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SMART AND INTELLIGENT PRODUCTION STRATEGY FOR THE FLOWER MARKET USING DATA MINING KNOWLEDGE-BASED DECISION

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ABSTRACT

The agriculture industry has been an enormous economic pillar in the production and consumption market value chain. The agriculture industry resets flower production factors with the agricultural technology revolution. The fastest technology provides innovative and intelligent decision-making strategies in seasonal cut flowers to increase production. This study briefs out existing farming practices, chain activity and farming technology's significant impacts on the agriculture field and garden industry. Authors try to investigate cut flower production status and analyze production values to design innovative and intelligent strategies, especially for seasonal flower production. The study employs a flower dataset; hence, it applies floral parameter inputs and data mining association rules to create an output of the flower production category, which fits appropriately to evaluate flower market production value in a particular season. The article's result reveals that the proposed flower production strategy provides efficient and intelligent guidelines to increase flower production according to market demand. This study suggests an intelligent and friendly production strategy for gardeners that indicates the flower market gets continuous and quality production to meet consumers' immediate market demand.

INTRODUCTION

We, the people globally, can see agricultural evolutionary trends in society. A more updated policy for agriculture is called sustainable agriculture, demanding a change in traditional farming output. Once conventional agriculture caused harmful effects in the agricultural framework, farming sites went through awful aftermath decisions about crops. Now, the agricultural industry is looking forward to adopting sustainable police for modern farming practices.

The agricultural product market has an excellent contribution to sustainable management. Sustainable agriculture farming principles experienced in agricultural ecology integrate market production and supply units, according to Das et al. (2020). Agriculture has both positive and negative impacts on the economy and human civilization. To meet global food demand, agriculture practices should be modified in how producers practice to produce more food, as claimed by authors (Pierrette et al., 2021). Sustainable agricultural practices are urgently needed to be promoted in the world production industry. Among them, a few categories are mentioned, i.e., pest control, farming mechanization, nutrient management, natural agroforestry, and soil and water management to improve agricultural practices to achieve sustainable agriculture. Another article (Reganold et al., 1990) stated that once agriculture was worst envy in case to produce food with labour efficiency, then started to apply chemicals and fertilizers and improved with mechanization in contrary damaging soil fertility. Hence, conventional agriculture practices became industrialized and achieved sustainable goals for high production criteria. The Industrial Revolution significantly affected agriculture (Ane & Yasmin, 2019) and integrated technology with agriculture to develop agricultural farming principles. More powerful computing devices are connected to farming activities

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published in a review article (Pongnumkul et al., 2015), such as smartphones, because their mobility behaves with natural activity changes. Producers efficiently work in fields with smartphone applications that are user-friendly to apply in fieldwork. Sensor devices are embedded, such as motion sensors, environmental sensors and position sensors. These sensors provide force, surroundings, environment, and position measurements to smartphones through communication channels. Sensors in smartphones are used in farm work and activities.

However, more research has been found to keep sustainable agriculture by developing agronomic practices and improving food security through soil management. White et al. (2012) proposed that soil contains optimum mineral elements for living organisms and good soil management also ensures sufficient nutrients for organisms. Due to the global population, changing climate and market pressure (Wang et al., 2017) need to accelerate production in agriculture. Authors suggest agriculture immediately needs breeding crops with higher production. Hence, advanced genomic processes can make fast crop breeding. To improve both productivity and sustainability, application genomics in agriculture is a rapid requirement comparing the growth of the population. Then, agriculture experienced the application of nanotechnology (Sabir et al., 2014) in farming practice. Nanotechnology transforms conventional agriculture into a new form with emerging technology which spreads fertilizer and pesticides in controlled order and accelerates crop production to reach the target position, also reducing crop loss. The authors recommend adapting this technology to make sustainable agriculture management.

