Review Article

A precision use of thermostat in livestock monitoring system in a poultry house

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Abstract

Nowadays, many new technologies developed in a lot of countries. These technologies are promising in many areas such as environmental monitoring, precision agriculture as well as in animal production. The purpose of this study was to define a better understanding of how new and advanced technologies affect the agriculture and livestock sector alike. Although agriculture and animal husbandry are among the most important sectors, advanced equipment and information technology cannot be used adequately. This situation leads to low production efficiency. It is also known that there can be a significant difference in temperature between the position of the climate control sensor (room temperature) and the area occupied by the animal. This study explores the advantages of using a temperature sensor for climate control, we would also like to draw attention to the possibility of applying advanced sensitive devices and information technologies that will contribute to increasing the efficiency of animal production

Keywords: precision agriculture, temperature sensor, animal production, environmental monitoring

Introduction

Given the continuous increase in world population and increasing incomes of countries such as Brazil, Russia, India and China, the demand for meat and animal products is expected to increase by at least 50% in the next twenty years. As a result, the first question that comes to mind is how to achieve high quality, sustainable and safe meat production that can meet this demand (Aydın, 2020). As an answer to this question intensive livestock systems are used today but serious problems are encountered with these systems. As the number of animals on farms increases, many farmers are concerned about food safety and animal health (Aydın, 2020). Because in previous years, farmers could control animal health and welfare through visual and auditory observations (Aydın, 2020). Today it is impossible for them to achieve this because of the increase in the number of animals made by the ease that's provided by the increased administrative and logistical cut-workload. Thus its imperative that farms be supported with technology in order to spot any problems in time and to take early measures in terms of the sustainability of intensive animal husbandry (Aydın, 2020). For this reason, sensitive animal husbandry techniques must be converted into practice in order to further develop the broiler sector in turkey and to compete with other countries of the world. But this is only possible when there are teams from different fields of research such as physiology, animal science and technology (Aydın, 2020). To achieve this in one word technology science and animal science must

cooperate and sensors used in agricultural monitoring system are among many things a researcher should be acquainted with in monitoring system. Monitoring system is considered to be an important part in precision livestock farming .A better understanding of how this technology works is vital, sometimes the process of algorithm and machine learning is needed (Benjamin and Yik, 2019). Precision Livestock Farming (PLF) is a shortcut that stands for precision farming, it comprised of many types of sensors that provide fully automated continues full time detailed information which are collected then processed to alert the farmer of any risks that could happen in the barn, this technology identify which animal do need direct care or attention or even elimination from the rest of the herd in case of having a certain contagious disease (Berckmans, 2017). PLF is a recent technology that aims to apply engineering principles on livestock farming in terms of monitoring and managing the production process by harnessing a model based control systems that provide the automatic management to meet the need of a certain goal (Aland and Madec, 2009).

There are always penalties when adopting new technology. The penalty can be even severe if the commercial manufacturer are not acquainted of the farmers need, because this technology must be affordable in terms of cost, use and reliable when working along with little maintenance (Aland and Madec, 2009) The fundamental principle, on which PLF specialty is dealt with is interpreted as, if the needs of livestock or crops are being met at the highest quality then the needs of farmers follow, moreover, the supply chain, involving the consumers as well (Andonovic et al., 2018).

There is recently a growing societal concern about animal's welfare, hence, there is a developing need for developing a welfare assessment method, that involves both behavioral and physiological parameters, although single indicator can determine whether the welfare is bad or good, a collection of indicators furthermore must be used for an adequate assessment, of welfare level (Candiani et al., 2008).

Thermostats sensor

The best way to insure that the brooding chickens at the correct heat level is by placing thermostats sensors , three to four inches above the floor (Bonzer et al.,1955), hence its placed high enough so that the birds can't reach them moreover records the exact temperature and humidity that the birds feel. In order to prevent the chickens from pecking the sensors, they should be raised higher a couple of feet off the floor, Once the birds are a week to ten days off. The reason of putting the sensors nearby the chickens, is because of the vertical thermal temperature differences in the barn (Aviagen, 2009).

