Final Report

Commercial validation of Weight-Detect™ and Enviro-Detect™ Machine

DECEMBER 2021

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Proudly funded by the Pork Producers' Committee of the Agricultural Produce Commission

AGRICULTURAL PRODUCE COMMISSION
Supporting Producers' Initiative

Contents

1 INTRODUCTION

Pig producers are actively invested in collecting and analysing data from their production systems to identify areas of inefficiencies and create opportunities for optimisation and productivity gains in a highly-competitive market (Banhazi and Black, 2009). For intensive pig farming, lack of a means to regularly estimate animal weight in a pen and air quality parameters have been a limiting factor to providing a baseline comparison for feed conversion, adherence to expected growth curves and detection of suboptimal growth periods due to compromised welfare, disease or adverse environmental changes (Banhazi *et al.*, 2012; Banhazi and Harmes, 2018). Putting animals individually across a weigh scale is costly in time and resources, creates injury risk for both staff and animals, and typically sets growth back through stress (Banhazi *et al.*, 2011). Measuring air quality parameters manually to understand the potential risk posed by sub-optimal environment for pigs and staff (in terms of respiratory problems) is again impractical and unrealistic under commercial conditions (Banhazi, 2009; Banhazi, 2021).

A 3-D non-intrusive visual imaging system (Weight-Detect™) that can estimate the overall live weight of a pen of pigs by segmenting them from the background, taking shape measurements in the image calibrated against known dimensional references and adjusting for conformance using stereoscopy has been developed (Figure 1 and 2) (Banhazi and Dunn, 2016). Under optimal conditions the system has estimated weights approaching the ± 1.5 kg precision level (compared to individual manual weighing) (Banhazi *et al.*, 2019). This estimation is relatable with the expected imprecision observed during manual weighing as well as the expected body weight loss associated with defecation and urination due to stress (Banhazi, unpublished 2018). Further work is still required to validate the Weight-Detect™ system under a commercial setting (Banhazi *et al.*, 2015; Hartung *et al.*, 2017).