Besides, more engineering and I.C.T. technological practices have been conveyed in several farming activities. Engineering occurs in agricultural farming practices recorded in a few articles. Researchers (Mo et al., 2014) established the idea of reusing materials to create lightweight products and emphasized that many waste materials are used to produce productive output. Waste material can damage the sound environment made by industry and can be applied for further processing input. IoT and cloud computing-based technology are applicable in fixing farming challenges investigated by (Awan et al., 2021). IoT technology can track environment monitoring, having the ability to diagnose and control the agricultural environment. Technology and engineering make conventional farming practice intelligent farming. However, IoT-based agriculture protocol requires low energy and is more stable with solid network connectivity.

Furthermore, to improve agricultural products and value chains, researchers conducted sensor and ICT-based data analytic procedures to transform agriculture into knowledge-intensive production agriculture. Basnet and Bang (2018) reviewed the article and explained that industrial zone agriculture gets through small and large-scale production criteria. They also proposed that sensor fusion and wireless sensor networks can get more data insights that reduce single technology or sensor limitations. I.C.T. establishes value chain activity and adds commercial value to agriculture. To commercialize agricultural crop article (Kanwar & Kumar, 2008) responds to different cultural media.

Therefore, the modern gardening system follows technology-based information management system research conducted by (Wang et al., 2010) to help the urban garden management system and integrated decision-making platform for designing, planning, simulation and programming for garden management, including planting, seeding, harvesting, maintenance and monitoring, depending on technological processes. CAD (Computer-aided designing) developed for landscape gardening in a review article (Tiwari et al., 2016)—technology-designed CAD tools to create 2D and 3D gardening models using computer-specified software. Then, flower production in market demand became a vital research topic. Article (Prodhan et al., 2017) studied cut and seasonal flower production and found that gerbera flower is weather long-lasting, has a unique beauty and more demand in the flower market—tissue culture for gerbera proposed by (Navya et al. 2017). Also, I.C.T., cloud computing, and switching technology emerged in farming activities to shift practices towards modern farming cultures. Cloud computing client-server technology directs agriculture in future generations (Abbasi et al., 2019) since data generated from plants or soils are heterogeneous, and an enormous amount needs to be connected by cloud applications for sustainable agriculture. IoT and I.C.T. are ample support duration for rural Viet Nam, presented by Kaila and Tarp (2019), internet access and agricultural production that could be used for efficient agrarian applications. Band and Ingole (2019) proposed innovative solar pump-switching technology for farming activities.

Studies covered flower gardening, IoT impacts on gardening, and thoughtful design planning for gardening conducted research by Rayhan and Rashid (2020) focus on gerbera flowers by horticulture dept. In Bangladesh, gerbera plots can be grown on all types of soil with moist conditions; another article (Giri & Beura, 2020) researched practices' effects on hybrid gerbera flowers. Agricultural IoT develops planning and design for innovative flower gardening (Jia, 2021). In the U.K., farm businesses adopt Internet technology for agricultural business production (Warren, 2004). In contrast, farmers are using internet technology in agricultural practices and related commercial companies with farming, business whereas farming results starkly compared to general agricultural business output. Near future agricultural practice will achieve online materials and suggestions for all sectors, statistics summary picked from Nepal and Bangladesh agriculturist graduates study (Ane & Nepa, 2021). Therefore, gardening on farms demands a smart production strategy. At the same time, gardeners may make intelligent planting decision just in time and apply industrial local and export market production plan to benefit economically by reducing manual labour gardening cost.

Therefore, this study's aim is to design innovative and intelligent production strategies for the flower market, suggesting that gardeners follow computer knowledge-based decisions in industrial flower production. Furthermore, production strategy helps flower producers to meet flower market demands with appropriate choices as well as enables them to verify different flower market cultures among the agriculture industrial community.

The paper is organized into several sections, such as an introduction briefing on the modern technological farming practice in the industry, technology development activity in gardening, and different research production scenarios for the flower gardens. Section of materials and methods, describe the proposed gardening strategy, flowchart steps discussion. The result and discussion section presents experimental output in graphics and production outcome aspects, and the conclusion section summarizes study findings, its limitations and future research applications.

