Accurate and quick evaluation of nutritional status of sheep by an improved mobile walk-over weighing system in field

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Abstract

For especially small ruminant animal studies, a mobile unit was built up for quick, easy and accurate live weight monitoring, especially to measure large number of sheep stocks in indoor and outdoor conditions. A Walk-over Sheep Weighing Station was designed and built by our experimental team, including devices and components for; 1. Identification of individual sheep with RFID eartags, 2. Walk over weighing scale, 3. Light alloy metal sheep handling and directing parts, 4. Data logger uploaded with specifically designed sheep evaluation software. All system units were modular and easily assembled and transported on a trailer towed by a standard car. The system was used in both indoor and outdoor conditions to measure stable and walk-over live weights of sheep. The weighing unit was additionally equipped with an improved automated device for controlling sheep's motion on the platform and thus measurements became more accurate. The walk-over-captured live weights of animals were found to be very close to stable weights with a very high correlation to both indoor and outdoor weighing trials (R2=0.99) and statistically were not different (P>0.05). The walk-over system has made systematic weighing of sheep more accurate, quicker and easier in indoor or outdoor conditions for both scientific and commercial purposes.

Key words: accurate walk over weighing, sheep liveweight change

1. Introduction

Sheep are usually weighed for evaluating the nutritional status of individual animals, groups or complete herds for both scientific and commercial purposes. Monitoring the weight changes of sheep has implications for assessing reproductive performance, accurately meeting market specifications and for animal health and welfare. For the people who work with sheep systematically, weighing a flock of sheep is a difficult job to carry out. Especially in pastoral conditions, conventional static manual weighing of big sheep flocks is an animal destructive, labor intensive and time consuming process for the reason that leading a grazing semi-wild sheep to the weighing scale and having it wait there stay still to obtain the exact live weight quickly is impractical in field conditions (Moule, 1995). In major sheep producing countries, a significant number of scientists have been doing research to develop a quick and accurate weighing system (Richards et al. 2006) which can be used in indoor or outdoor field conditions (Anonymous, 2012) to facilitate the weighing process with an easy, less destructive and quick way of monitoring sheep became necessary to work under the field conditions.

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Methods for reliable and dynamic weighing of livestock have been studied for a long time by several researchers. Filby et al.(1979) did the initial work in dynamic weighing and Ren et al (1992) proposed measuring dairy cattle continuously and comparing the average body weight with the previous measured value with a maximum weight error to 30 kg for dairy cattle. Animals have to walk through the platform separately. The crowding and fast running of the livestock make the correct weight estimation difficult, and the measurements go beyond the acceptable error margins. In Polat et al's study (2007), walk over weighing results were not consistent with the stable live weight of the animals because the same animals had been weighed numerous times and there was high variation between stable and walk over weights. Peiper et al. (1993) addressed the crowding problem by introducing a step to slow down animal movement in front of the weighing platform. This solution proved to give better results, yet inaccuracies still occurred whenever animals passed over the weighing platform too fast. Pastell et al. (2006) mention that 4-leg coordination is important for accurate weighing of animals on the weighing platform. In Australia, Richards et al. (2006) concluded that individual weights can vary dramatically according to animals' position on the platform and how long an animal has remained there. Cveticanin (2003) developed a new statistical approach to dynamic weighing called fuzzy logic to concentrate on calculation of data by adding an extra calculation function to cut and disregard odd numbers. In our previous study, we also compared static and calculated live weight, but not on walking coordination of animal (Polat et al, 2007). In calculation formula in data logger, a high variation coefficient filter was added to evaluate the figures coming from the scale indicator and eliminate the numbers with a higher variation coefficient than 10. Using this elimination method, we obtained more accurate numbers for live weight, but it also reduced the quantity of numbers flowing through the data logger to be able to justify the actual live weight and sometimes re- weighing animals became necessary, which required extra time and energy.

As a result of Polat et al. previous studies (2007), we assumed that during the walk over weighing process, animals' movements must be better controlled on the platform by a supplementary device to give animal a smoother walk to obtain more accurate live weights, without slowing down the weighing practice. With this research, we improved walk-over weighing system to obtain more accurate live weight measurements.

In this paper, we present a better technique for weighing walk over sheep which is more accurate, quick and easy, especially in comparison to conventional static live weight measuring methods.

2. Materials and Method

2.1. Animals

The indoor part of the experiment was conducted at Selçuk University, Faculty of Veterinary's Sheep House, with 8 mature sheep selected for this process. The outdoor part of the experiment in field conditions was held in Sivas, Kangal district, in rural conditions. A privately owned sheep farm herd was used in this study. The sheep used in the experiment both for indoor and outdoor measurements were tagged with ear tags containing low frequency RFID (EC, 2004) (Radio Frequency Identification Device transponders). To identify the animals, medium range (100 cm) RFID readers were applied to the system.

