**Supplementary Material 1:** Features for determining the sugarcane yield

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| No. | Feature | Unit | Type | Description |
| 1 | Area | Ha | Numeric | A scalar quantity that shows the plant area. |
| 2 | Planting Period | A/B | Categorical | Sugarcane planting age, where A shows the planting period in the 1st & 2nd week while B shows the 3rd & 4th week of the current month. |
| 3 | Varieties | - | Categorical | Groups of sugarcane plants with different characteristics and properties. |
| 4 | Total soluble solid (°Brix) | % | Numeric | Dissolved solids in a liquid used to estimate the sugar content of an aqueous solution. |
| 5 | Polarization value (Pol) | % | Numeric | Sucrose content |
| 6 | Purity | % | Numeric | The figure indicates the sap purity level in the sugarcane processing sector. |
| 7 | Clear Juice | % | Numeric | The first or initial sugarcane juice milling. |
| 8 | Maturity Factor | % | Numeric | Sugarcane maturity level indicator that determines optimal harvest time |
| 9 | Coefficient of improvement | % | Numeric | An indicator that shows the potential increase in sugar content in sugarcane stem after a certain period of time. |
| 10 | Coefficient of resistance | % | Numeric | An indicator that shows the ability of sugar cane to maintain its sugar content after a certain period. |

**Supplementary Material 2:** Features for productivity determination

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| No. | Feature | Unit | Type | Description |
| 1 | Area | Ha | Numeric | A scalar quantity that shows the plant area. |
| 2 | Planting Period | A/B | Categorical | Sugarcane planting age, where A shows the planting period in the 1st & 2nd week while B shows the 3rd & 4th week of the current month. |
| 3 | Varieties | - | Categorical | Groups of sugarcane plants with different characteristics and properties. |
| 4 | NPK | kgs/Ha | Numeric | Nitrogen (N), phosphorus (P), and potassium (K) are the three primary macronutrients essential for plant growth. |
| 5 | ZA | kgs/Ha | Numeric | Provides nitrogen and sulfur that are essential for vegetative growth. |
| 6 | KCL | kgs/Ha | Numeric | Provides potassium, which is crucial for overall plant health, flowering, and fruit production. |
| 7 | Center to Center | m | Numeric | Distance between the midpoints of two adjacent sugarcane plants. |
| 8 | Juring Factor | m | Numeric | The percentage of land area planted with crops compared with the total land area, |
| 9 | Number of Stem Cells | pi | Numeric | Count the number of sugarcane stems within 1 m. |
| 10 | Stem Height | m | Numeric | Stem height was measured from the soil surface to the top ring or node before the shoot. |
| 11 | Stem Diameter | Cm | Numeric | The width of a sugarcane stem is calculated. |
| 12 | Stem Weight | Kgs | Numeric | Measuring the weight of the sugarcane stem per meter. |
| 13 | Rainfall | mm | Numeric | the volume of rain that falls and gathers in a location during a predetermined period |

**Supplementary Material 3:** Descriptive statistics of sugarcane yield before pre-processing

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Features** | **Sat.** | **N** | **Min.** | **Max.** | **Mean** | **Std. Deviation** |
| 1 | Area | Ha | 2,225 | 0.1 | 20 | 3.69 | 4.09 |
| 2 | Planting Period | - | 2,225 | - | - | - | - |
| 3 | Varieties | - | 2,225 | - | - | - | - |
| 4 | °Brix | % | 2,225 | 8.25 | 20.05 | 14.77 | 1.64 |
| 5 | Pol | % | 2,225 | 8.85 | 22.41 | 13.81 | 2.35 |
| 6 | Purity | % | 2,225 | 57.64 | 93.86 | 80.88 | 4.63 |
| 7 | Clear Juice | % | 2,225 | 6.26 | 19.11 | 11.64 | 1.81 |
| 8 | Maturity Factor | % | 2,225 | 19.43 | 91.19 | 46.24 | 9.06 |
| 9 | Coefficient of improvement | % | 1,335 | 77.72 | 162.09 | 114.29 | 10.86 |
| 10 | Coefficient of resistance | % | 1,335 | 0.00 | 127.28 | 106.84 | 6.26 |