MATERIALS AND METHODS

Flowchart Steps for Strategy

The following flowchart, figure 1, describes a proposed smart and intelligent working strategy for flower market production in a research experiment. The model takes flower specifications as input parameters, i.e., colour, bloom, growth, shape, size, and petal quality. Input data needs to be processed into information. To identify flower production categories K-NN data mining algorithm is designed to plot similar and dissimilar flower data into categories. Applied algorithms produce information from raw data facts—association rules in the data mining approach form knowledge for process application. Knowledge applications forward the data information to the decision stage. Decision value matches whether to market demand; then flowers are ready to supply unless there are further steps to follow for alternate decisions. Alternative decisions are iterative looping to generate knowledge since another decision is requested to meet the market. Therefore, the right decision depends on the current flower parameter. Model flowchart allows gardeners to decide about flower production based on data inputs and generated knowledge information. This automatic computer application decision helps the gardeners to predict which action to perform next.

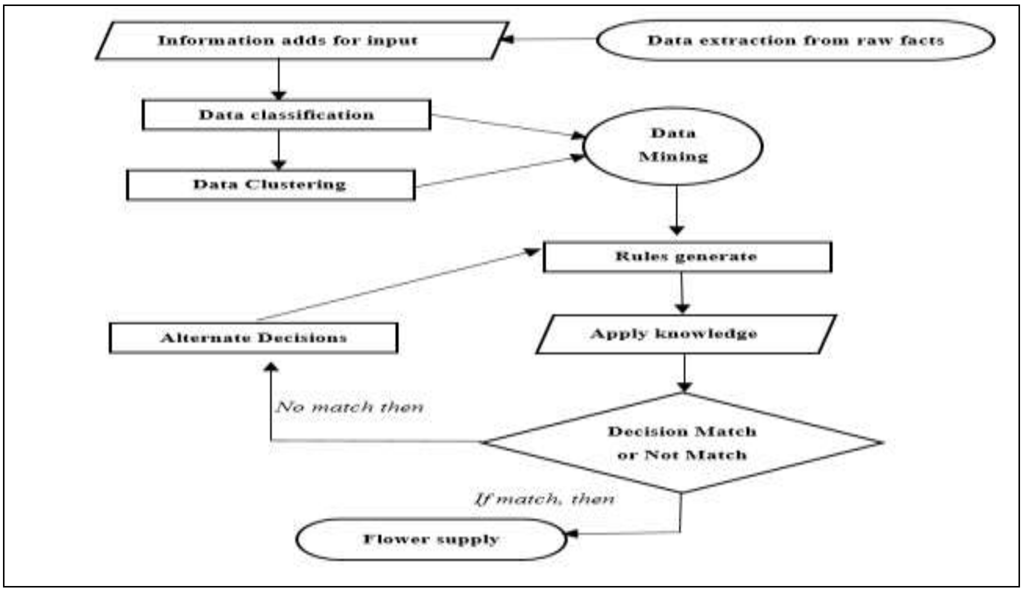

Figure 1. Flowchart for intelligent decision in flower production

Data Mining Algorithm

Data mining in flower agricultural enterprises creates immense opportunities to explore data and make a relationship form between necessary hidden patterns of data. A study (Milovic & Radojevic, 2015) carried out on data mining applications for agriculture and data mining finds rules from data to make decision patterns for unknown data objects. The k-NN algorithm is very closely planned for a prediction about flower classification because it does not require a training dataset before sorting. Then it can be easily classified into a few categories using the K- N.N. algorithm edited by Steinbach and Tan (2009). This article applied the K-NN data mining algorithm and designed an algorithm model for the study (Figure 2). The algorithm draws six categories for the flowers dataset. Each colour gerbera groups into flower types before separating the training and testing dataset. Binary classification is applied for decision control work described in the article (Bahel et al., 2020; Issac et al., 2021). The binary classification works on computer decision control applications, so we select a binary classifier for multi-class identification of the flowers dataset. That learns data classification to outcome decisions. Classifiers identify flowers in multi-class contains variables, i.e., flowers dataset and levels like flowers in the multi-category.

```
begin,
    input: D; the whole flower dataset of training and test observation,
x; vector of sample attributes, y; independent data variable, L; set of
category used to label the data objects, d; distance between two
independent variables.
                    do loop for each data objects ε x, y
                        find distance d (x, y)
                            while(n-1); n=no. observation;
    output: Lx and Ly ε D, all data objects,
                        end.
```