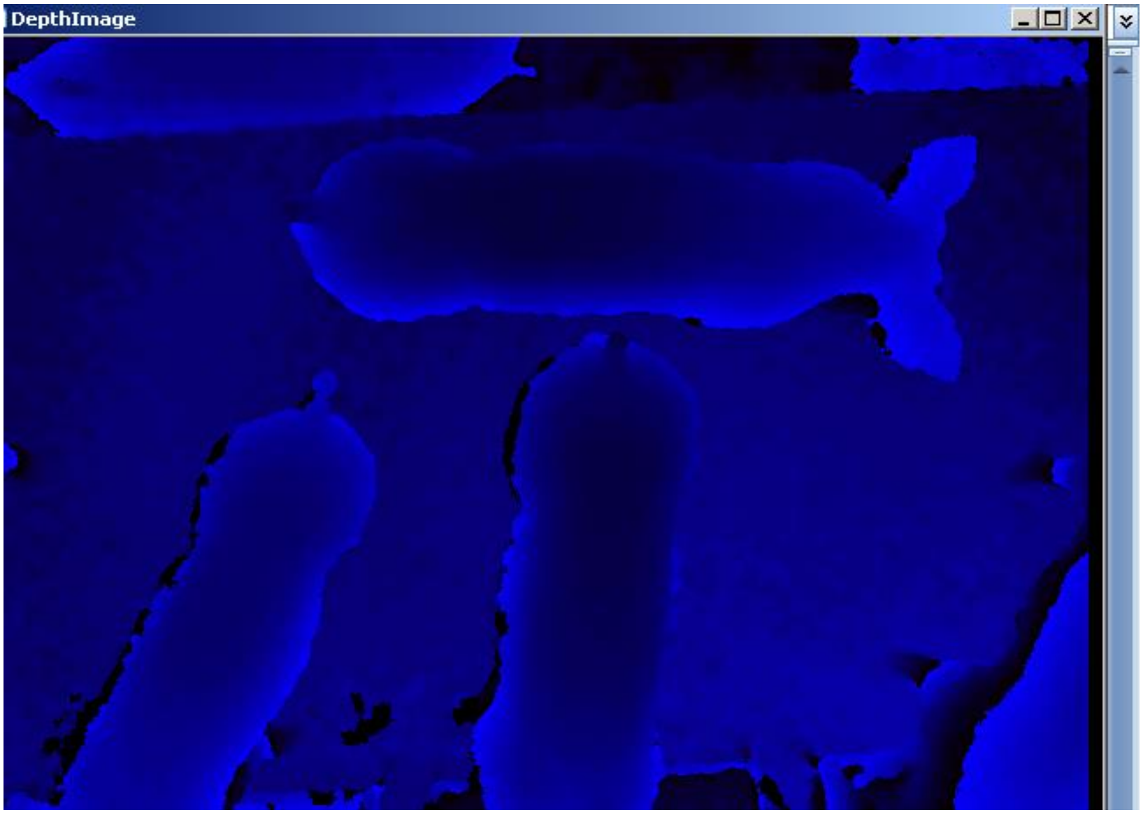

Figure 1: 3D images captured by the Weight-Detect™ system on a commercial farm in Victoria.

Figure 2: The Weight-Detect™ system.

An advantage of Weight-Detect™ is being able to determine the average daily weight and hence growth rate of a pen of pigs. This means that it is possible to detect when differences in growth rates occur and possibly implement changes. For example, Figure 3 shows where growth stagnation episodes have occurred on an Australian farm over time. These periods of low growth rates add nearly a week to the time pigs will reach the targeted sale weight.

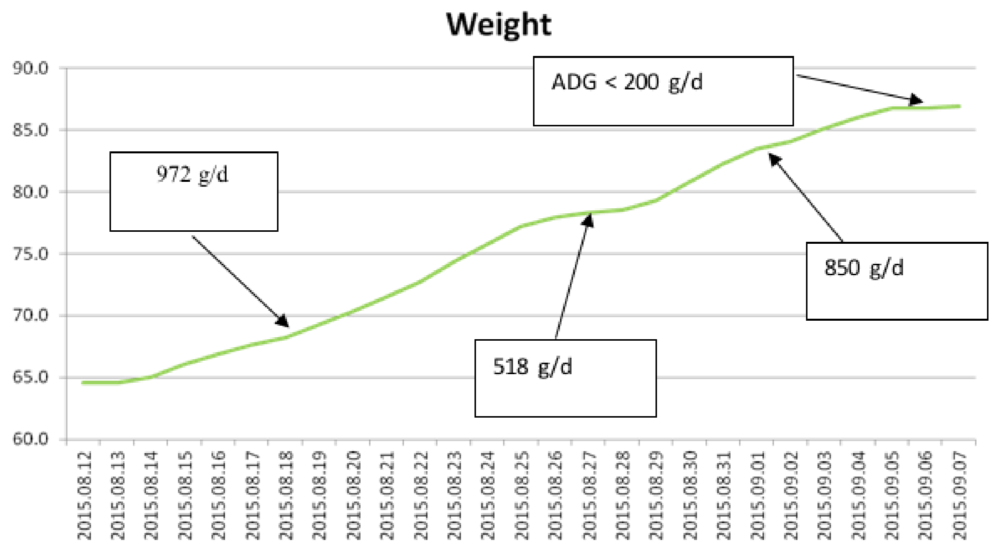

Figure 3: Growth stagnation episodes identified at an Australian pig farm over a period of time.

A compact environmental monitoring system (Enviro-Detect™) has also been developed that continuously logs relative humidity, air temperature, ammonia, dust and carbon dioxide concentration information as well as ventilation levels. The system also has the potential to automatically calculate emission rates to allow defendable information to be made available to producers. Moreover, based on previous research the system can calculate the potential risk posed by sub-optimal environmental conditions (Banhazi, 2013). By using Enviro-Detect™ and Weight-Detect™ units on the same farm, the relationship between environmental factors and weight gain can potentially be calculated.