2.2. Weighing Scale and Weighing Process

A metal-constructed 250 cm long and 40 cm wide, open front and end crate type scale was built with a set of weigh bars (Thunderbird Australia). Its maximum capacity was 250 kg in 1 g sensitivity. The scale was available for both walk-over and stable weighing of animals with a built-in data logger designed for this purpose locally (Servonel, Turkey) with a microprocessor for collecting and transferring data to the PC. For measuring, collecting, storage and analysis of all data, a software program was prepared. The data collected in the data logger was transferred to a PC with RS232 connection module. The weighing platform (Fig. 1) was set and the crowded sheep were kept inside the yards and led through a race to the weighing platform one by one. Right before they entered the platform (Point A), the RFID Reader recognized the sheep's identities. Whenever a sheep arrived at the platform (Point C) and 4 legs were on top, the optical entrance sensor activated strain gauges of the scale and weighing phase started. Sheep kept walking on the platform and through to the end, right before the animal left the platform, the exit sensor ended the weighing process. While one sheep walked through the platform, within a few seconds, it was weighed continuously by the scale strain gauge indicator at least 35 times and the measurements were sent to the data logger. The average weight of the animal was calculated and transferred to the online connected computer. If the animal was moving too slowly, the microprocessor of the data logger was stopped after obtaining the accurate live weight signal coming from the indicator. The sheep's moving or not moving on the platform was considered to be very important; thus, it had to be controlled to obtain an accurate weighing result. For this purpose, an electronic motion control device was added to our improved system, so the movement of the sheep was controlled and synchronized automatically by the data logger. How it happened was that the walking speed of the animal was determined between the detector of RFID reader and the weighing activation sensor. If the sheep was too fast, which meant that the motion was imbalanced and might result in an inaccurate weighing, then an automatic barrier (Point E), which was built up through the end of the scale, went down suddenly to hesitate and slow down the very fast running of the animal on the platform (Fig. 1). With this sudden hesitation, the live weight of the animal was captured correctly and the platform barrier opened up to let the animal go outside the platform.

2.3. Sheep Handling Panels and Trailer

For handling, collecting and directing animals, lightweight easy-to-assemble modular aluminum panels were constructed. All of the equipment was loaded on a trailer for transportation which could be towed by a regular car in field conditions (Fig. 1).

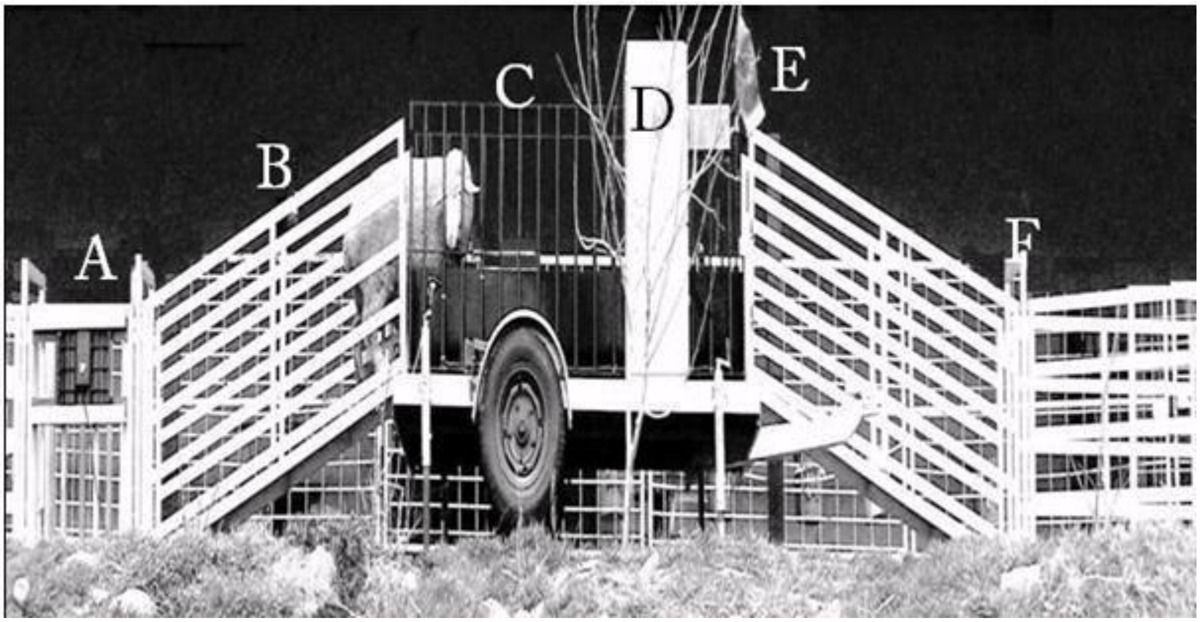

Figure 1. Mobile sheep measuring station; A: RFID reader, B: scale entering hump, C: scale; walking platform, D: control board and data logger, E: speed and coordination barrier, F: light alloy aluminum race and yard panels

The data were statistically assayed by descriptive statistics concerning means, p-paired test, correlation tests, minimum maximum variance coefficients and standard error values using SPSS Inc. package program (SPSS, 2006).