Figure 2. K-NN algorithm applied for flower production strategy

To learn the data model, the whole dataset is divided into train and test datasets. The training dataset is organized, and the distance value is used to classify the test dataset into flower categories. Amont datapoints distance metrics (**d_t**) is calculated while **x** and **y** are variables of data points, **n** is the number of total observations, as following Euclidean distance equation1,

$$d_t(X,Y) = \sqrt{\sum_{i=0}^{n-1}(x_i - y_i)^2} \quad \ldots\ldots\ldots(1)$$

Computer Application for Decision Process

The Data Pre-processing steps of computer application for smart and intelligent production strategy is shown in Figure 3. Firstly, import the data libraries in the implementation file. The Flowers database containing flower parameters such as colour, petal quality, bloom time, and flower status needs to load in a computer execution file. Flower input dataset load in computer memory .cvs format. The dataset has 3000 entries with four data variables. In summer, autumn and winter, the flower growing rate is different, so the experiment accepts different range samples for observations in each seasonal output. Split the dataset for analyzing dataset into train and test data. Data mining algorithms applied for flower classification and association rules find knowledge-based rules for the outcome as a decision. Finally, computer decisions are graphically viewed by experts or gardeners to analyze market production decisions on flower gardening.

```
#import libraries
#importing dataset
#extract independent and dependent variables
#Splitting the dataset
    -training and
    -test set
#feature Scaling
    Standardization or Normalization
#predict testResult
#output the graphical view
            Confusion matrix or graphical view or dataSummary
```

Figure 3. Pre-processing steps for strategy

Association Rule in Data Mining

Association rules data mining plots independently different raw data that happens repeatedly within the extensive database. Data classification provides several categories where each class has similar samples, i.e., each category dataset matches or is closer to other categories.

Association rule was established, and the flower data sample showed a strong relationship. The association rule analyzes the whole dataset and classifies the dataset into category decide on flower production in three seasons. Defined rules for data occurrence numbers as counting support(s_d) and confidence(c_d) numbers for data observations by following equations expression2,

If X_{value} = { fn1,fn2,fn3,fn4} then {Y_{value}} …………..(2)

Analyzed data are observed to margin into support and confidence frequency numbers. Evaluation expression is measured as support count ($\mathbf{s_d}$) and confidence count ($\mathbf{c_d}$) occurrence. In contrast, data value occurrence is defined as $\boldsymbol{\sigma}$, the observation set is **n,** and the data variable is denoted as fn. The rule satisfies the following equation expressions: 3 and 4.

$\mathbf{s_d} = \sigma(\{fn_1, fn_2, fn_3, fn_4\}) \;/\; |n|$ ………………………..(3)

$\mathbf{c_d} = \sigma(fn_1, fn_2, fn_3, fn_4) \;/\; (fn_1, fn_2, fn_3)$ ………………(4)

Association rule data mining helps to define similar and dissimilar flower groups by observing frequently occurring patterns. This study makes information including rule1, rule2 and rule3. Information generates knowledge by analyzing flowers' different categories. Knowledge presents meaningful parameters that act as decision outcomes. The study developed three rules to construct information to establish knowledge and then come into production decisions. Each decision is applied to knowledge extracted from data information. Rules work, for instance, is following Figure 4.