The systems have the ability to provide the producer with weekly reports on weight and various environmental variables which will allow the producer to make informed decisions and implement timely and appropriate production management actions. This should ultimately result in an increased return to the producer. Therefore, this project aimed:

1. To demonstrate that the Weight-Detect™ and Enviro-Detect™ systems can be used in a commercial setting to reliably and accurately detect pig weights and environmental variables.
2. To demonstrate that the Weight-Detect™ and Enviro-Detect™ systems can be used in a commercial setting to provide useful information to the producer and ultimately improve productivity.

2 PROJECT METHODOLOGY

Three (two standard and one experimental) Weight-Detect™ units (PLF Agritech, Toowoomba, Australia) were installed on a commercial farm in a grower-finisher shed (Figure 4). Each unit was installed in a high traffic area 2 m above the floor of the pen. Each standard unit observed one pen (approx. 15 pigs per pen). The experimental unit was installed alongside a standard unit above one pen. Each pig in the pens associated with the Weight-Detect™ unit was manually weighed at 2 weekly intervals over the period they were in the grower-finisher accommodation (from 13 weeks to approximately 21 weeks of age). This was repeated over 3 batches of pigs through the facility. An Enviro-Detect™ unit was also going to be installed but this did not occur for reasons outlined in the 'Results and Discussion' section of this report.

Figure 4: Weight-Detect™ installed in a conventional shed.

The data from the Weight-Detect™ machines was analysed to predict the weights of the pigs and then compared against the data obtained from manually weighing the pigs. It was also compared to the manual weights using Lin's concordance correlation coefficient (Genstat 21; VSN International Ltd). This provided valuable data to ensure that the machine can accurately predict pig weights in a commercial facility.

To help with data interpretation, farm workers were supplied on their mobile phones with an Android based program (PLFEvent) that facilitated quick and trouble free gathering of important management data daily, such as change of diet, medication or vaccination events and other management tasks directly related to the movements of pigs (Figure 5). After program installation, the daily data collection is done quickly and easily via the use of checkboxes. The finalised survey results are automatically sent to a cloud-based web application (ADAMS) when the "Save and Send" button is pressed. The cloud-based web application (ADAMS) stores the data that can be correlated the changes in management procedures to weight gain changes and/or changes in environmental conditions.

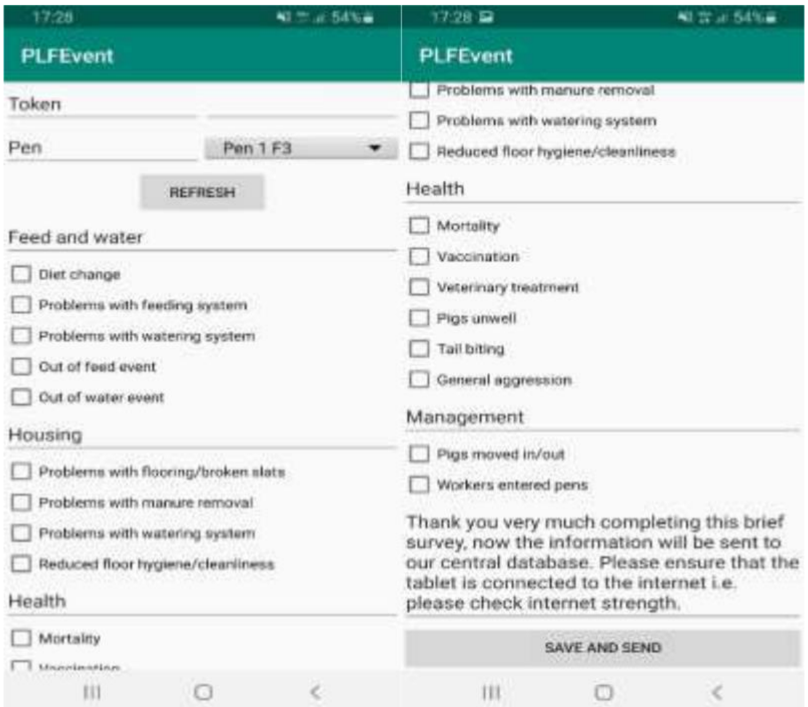

Figure 5: Screen shot of the data collection software used on the study farm.

Reports were provided which detailed growth rate in the individual pens. Other details included the average weight, standard deviation, weight distribution, pig movements and human movement in the pen (see Appendix 1 for an example of a report).

