Design and construction of intelligent control system in processing steps of Flue-cured tobacco

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ABSTRACT: Tobacco curing is an important process for the flue cured tobacco production system. To get high quality and reduce the production costs, automatic control facilities are used to the curing process and many types of automatic controllers are currently available. As the labor cost increasing, it is essential to reduce the labor and the workload required in the curing process, reduce the fuel consumption and increase the benefits of the tobacco production. This study was carried out for design and construction of intelligent control system in processing steps of Flue-cured tobacco and in comparison with traditional method (manually) on quality characteristics, production and labor costs and save of time. This study was done in Tirtash Research and Education Center at 2010-2013 for the first time. Leaves were cured in 4 picks up and 2 treatments. The system has three cycles, manually, automatically and semi-automatically. The common tobacco curing process divided to four stages. Ability to monitor and control the various stages of tobacco processing. Hardware lock device has been processed to enhance safety, save information in memory courses, reaction to Update alarms defined, Send SMS to the failure of the fan and burner and etc. Results showed that Using of intelligent control system in processing steps of flue-cured tobacco, reduced number of labor, save of time (60-160 hours) and increased quality of tobacco (20-30%). The control system can be used to control the environmental parameters in the curing barns for various tobacco leaves. It has characters of convenience, high level of automation, high efficiency and low labor cost.

Key words: Flue-cured tobacco, intelligent control system, Design, construction

INTRODUCTION

Tobacco is a commercial crop in many countries like China, India, Brazil, United States, European Union, Zimbabwe, Indonesia, and etc because of its high economic value. Farmers will do grading based on the quality of the flue-cured tobacco leaves before taking them into a market. Quality inspection of the flue-cured tobacco leaves plays a crucial role in quality assurance, since the quality of the flue-cured tobacco leaves determines the quality of tobacco products (Guru et al., 2011). Tobacco curing is an important process for the flue cured tobacco production system. The quality of the cured tobacco leaves is subject to control process of the temperature and humidity in the curing barn. To get high quality and reduce the production costs, automatic control facilities are used to the curing process and many types of automatic controllers are currently available (chen et al., 2009). Automatic control technology has been widely used in industrial and agricultural production in world. For example, in the process of tobacco curing, the automatic control of the temperature and humidity in the barn solves the difficult in traditional curing process in which the temperature and humidity is not easy to control and the labor intensity is big. The applications of the bulk curing barns improve the production efficiency and increase the tobacco farmers’ incomes. However, the recent controllers for the bulk curing barns are labor dependent. Especially when the tobacco leaves to be cured are harvested in various maturity degrees and in various weathers, the required control process of the temperature and humidity in the curing barns varies. And various species of the tobacco leaves need various curing process. The controllers for the bulk curing barns can only control the temperature and humidity by the presetting curing phases. It cannot identify the features of the tobacco leaves to be cured and adaptively control the curing process. As a result, some curing specialists must be present to tutor the control process. That increases the workload and the labor cost for tobacco curing and the quality of the cured tobacco is subject to the specialists’ experiences (Larry, 2008). As the labor cost increasing, it is essential to reduce the labor and the workload required in the curing process, reduce the fuel consumption and increase the benefits of the tobacco production. To improve the automation level in tobacco curing process, many researchers have been done on the chemical process of the tobacco leaves in the curing process and the intelligent control and fuzzy control technologies are developed for automatically control the
curing process (Ihosvany et al., 2005; Zhao et al., 2006; Ma et al., 2007; Liu et al., 2009; Kang, 2009, Jian-Hui et al., 2014). However, in agricultural applications, actuation system for controlling agricultural facilities is also important to support farmers to get high productivity (Gonda & Cugnasca. 2006). In this study, an intelligent control system having local was developed to establish the optimal and temperature and humidity control in the barn of tobacco. The developed system was adopted for managing the curing system for flue cured tobacco cultivation in IRAN.

MATERIAL AND MEHTODS

In this study, an intelligent system controller tobacco processing was designed and built in Tirtash Research and Education Center, Iranian Tobacco Company with the following specifications: The control panel has Dimensions of 68 cm × 50 cm × 20 cm with three cycles, Manual, semi-automatic and automatic. Electricity of system was single-phase 220 V, 50 Hz and 11 Am. System has two parts, mechanical (curing chamber) and electrical (curing control system) sections.

Mechanical equipment

This section has a fan with a power air movement around 20,000 cubic meters per hour and a gas burner with a thermal capacity is 98,000 kcal. Fan and burner by wires connecting the intelligent control system.

Electrical equipment

This section has a cabinet (power and control) are designed internal components as follows: electronic components of intelligent control system, menu part, curing set, cycle select and alarm. The ability of this system are Time display, temperature dry and wet set, display the maximum temperature in stages, difference between high and low drying temperature, the rate of increase in dry and wet temperatures, password change and stopping and starting of stages. After the construction of intelligent systems, flue -cured tobacco seedlings were transplanted in mid-May at the Tirtash Research and Education Center. General practices (irrigation, pest and diseases) and priming operation were done at the right time. The leaves were placed inside the barn. Then all the leaves were cured in three barn under three treatments (manually, semi-automatic and automatic) in four Pick up and four replications. After the leaves were cured then were separated according to color, size and quality and then were evaluated. Leaf samples were analyzed to determine the chemical properties of the leaf (reducing sugars, nicotine and protein). The average price factors, times changes of temperature, labor number, gas and electricity consumption treatments were measured. Data analysis was performed to compare them using the SAS program.