Rule 1: *If gerbera cultivar is better petal quality and healthy flower then production system is 80%.*	Information: better petal quality and healthy flower Knowledge: Flowers are in demand Decision: production system is high
Rule 2: *If gerbera cultivar is good petal quality and healthy flower then production system upto 70%.*	Information: average petal quality and healthy flower Knowledge: Flowers unfit in market Decision: production system average
Rule 3: *If gerbera cultivar is poor petal quality and spot flower then production system under 50%.*	Information: poor petal quality and spot flower Knowledge: Good flowers not bloomed Decision: production system below the mark

Figure 4. Association rules data mining. Raw data is extracted to make information that constructs knowledge. A decision is made by computer applications based on knowledge working principle.

Research Area and Dataset

For design and experiment purposes, a gerbera flower garden is prepared. Three thousand survey data entries are primarily selected with six different colours. The detailed profile is listed in Figure 5. Gerbera garden area is located near Tangail district (beltiabari) in Dhaka division, Bangladesh. The garden land of 0.5 acres was prepared for gerbera plantation. Gerbera daisies (Gerbera jamesonii) are bright, colourful and seasonal cut flowers. Gerbera daisies have yellow, orange, pink, lavender and red and more plants are preferred for the flower market.

Figure 5. Six cultivars of gerbera daisies plant (a-f)

Garden Preparation and Management

The garden plant requires a bed height of 45 cm and width of 60 cm, i.e., on bed preparation, there are two flower planting rows: one plant to second plant horizontally space 37.5 cm and vertically 30 cm. We follow functional gardening plan management that requires an open ventilated playhouse; it takes sufficient light intensity from nature for cultivation, and following garden management practice ensures maximum output (Home et al., 2018; Maitra et al., 2020). Gerbera requires approximately 500 to 700 ml of water per plant daily. The soil of gerbera beds is to be kept moist, but excess water should be avoided. Thus, our gerbera garden is prepared with 2024 square metres of playhouse area with 3000 seeds for cultivation. The Gerbera plant bed is shown in Figure 6. The authors outline three different times for gerbera cultivation in Bangladesh perspective. Due to geographical diversion, data samples are collected at four-month intervals around the year. Gerbera is a three-year flower commercially cultivated in a garden. An average of 80-90 days is required to bloom after first plant cultivation. A recent year (March, 2022-February, 2023) was chosen to plant the gerbera flowers and collected data in 3 times (in winter, summer, autumn) of four-month intervals. So natural climate effects can be retrieved, and extracted data are stored in the flower dataset before 11 a.m. and in the evening before 6 p.m., the preferred time selected for gerbera harvesting.

Figure 6. Bed Preparation for Gerbera Cultivation under Polyhouse. Plants' bed height is 45 cm and width 60 cm; plants require spaces between horizontally 37.5 cm and vertically 30 cm.

RESULTS AND DISCUSSIONS

In the proposed strategy, attention must be drawn to ensure effective and quality number output rather than productive less number flower supply. The supportive, innovative application acts as farm guidance for monitoring flower plant production for the best outcome through the intelligent system; thus, gardeners are confident using intelligent strategy and application to understand computational market value and feel interested in innovative gardening. Data mining smart application for gerbera garden makes an innovative bridge between producers by adding additional skilled power to gardeners; figures 7, 8 and 9 show the proposed strategy output circumstances in summer, autumn and winter, respectively.

Winter record results show that flower status usually is growing, colourful blooming is peak value, and poor petal quality is equal to zero on the graph plane (figure 7). Graph point recommends that yellow and orange flowers have average growth, bright colour and a good number in production. The pink colour flower has dissimilarity from other coloured flowers. Pink gerbera flower condition is not good, and fragile flowers are blooming. Among plants, 300 flower plants are weak. Few are delay bloomed. Fifty plants have poor petal quality. Yellow, orange and pink gerbera plants are equal numbers in production units.