3 RESULTS AND DISCUSSION

The results obtained are presented in Figure 6-14 and Tables 1 and 2. Midway through the trial, one of the cameras was replaced (changing from F2 to F3 camera). Data from the experimental camera is not provided.

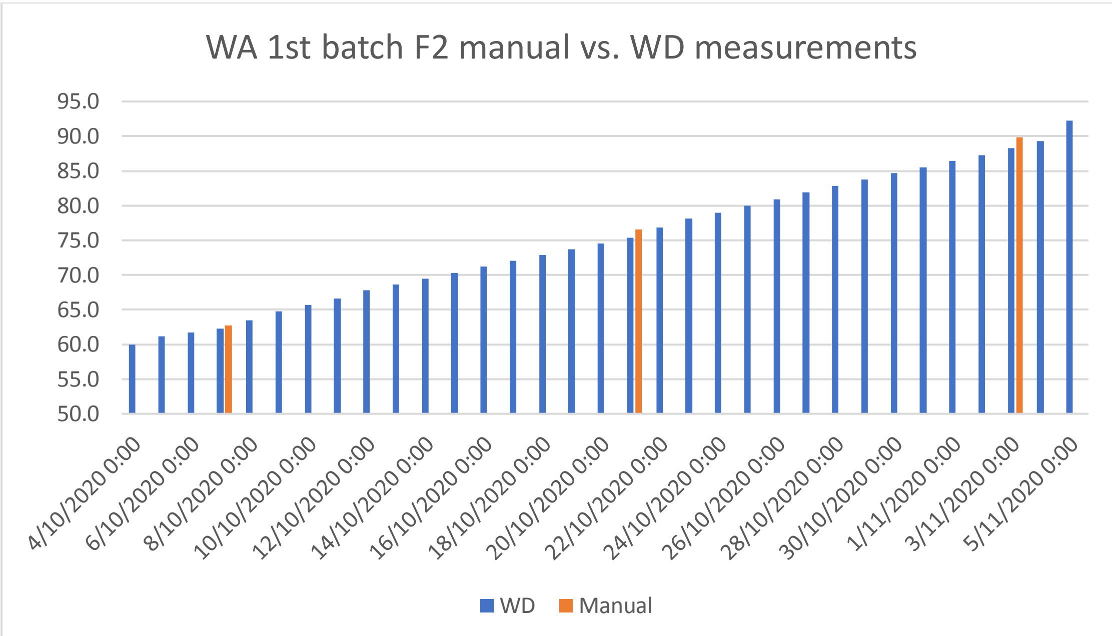

Figure 6: Batch 1 F2 data in 2020 from the WA farm (female pigs).