RESULTS AND DISCUSSION

Analysis of variance treatments (Table 1) showed that the treatments evaluated in terms of hours worked, labor number, labor cost, the average price of tobacco, the amount of gas and electricity consumption and percentage nicotine significant difference in levels one and five percent and factor percent reduce sugar and protein were not significantly different.

![Table 1. analysis of variance (mean squares) the different treatments](image)

<table>
<thead>
<tr>
<th>Protein (%)</th>
<th>Reduce Sugar</th>
<th>Nicotine (%)</th>
<th>Electricity (KW)</th>
<th>Gas (M³)</th>
<th>Price of tobacco (rial)</th>
<th>Cost of labor (1000 rials)</th>
<th>Number of labor</th>
<th>Time (H)</th>
<th>Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>0/32</td>
<td>0/62</td>
<td>0/01</td>
<td>312/5</td>
<td>623/5</td>
<td>2559005</td>
<td>15000</td>
<td>0/66</td>
<td>41</td>
<td>3</td>
</tr>
<tr>
<td>0/09**</td>
<td>8/7**</td>
<td>0/08*</td>
<td>4870**</td>
<td>8953**</td>
<td>114589107**</td>
<td>27050625**</td>
<td>1202**</td>
<td>77908**</td>
<td>2</td>
</tr>
<tr>
<td>0/36</td>
<td>2/92</td>
<td>0/014</td>
<td>231</td>
<td>57</td>
<td>2127635</td>
<td>13125</td>
<td>0/58</td>
<td>31</td>
<td>6</td>
</tr>
<tr>
<td>13/5</td>
<td>12/8</td>
<td>13</td>
<td>5/3</td>
<td>2/7</td>
<td>3/2</td>
<td>6</td>
<td>5/8</td>
<td>5/5</td>
<td>(%)Cv</td>
</tr>
</tbody>
</table>

Ns=Non-significant, * & **=significant at 5% and 1% level of probability

![Table 2. mean compare the different treatments](image)

<table>
<thead>
<tr>
<th>Gas (M³)</th>
<th>Electricity (KW)</th>
<th>Nicotine (%)</th>
<th>Price of tobacco (rial)</th>
<th>Cost of labor (1000 rials)</th>
<th>Number of labor</th>
<th>Time (H)</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1650a</td>
<td>1600a</td>
<td>1a</td>
<td>39182c</td>
<td>6000a</td>
<td>40a</td>
<td>265a</td>
<td>Manual (Control)</td>
</tr>
<tr>
<td>1120b</td>
<td>1325b</td>
<td>0/88ab</td>
<td>49870a</td>
<td>562b</td>
<td>4b</td>
<td>25b</td>
<td>Semi- automatic</td>
</tr>
<tr>
<td>1050c</td>
<td>1315b</td>
<td>0/8b</td>
<td>45050b</td>
<td>337c</td>
<td>2c</td>
<td>10c</td>
<td>Automatic</td>
</tr>
</tbody>
</table>

A) Hours of work

The results showed that the control treatments (increased temperature by manually) had the highest Hours of work with a total of 265 hours due to increasing temperature in the barn for every hour between 0/5 to
1 °C in a 4-step process (Table 2). The treatment of automatically had the lowest Hours of work. Zhang et al (2013) reported Reduction of working hours on the use of intelligent systems.

**B) Number and labor costs**

Treatments in the number of workers and labor cost had significant differences at the one percent level (Table 1). Control treatment had the largest number of workers, and cost with 40 number and cost about 6 million rials. However, the automatic method had the least with two people working and cost about of 337 thousand riyals. Larry (2008) found similar results.

**C) The average price of tobacco**

Treatments were different for the average price and the quality of tobacco. Treatment of semi-automatic was the best with about 49 thousand rials (21%) and the control treatment was the lowest average price with was 39 rials. Semi-automatic methods of control can lead toward a better and more precise control of temperature and humidity conditions within the control of the burners and fan. But automated method had lower average price ratio to the semi-automatic method can be due to the lack of uniformity in ripen of leaves and lack of better control of tobacco leaves in barn. Lopez et al (2005) reported a good quality tobacco leaf used in intelligent systems.

**D) The amount of energy (gas and electricity)**

Control treatment had more energy due to lack of appropriate control conditions within the cabinet, but the other two methods had the lowest of energy use with intelligent control of temperature and humidity. Larry (2008) and Lopez et al (2005) reported reduction of energy consumption in the use of intelligent systems.

**G) The percentage of nicotine**

Control treatment had the highest nicotine with 1% nicotine in tobacco leaves cured. Changes in nicotine content of tobacco leaves most affected by culture conditions, genetic varieties and about 10 to 15 percent are influenced by the curing conditions.

**CONCLUSIONS**

The use of intelligent systems has positive effect on improving the quality and management of resources. This system is optimal for reduce production costs (cost and number of hours worked. The best way is to use of semi-automatic.

**REFERENCES**