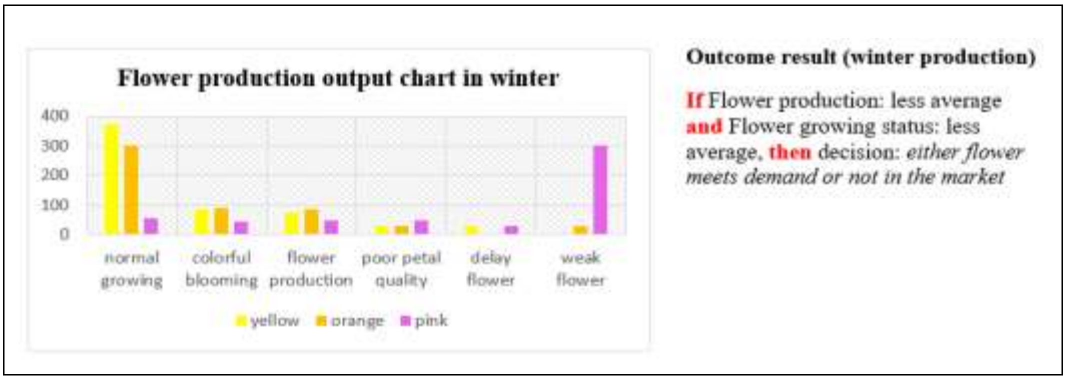

Figure 7. Production output and outcome flower decision in winter

Gerbera cultivars, i.e., pink, orange and yellow colours, are picked and experimented in winter environments. Yellow gerbera summarized that flowers have a good supply in market demand. No weak flowers are bloomed in season among the dataset. The highest flower stalks, usually with brightness, bloomed. Data mining applications decide if yellow gerbera can meet user demand by gerbera production, then decide any alternative decisions for orange or pink colour gerbera production and supply in the winter season. Gardeners may get production numbers and solutions to produce more yellow gerbera flowers. The outcome of the flower decision chart is shown in Figure 7.

Summer records in flower production say that harvesting time temperature is between 20-27^{0}c recorded. After winter results, most of the plants are not equal level to the experiment. Then, only 1500 gerbera flower plants are selected. There are also six different colours. Each plant is 250 for observations due to high temperatures in the summer March to June period considered for data surveying. Data sample orange, pink, and lavender flower plants combination is taken. Here, three colours of flowers are typically grown. Orange and pink colours are more bright and blooming than lavender gerbera. However, the lavender gerbera 135 plants are delayed to grow. All lavenders are good-quality petal flowers. Pink gerbera is better than the winter result. This time, orange, pink, and lavender gerbera plants are at average levels in production units—figure 8 shows a statistical view of summer flower decision.