House. In other words the temperature near the ceiling is different than the temperate near the floor because warmer air is lighter in weight and tends to be in the upper layers, (Czarick and Fairchild, 2011). As in figure (1) It's advisable to use electronic thermostats because when try to maintain the proper barn temperature, There will be a main problem, facing broiler producers when in term of accuracy (Czarick and Lacy, 1998 ; Al-Chalabi et al., 2016).

Figure 1: Electronic thermostat. (Adapted from Al-Chalabi et al., 2016).

*** Electrical devices of recording type (Data Logger) to measure temperature and relative humidity.**

Technological specifications for (Data Logger THC- 4) (electronic thermometer and humidity logger)

A. Dimensions of the device are length 90mm, 47mm, height 17mm.
B. It measures a temperature range between 30 degrees Celsius below zero to 60 degrees Celsius above zero.
C. Accuracy in temperature measurement is ± 0.5 at the range (20 m to + 40 ° C), otherwise the margin of error is ± 1.0.
D. The unit of measurement is the applicable degree installed in the electronic management program from the factory.
E. Part of its area from 0 to 99%.
F. Accuracy and technique accuracy is ± 3 ° C when the temperature is 25 ° C and the humidity is between (90 ~ 20).
G. The recording range reaches 16,000 readings.
H. Recording time interval is possible every 10 seconds ~ 24 hours.
I. Power supply via 2450CR battery or via USB calculator cable.
J. The battery life is one year during normal conditions. If the recording is programmed every 15 minutes and the alarm tone is not activated, but if it is activated and the reset key is pressed, the battery life will be reduced to seven months.
K. The device is connected to the computer, and through a special program, the data is uploaded.

Al-Chalabi et al., (2016), used several electronic thermostats placed in different sites indoors. They recorded fluctuations ups and downs in data concerning the temperature recorded by an individual device placed in a certain site or position in the broiler house table (1).

Materials and methods

Used nine devices of data logger THC- 4) Humidity & Temperature Data Logger) that were manufactured by Shenzhen U-Control Electric Co., Ltd china, used to record the temperature and humidity in the house along with one device outside for measuring the Homogeneity of heat inside the house in one hand and compare it with heat temperatures outside for testing the efficiency of controlling the mini climate inside .they were placed in three zones, three per zone. Afterward programmed to record data every 5 minutes. Then the data was collected periodically by connecting the devices into the computer one in turn. Anemometer was used to measure air velocity as well.

Table 1: Shows the weekly rates of heat temperature (°C) inside and outside the broiler House. (Adapted from Al-Chalabi et al., 2016)

weeks	Average of air tempers measure nature			
	Zone1 333 bird	Zone2 333 bird	Zone3 333 bird	Outdoors weather
1	29.25	30.44	30.69	14.98
2	26.14	27.35	27.32	19.38
3	23.03	23.51	21.74	17.37
4	19.19	22.59	20.95	17.95
5	18.77	20.78	18.91	18.22
average	23.28	24.93	23.92	17.58

*** Readings recorded of one device, in the beginning of rearing period it had (+ minus plus 2 degrees) then the gap in fluctuations even increased at the end of rearing period during day and night reached (+ minus plus 3degrees) . some days variations have reached to (+ minus plus 4 degrees) ,but it was on a limited scale and lasted for a few days only.**