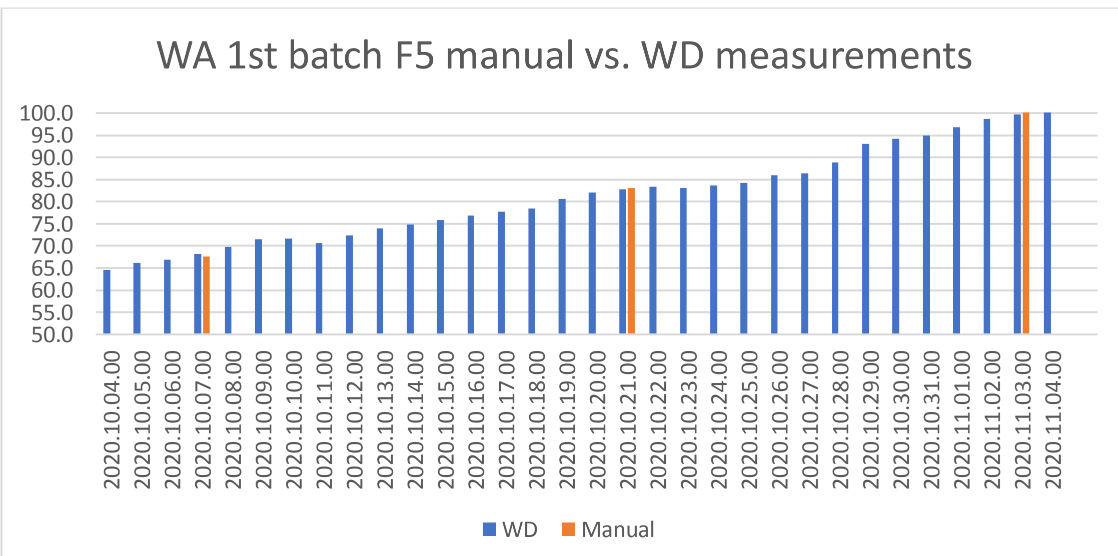

Figure 7: Batch 1 F5 data in 2020 from the WA farm (male pigs).

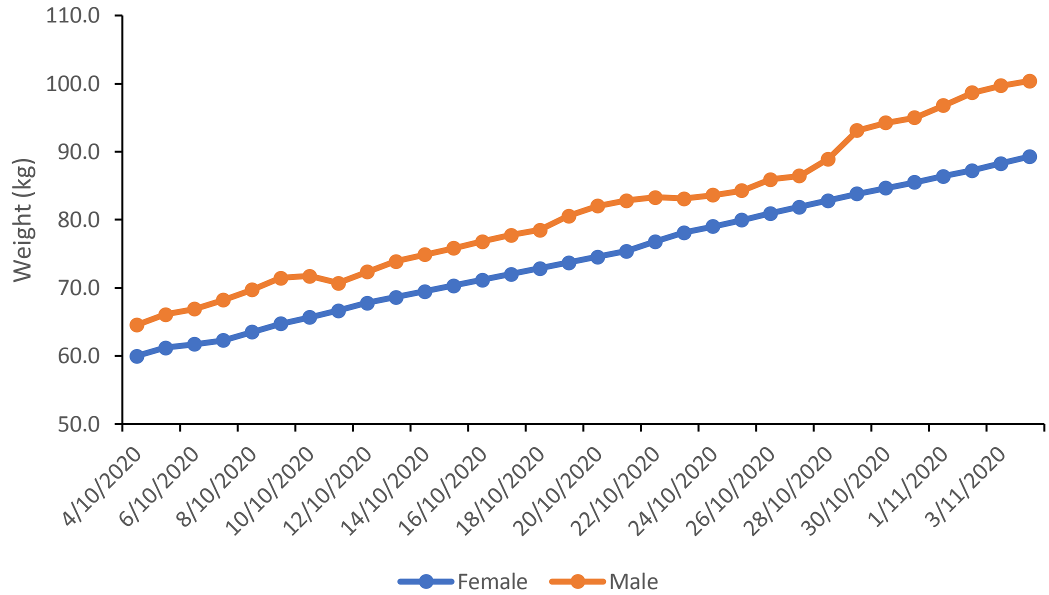

Figure 8: Batch 1 Predicted daily weights for male and female pigs from two different pens.

As observed in Figure 8 in Batch 1 the female pigs grew more steadily while the male pigs seemed to be variable in their growth rates. No factors were identified that would have contributed to the variable male growth rates. However, the wavy growth pattern of the male pigs indicates that the pigs were possibly not performing to their maximum growth capacity.