3. Results

3.1. Indoor Weighing

One night before the experiment, the animals were not fed to prevent heavy defecation or urination loss effect during the weighing procedure. At the commencement and end of the weighing practice, the calibration of the scale was checked for ensuring balance and calibration was approved. At first, the weighing platform was set for the stable weighing module and the test sheep were weighed to obtain stable live weights. After that, the same scale was quickly converted into walk over mode and the sheep were forwarded to cross the weighing platform numerous times and live weights were recorded (Table 1). For the indoor experiment, the sheep were intended to be weighed 12 times in the walk over phase; in the meantime, they were watched for urination or defecation. Whenever such incidents occurred, the animals were discarded and not weighed any further. The stable and walk over live weights were compared and walk over weights of animals were found highly matching to their stable live weights (R2=0.999). According to the Paired t Test comparing the stable and walk over weight measurements, the difference between 2 measurement systems was found to be (P=0.799), which was statistically insignificant (P>0.05).

Table 1. Comparing stable and walk over live weights of sheep in indoor conditions

	Stable weights		Walk over weights				
Animal ID	kg	n	Mean kg	Min kg	Max kg	Variance	SE
1	87.3	6	87.20	85.96	87.79	0.01	0.28
2	68.4	5	68.43	66.85	69.85	0.02	0.52
3	54.7	11	54.98	53.43	56.17	0.02	0.26
4	75.2	8	75.02	73.74	75.85	0.01	0.26
5	53.9	9	53.94	53.36	55.24	0.01	0.20
6	76.9	8	76.72	76.08	77.43	0.01	0.19
7	64.9	9	65.14	64.46	66.49	0.01	0.23
8	69.8	8	69.80	68.79	71.43	0.01	0.36
Sum		64				0.01	0.26

In Fig. 2, a complete weighing phase of one sheep on walk over mode, in free and controlled motion conditions was compared. Digital signals coming from the scale's indicator were diagnosed and presented on a graph. Walk over weighing without using motion control barrier caused a sharp fluctuation on the graphic curve from 80.89 kg to 93.47 kg with a very high variation coefficient (CV=10.60), although the controlled mode data line was more flat, numbers ranging from 85.96 to 87.79 kg with a variance of 0.01.

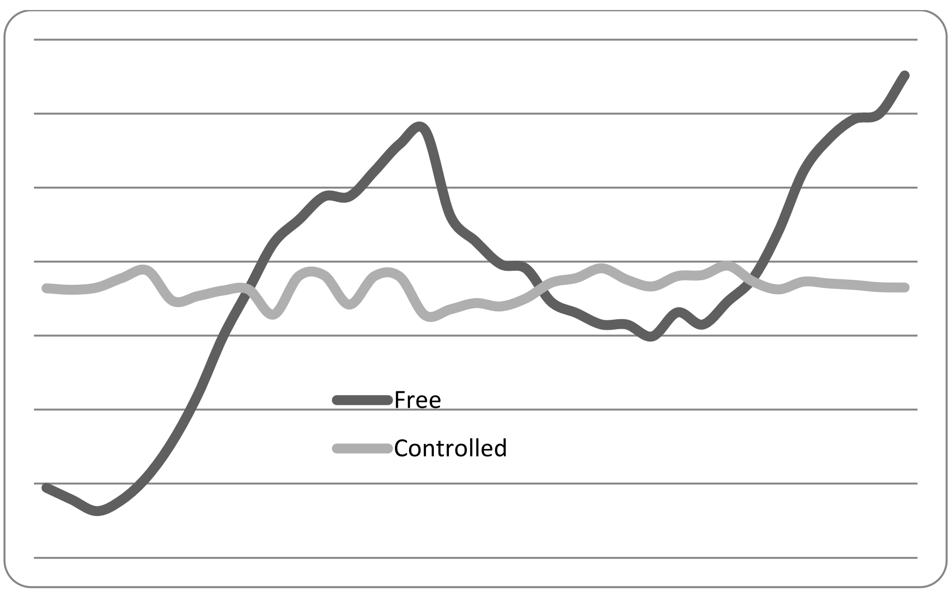

Figure 1. A complete weighing phase of walk over sheep with and without speed control on the weighing platform