Ali (2016), used nine electronic sensors, of Temperature and Relative humidity inside a house (of data loggers, type called TH-4) that was manufactured by Shenzhen U-Control Electric Co., Ltd. As illustrated next in the figure (2), each zone locations of sensors were: - near the ventilation slot, in the middle and near the exhaust air slot, where the fans exist. One single sensor placed outside, to monitor changes in the outside environment (weather), moreover to obtain a clear picture of developments, inside the house, in terms of fluctuations in the relative humidity and air temperature, from the moment air enters the house, until it left it. the work of monitoring , of what data Logger devices did, could be summed up to first measuring and recording parameters such as temperature, and humidity ,which were stored within individual device, then after a specified period, (any period suits the user say one week) the data were download by connecting the devices into PC through an installed interface that which represented the means of communication , along with a cable (link) ,between the device and computer, the devices one after the other, linked to PC and data are collected into an excel sheet. Through the analysis of those data of (Relative humidity, and temperature, diagnoses are conducted).

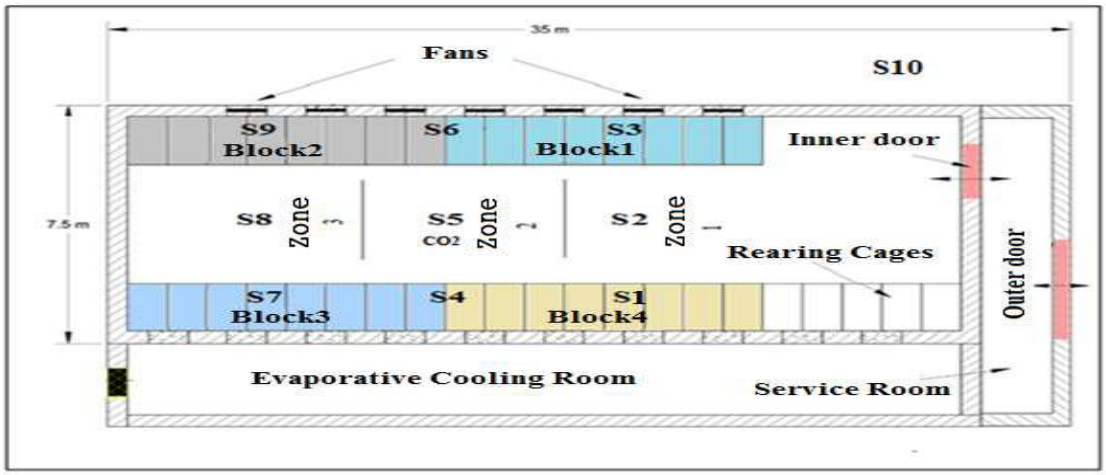

Figure 2: Location of sensors (s) inside a poultry house (Adapted from Ali, 2016).

*** (S1, S2, S3, S4, S5, S6, S7, S8, S9): sensors (Data Loggers) of temperature and Relative humidity placed inside to monitor the internal environment.**
*** S10: sensor (Data Logger) for temperature, Relative humidity, placed outside the house to monitor the external environment.**
*** CO2: sensor (Data Logger) for carbon dioxide gas.**

Ali, (2016), used a sample of the processed data of a complete day (24 hours) acquainted from zone 3 of the study conducted for five weeks, from 9/2 to 3/14/2016. The higher relative humidity of 60.60 was recorded by a sensor which is places in zon 3 in the gray color. Of figure 2 (Czarick and Fairchild, 2004). Used another way of monitoring the thermal parameter. They mentioned that the best way of evaluating any heating system in other word how good a job is, in terms of worming the floor in a broiler house, is by using a thermal imaging camera. A thermal imaging camera, basically measures 17000 floor temperate, at one time, hence provide a color picture that which correlate to temperature. Thus by looking into the images obtained by a thermal camera, it should be very easy to understand the thermal environment within a house moreover how a heating system actually heats a house. The following figures 3 are tacking using thermal camera. It's worth mentioning that Non-contact/infrared thermometers are also effective devices for poultry producers and turkeys. Because it offer multiple uses for instance: it can be used for checking floor temperature while brooding whether there is overheating during hot weather. Or even to evaluate the condition of wall and ceiling insulation. It measures the temperature of any surface. The non-contact thermometer works much like a camera in terms of the covered surface area, in other word it increases with distance. Thus a spot size of 6:1 would measure, a spot one inch in diameter at a distance of six inches. whereas a spot size of two inches at distance of 12 inches would double into 4 inches at a distance of 24 inches (Czarick, 2007).