**Supplementary Material 4:** Descriptive statistics of productivity before the preprocessing process

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Features** | **Sat.** | **N** | **Min.** | **Max.** | **Mean** | **Std. Deviation** |
| 1 | Area | Ha | 2,656 | 0.06 | 40.00 | 3.21 | 3.72 |
| 2 | Planting Period | A/B | 2,656 | - | - |  | - |
| 3 | Varieties | - | 2,656 | - | - |  | - |
| 4 | NPK | kgs/Ha | 2,656 | 200 | 700 | 463.29 | 150.87 |
| 5 | ZA | kgs/Ha | 2,656 | 600 | 1,000 | 780.20 | 174.45 |
| 6 | KCl | kgs/Ha | 1,099 | 100 | 100 | 100 | - |
| 7 | Center to Center | m | 2,656 | 1.10 | 1.15 | 1.11 | 0.02 |
| 8 | Juring Factor | m | 2,656 | 8,695.65 | 9,090.91 | 9,008.46 | 160.62 |
| 9 | Number of stem cells | m | 2,656 | 4.00 | 9.85 | 6.61 | 0.89 |
| 10 | Stem Height | m | 2,656 | 0.89 | 3.42 | 2.41 | 0.34 |
| 11 | Stem Diameter | cm | 2,652 | 1.06 | 3.65 | 2.41 | 0.20 |
| 12 | Stem Weight | Kgs | 2,656 | 0.30 | 0.78 | 0.45 | 0.07 |
| 13 | Rainfall | mm | 2,656 | 1,682 | 3,050 | 2,172,02 | 374.99 |

**Supplementary Material 5:** Descriptive statistics of sugarcane yield after pre-processing

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Features** | **Sat.** | **N** | **Min.** | **Max.** | **Mean** | **Std. Deviation** |
| 1 | Area | Ha | 2,225 | 0.1 | 20 | 3.69 | 4.09 |
| 2 | Planting Period | - | 2,225 | 0.00 | 7 | 4.07 | 1.73 |
| 3 | Varieties | - | 2,225 | 0.00 | 12 | 2.46 | 3.78 |
| 4 | °Brix | % | 2,225 | 8.25 | 20.05 | 14.77 | 1.64 |
| 5 | Pol | % | 2,225 | 8.85 | 22.41 | 13.81 | 2.35 |
| 6 | Purity | % | 2,225 | 57.64 | 93.86 | 80.88 | 4.63 |
| 7 | Clear Juice | % | 2,225 | 6.26 | 19.11 | 11.64 | 1.81 |
| 8 | Maturity Factor | % | 2,225 | 19.43 | 91.19 | 46.24 | 9.06 |

**Supplementary Material 6:** Descriptive statistics of productivity after pre-processing

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Features** | **Sat.** | **N** | **Min.** | **Max.** | **Mean** | **Std. Deviation** |
| 1 | Area | Ha | 2,656 | 0.06 | 40.00 | 3.21 | 3.72 |
| 2 | Planting Period | A/B | 2,656 | 0.00 | 15 | 7.29 | 3.38 |
| 3 | Varieties | - | 2,656 | 0.00 | 27 | 3.18 | 7.10 |
| 4 | NPK | kgs/Ha | 2,656 | 200 | 700 | 463.29 | 150.87 |
| 5 | ZA | kgs/Ha | 2,656 | 600 | 1,000 | 780.20 | 174.45 |
| 6 | Center to Center | m | 2,656 | 1.10 | 1.15 | 1.11 | 0.02 |
| 7 | Juring Factor | m | 2,656 | 8,695.65 | 9,090.91 | 9,008.46 | 160.62 |
| 8 | Number of stem cells | m | 2,656 | 4.00 | 9,85 | 6.61 | 0.89 |
| 9 | Stem Height | m | 2,656 | 0.89 | 3.42 | 2.41 | 0.34 |
| 10 | Stem Diameter | cm | 2,656 | 1.06 | 3.65 | 2.41 | 0.20 |
| 11 | Stem Weight | Kgs | 2,656 | 0.30 | 0.78 | 0.45 | 0.07 |
| 12 | Rainfall | mm | 2,656 | 1,682 | 3,050 | 2,172.02 | 374.99 |

**Supplementary Material 7:** Parameters and descriptions/values used

|  |  |  |
| --- | --- | --- |
| **Technique** | **Parameters** | **Descriptions/Values** |
| SVR | SVM kernel function | Polynomial |
| Cost (C)  Epsilon (ε)  Gamma (g)  Degree of the kernel (d) | 1.00  0.10  Auto  3.0 |
| RF | Number of trees (Ntree) | 10 |
| Do not split the subset size | 5 |

**Supplementary Material 8:** Flowchart of the current prediction method and machine learning

current process

Machine learning (ML) model

Prediction

Collected field observation data

Manual calculations

Delay

Data recap manual

Start

Dataset

Prediction

End

End