NO</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>8</td>
<td>10</td>
</tr>
</tbody>
</table>

H(S_{HHHC}) = - \left( \frac{2}{10} \right) \log_2 \left( \frac{2}{10} \right) - \left( \frac{8}{10} \right) \log_2 \left( \frac{8}{10} \right)

H(S_{HHHC}) = 0.7219

1.7.1.3 LOW HARVEST HIGH COST

Using technology the production which is done with low harvest and high cost

<table>
<thead>
<tr>
<th>YES</th>
<th>NO</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>3</td>
<td>10</td>
</tr>
</tbody>
</table>

H(S_{LHHC}) = - \left( \frac{7}{10} \right) \log_2 \left( \frac{7}{10} \right) - \left( \frac{3}{10} \right) \log_2 \left( \frac{3}{10} \right)

H(S_{LHHC}) = 0.8812
1.7.1.4 LOW HARVEST LOW COST

Using the technology he production which is done with low harvest low cost

<table>
<thead>
<tr>
<th></th>
<th>YES</th>
<th>NO</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>9</td>
<td></td>
</tr>
</tbody>
</table>

\[ H(S_{\text{LHLC}}) = - \left( \frac{1}{10} \right) \log_2 \left( \frac{1}{10} \right) - \left( \frac{9}{10} \right) \log_2 \left( \frac{9}{10} \right) \]

\[ H(S_{\text{LHLC}}) = 0.4689 \]

FINDINGS AND CONCLUSION

Agri-products are one of the most perishable products in which the technology has to be developed and should make a great sense in which this industry is one of the back bone industry for India. This industry cannot be made like the other industry hence the products are perishable and makes a huge loss for the Indian economy in which the government also can take steps to make the industry grow bigger with the new technologies both in the harvesting and the logistics so that the work as well as the risk and handling of products can be made easier in which the product also can have its durability for a greater while. While the technology in logistics plays the vital role in the agri products like choosing the right logistics both in the terrain and the hilly terrain area makes the product to reach with the better quantity and the better time in the distribution agri products. Since there are other algorithms even they can be used for the better and accurate outcomes.

REFERENCES


[6] apeda.gov.in/