Table 2: A sample of the collection of sensors placed outdoors in addition others placed in thermal Zone 3 inside the barn. (Adapted from Ali, 2016)

Outdoor sensor		Sensor9		Sensor8		Sensor7	
Ave/h		Ave/h		Ave/h		Ave/h	
Hum.	Tem.	Hum.	Tem.	Hum.	Tem.	Hum.	Tem.
67.00	12.00	45.10	33.61	41.31	35.70	39.11	34.95
68.21	11.70	44.75	33.70	40.11	35.91	39.10	34.91
69.40	11.30	44.20	33.71	39.30	36.00	40.80	34.92
70.10	11.50	44.65	34.00	39.50	36.25	43.10	35.11
71.55	11.60	46.00	34.25	40.35	36.51	44.00	35.30
73.40	11.50	47.61	34.50	41.15	36.75	45.15	35.50
73.05	11.70	50.55	34.50	43.95	36.65	47.61	35.40
72.15	11.95	54.65	34.15	48.00	36.11	51.45	35.05
69.75	12.60	54.92	33.85	49.30	35.72	52.61	34.95
67.20	13.10	52.11	33.40	47.55	34.95	50.30	34.50
63.15	14.65	55.41	32.95	51.60	34.31	51.61	34.15
57.85	16.05	59.11	32.40	54.40	33.81	53.90	33.80
50.05	16.95	55.71	31.70	51.80	33.45	52.11	33.40
46.45	17.05	51.35	31.45	48.55	33.51	49.15	33.35
45.20	17.15	48.35	31.75	45.35	33.85	46.15	33.65
45.20	16.75	47.15	32.00	44.00	34.15	44.20	33.95
48.10	15.35	50.91	32.51	47.45	34.41	46.30	34.30
51.65	14.30	54.15	32.75	50.25	34.62	48.61	34.50
53.50	13.90	53.00	32.55	47.90	34.55	47.41	34.25
55.40	13.45	54.00	31.85	47.90	33.70	48.75	33.32
57.40	12.25	55.95	31.65	49.85	33.45	50.85	33.10
60.35	11.65	54.81	31.90	48.91	33.80	50.15	33.42
53.50	13.90	53.00	32.55	47.90	34.55	47.41	34.25
69.85	12.90	53.92	33.95	49.40	35.42	51.91	33.85

***Hum. =humidity, Tem. =temperature, Ave. = average, h= hour**

Table 3: Some Descriptive Statistics (Adopted from Ali, 2016)

9 Hum.	9 Tem.	8 Hum.	8 Tem.	7 Hum.	7 Tem.	Descriptive Statistics
51.08	32.95	46.31	34.91	47.41	34.34	**Mean**
0.27	0.06	0.27	0.07	0.26	0.05	**Stander error**
51.80	32.80	46.45	34.60	47.90	34.50	**median**
44.30	31.70	39.20	33.60	47.90	34.90	**mode**
4.58	1.04	4.59	1.17	4.35	0.79	**Standard Deviation**
20.95	1.09	21.11	1.37	18.93	0.62	**Sample variance**
16.60	3.50	18.10	4.20	18.00	3.30	**Range**
44.00	31.30	39.10	32.90	38.10	32.50	**Lest value**
60.60	34.80	57.20	37.10	56.10	35.80	**Highest value**
14711.50	9490.20	13338.30	10053.80	13654.40	9890.20	**Sum**
288.00	288.00	288.00	288.00	288.00	288.00	**No. of readings per day**