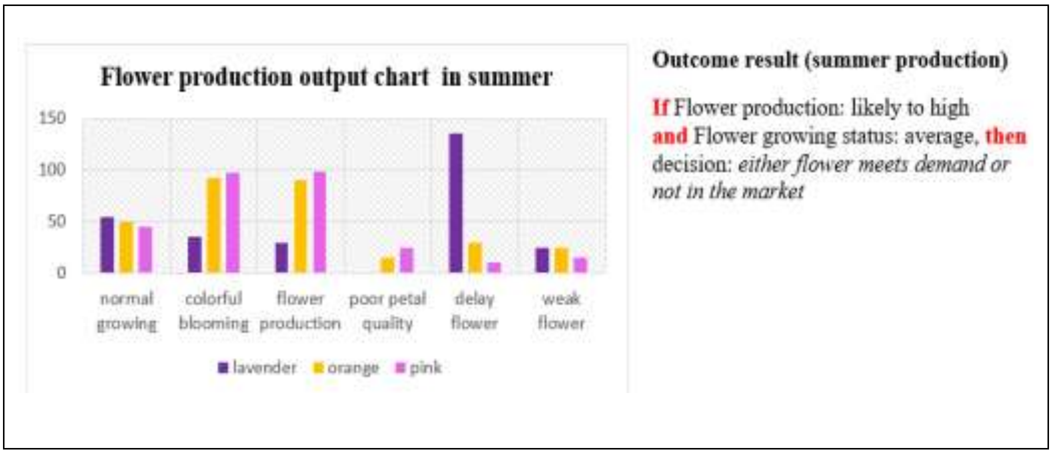

Figure 8. Production output and outcome flower decision in summer

Gerbera cultivars, i.e., orange, pink, and lavender colours, are picked and experimented with in summer environments. Pink gerbera summarized that flowers have less delayed blooming and poor petal quality. Large flower stalks production with brightness has average growth. Data mining applications decide whether pink gerbera can meet user demand by gerbera production, then decide any alternative decisions for orange or lavender colour gerbera production and supply high production in the summer season. Gardeners may get good production numbers and solutions to produce more pink gerbera flowers. The outcome flower decision chart is shown in Figure 8.

Survey result outcomes in autumn specify that four gerbera colour flowers, red, white, pink, and yellow combination, were measured for result analysis. Newly red and white are experimented and the rest, pink and yellow, are repeated colours in winter and summer. The majority of red is weak conditions. Others have a few poor petals and delayed flower growth. Average growing and bright flowers are less produced than the other two times. Figure 9 shows a statistical view of autumn flower decisions on the gerbera flower.

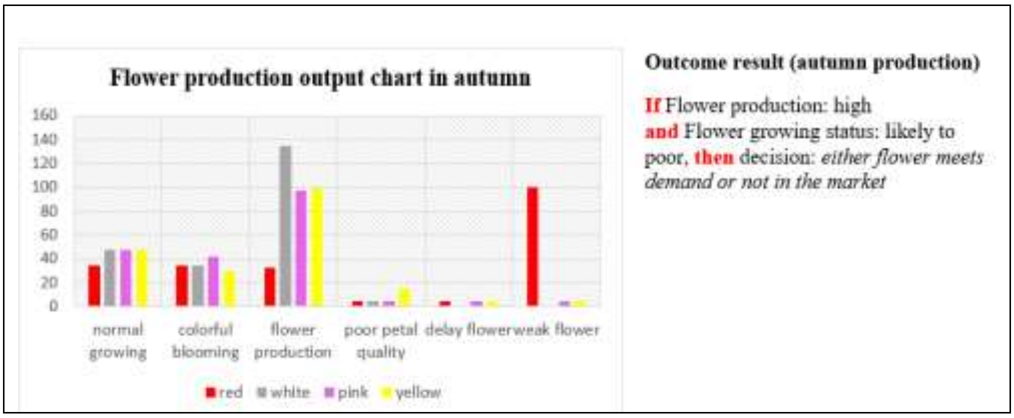

Figure 9. Production output and outcome flower decision in autumn

Gerbera cultivars i.e., red, white, pink and yellow colors, are picked and experimented in summer environments. Red gerbera summarized that flowers have less production performance in the season, large flower stalks are weak conditions, so demand for red colour is below the mark, and flowers have obstacles in normal growing, and flowers are not bright colours. Data mining applications decide in autumn; red gerbera production is no sound output, then any alternative decisions for white, pink and yellow colour gerbera production and supply in the autumn season. Gardeners may get production numbers and solutions to produce whiter, pink and yellow gerbera flowers. The outcomes flower decision graphical chart is shown in Figure 9.

CONCLUSION

In conclusion, it is a revolutionary time for gardeners' interest in flower agriculture to apply wise production decisions and intelligent flower plantation strategies. Flower market dimensions are changing in competitive market design, forwarding gardening concepts from village to urban areas; the authors proposed a thoughtful and intelligent production strategy for flower gardens that helps gardeners to apply knowledge-based decisions to reduce multiple bottlenecks in the flower market. Judgement would be brilliant to solve significant due to flower market threats and managing consumer demand in any complicated situation. The study has experimental limitations applied to flower garden datasets. Next, we will take actual market production data and design an A.I. (Artificial intelligence) interface with agricultural technology to predict smart flower production decisions that may apply to existing flower markets. Now is the right time for garden industrialization, when gardeners need good ideas for production and consumption. To meet growing flower plantation demand, innovative application in gardening is essential to boost quality production and proper supply in the market.

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