3.2. Outdoor Weighing

The weighing unit was set with all of the components, eg. sheep collecting panels and re-directing gates, outside of the sheep yards and a flock of 120 sheep were exercised and accustomed to the weighing system 1 day earlier. The animals stopped feeding the previous night to prevent heavy defecation or urination loss during weighing trial. The sheep flock was quickly weighed primarily on stable and then on walk-over mode, and live weights were recorded. Animals were observed for urination and defecation loss and such animals were discarded from weighing as described above in indoor conditions section, so 96 animals' weighing results were included in our scientific data. It is clearly seen in Table 2 that 96 sheep's stable and walk over weights were closely parallel (P=0.599), and the difference was very low and statistically insignificant (P>0.05). It means that the walk over weighing of sheep accurately matched stable method results.

Table 1. A comparison of walk over and stable weighing of a flock of sheep in outdoor conditions

Weighing mode	n	Minimum	Maximum	SD	Variance	SE
Walk-over	96	48.27	88.04	11.07	122.50	1.13
Stable	96	48.30	87.80	11.01	121.33	1.12
Sum	192			11.04	121.92	11.13

In Fig. 3 the high correlation (R2=0.996) between stable and walk over weights are presented, which proves that walk over weighing results are consistent.

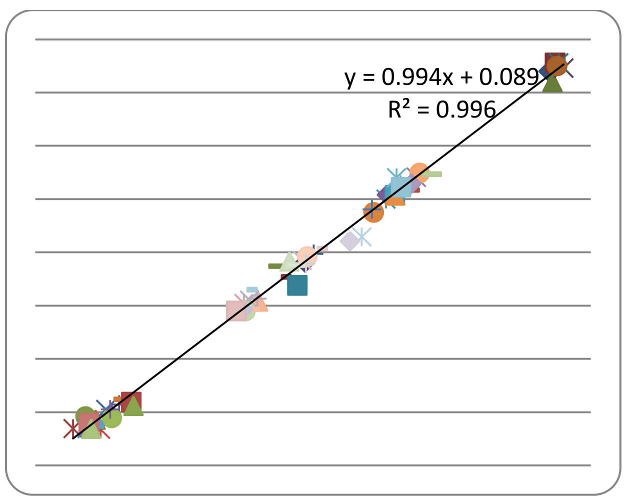

Figure 3. The correlation between stable and walk over weighing of a flock of sheep

4. Discussion

Principally, when the animal walks into the platform and 4 legs are instantly on the scale, the starter sensor commences the weighing process while the animal is normally walking on the platform. The weighing scale is capable of making numerous measurements in less than 2 seconds while the sheep is on the platform. Whatever the speed of the animal is, the strain gauge receptors of the weighing indicator collects enough series of numbers to calculate average weight. Whenever the animal reaches the platform with an uncontrolled speed and unbalanced body mass, and its weight is not distributed to the 4 legs (Pastell et al, 2006), some unexpected strength imbalance is reflected from the weighing platform to the indicator with a highly uneven set of numbers (Polat et al., 2007) as shown in Fig. 2. This causes an emergence of abnormal figures about the animals' bodyweight, which is out of range with a very high variation coefficient (Cveticanin, 2003). When the animal's motion is steady on the platform, more even numbers are obtained with a lower variation coefficient of 0.01 (Fig. 2) to estimate the actual live weight of the animal. To perform this application during the weighing process, the speed of the animal is diagnosed automatically to recognize that the motion of the animal on the platform is steady and, if it is not, as described above, the speed barrier is activated by the data logger and suddenly goes down to slower and provide the animal a smooth and steady walk and balance on the platform. This manipulation results in capturing an unbiased accurate live weight measurement during the walk over weighing.

When the results of this latest experiment are compared with Polat et al.'s study (2007), it is quite clear that when the motion of the sheep was controlled on the platform, the variation of the figures was lower, which was due to smooth and balanced walking of sheep maintained by the automatic motion control barrier placed on the weighing platform. This automatic control helped us obtain more accurate numbers as live weights of animals from the walk over weighing system, which became more reliable to use both in indoor and outdoor conditions.

Conclusions

The walk over weighing system has eased and quickened the weighing process for both animals and stockmen or scientists who weigh sheep systematically. The animals were not distressed by riding, collecting and gathering stress in harsh and abusing conditions. The stockmen also do not have to spend extra physical effort to control the sheep herd. A recently adapted motion barrier controlled the animals' movements on the weighing platform so that highly accurate results were obtained for evaluating live weights and nutritional status of the sheep. Placement of animal handling systems on a trailer and their transportation to wherever needed is very practical for especially field condition researches. The easy-to-set up configuration of parts of the systems was also very beneficial. The software can store flock, group or individual animal's detailed recordable data such as live weight, condition score, breeding, disease, vaccination etc. in a database in the computer.

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