*** Hum. =humidity, Tem. =temperature.**

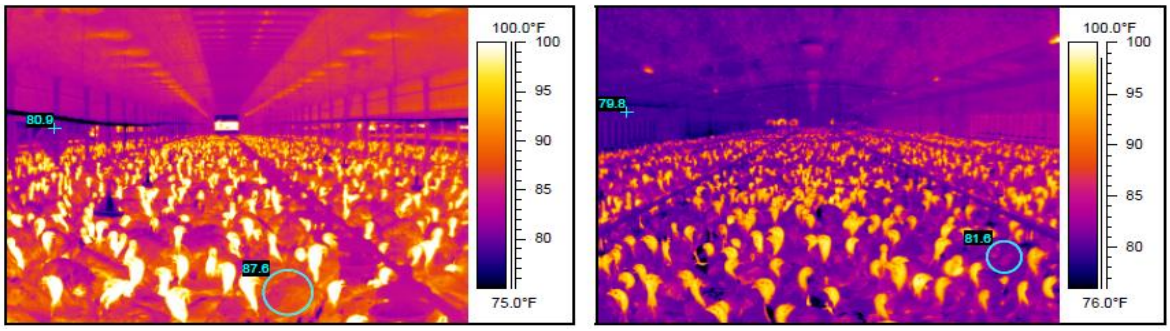

Figure 3: Naturally-ventilated bird's barn on the left hand and a tunnel-ventilated bird's house on the right hand(Adopted from Czarick, and Fairchild, 2004).

∗ A thermal imaging camera, basically measures temperate, at one time, hence provide a color picture that which correlate to temperature

Conclusion

Unfortunately, the production of broiler chickens in our country is not in good quality. That reflection could be seen in agriculture as well. It is because of this reason that thermal and humidity sensors along with image and sound sensors analysis software has been developed and introduced to our country. The fully developed observation area can be specified as reel-time (24/7) observation of welfare of the animals. Availability of sufficient use of wireless networks is important. A farmer must be provided with certain gears, even within with small farms that could Work alongside in the field of chicken production business in our country. Animal husbandry must put techniques into a practice in developing the poultry sector hence to compete with other countries of the world. But this is only possible when there are teams of various different types such as physiology and zoology. The shortcut is for the science of technology and wealth sciences to collaborate to achieve this.

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الاستخدام الامثل للثرموستات في نظام المراقبة البيئية لحظائر الدواجن

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المستخلص

في الوقت الحاضر ، تم تطوير العديد من التقنيات الجديدة في العديد من بلدان العالم. هذه التقنيات واعدة للغاية في العديد من المجالات مثل المراقبة البيئية والزراعة الدقيقة وكذلك في الإنتاج الحيواني. الغرض من هذه الدراسة هو تحديد الاستخدام الامثل و كيفية تأثير التقنيات الجديدة والمتقدمة على قطاع الزراعة والثروة الحيوانية على حد سواء. على الرغم من أن الزراعة وتربية الحيوانات من بين أهم القطاعات ، إلا أنه لا يمكن استخدام المعدات المتطورة وتكنولوجيا المعلومات بشكل كافٍ، هذا الوضع يؤدي إلى كفاءة إنتاج منخفضة. من المعروف أيضًا أنه يمكن أن يكون هناك اختلاف كبير في درجة الحرارة بين موضع مستشعر التحكم في المناخ (درجة حرارة الغرفة) والمنطقة التي يشغلها الحيوان. تهدف هذه الدراسة إلى استكشاف بعض مزايا استخدام مستشعر درجة الحرارة (الثرموستات) للتحكم في المناخ. كما نود أن نلفت الانتباه إلى إمكانية تطبيق الأجهزة الحساسة المتقدمة وتقنيات المعلومات التي من شأنها أن تسهم في زيادة كفاءة الإنتاج الحيواني.

الكلمات المفتاحية: الزراعة الدقيقة، حساس درجة الحرارة، الإنتاج الحيواني، المراقبة البيئة.