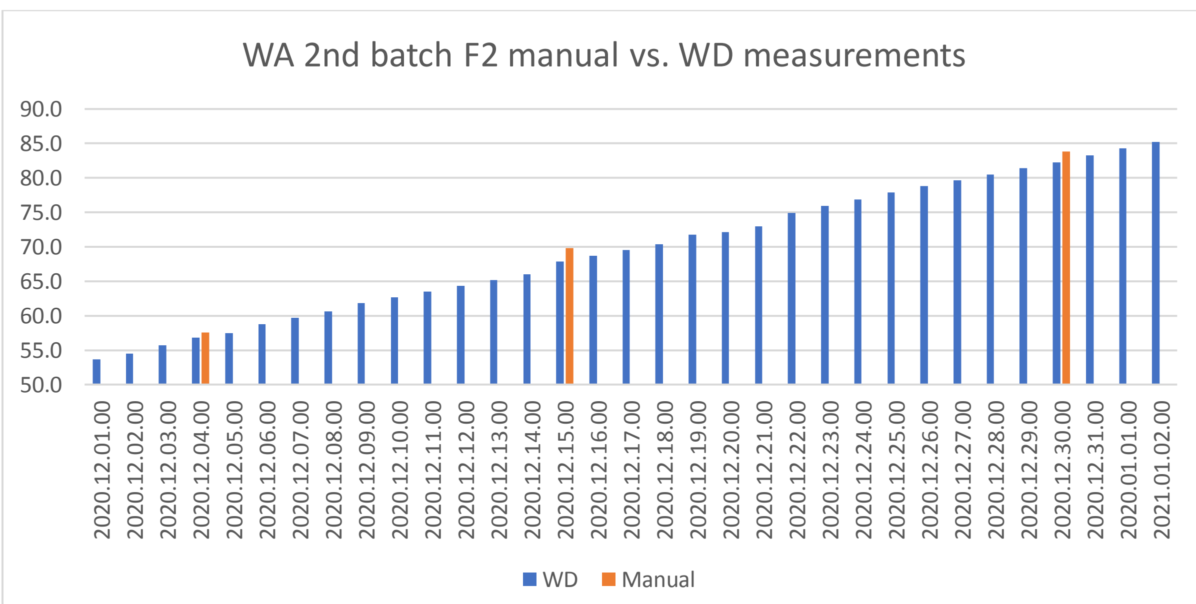

Figure 9: Batch 2 F2 data in 2020/2021 from the WA farm (female pigs).

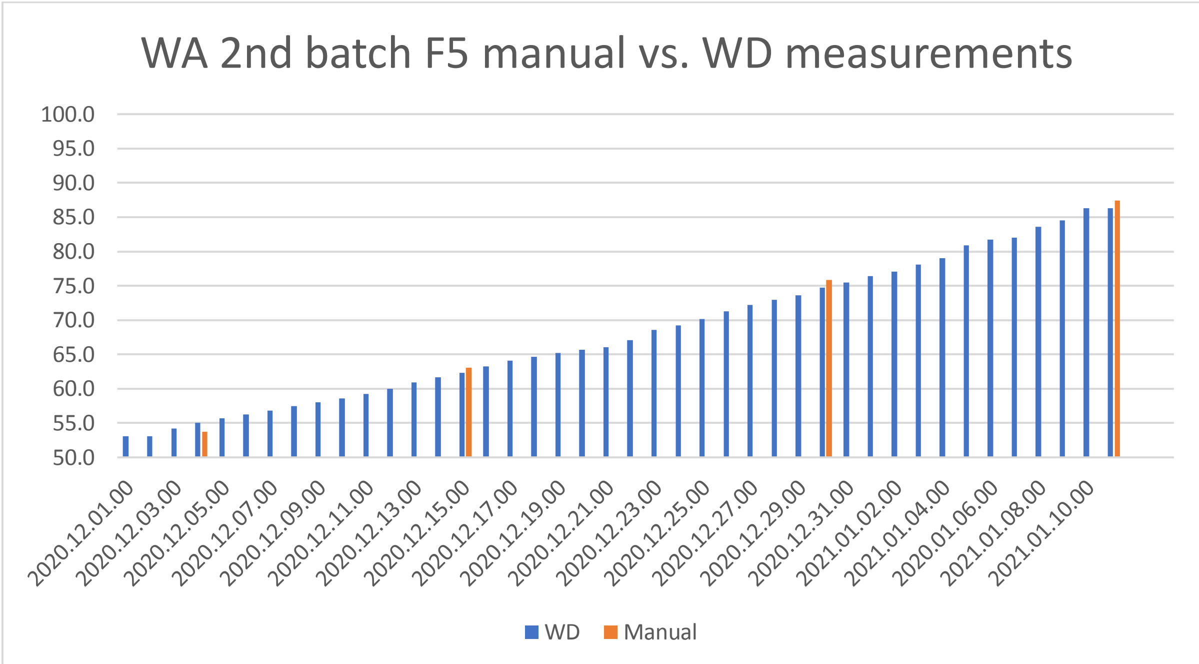

Figure 10: Batch 2 F5 data in 2020/2021 from the WA farm (male pigs).

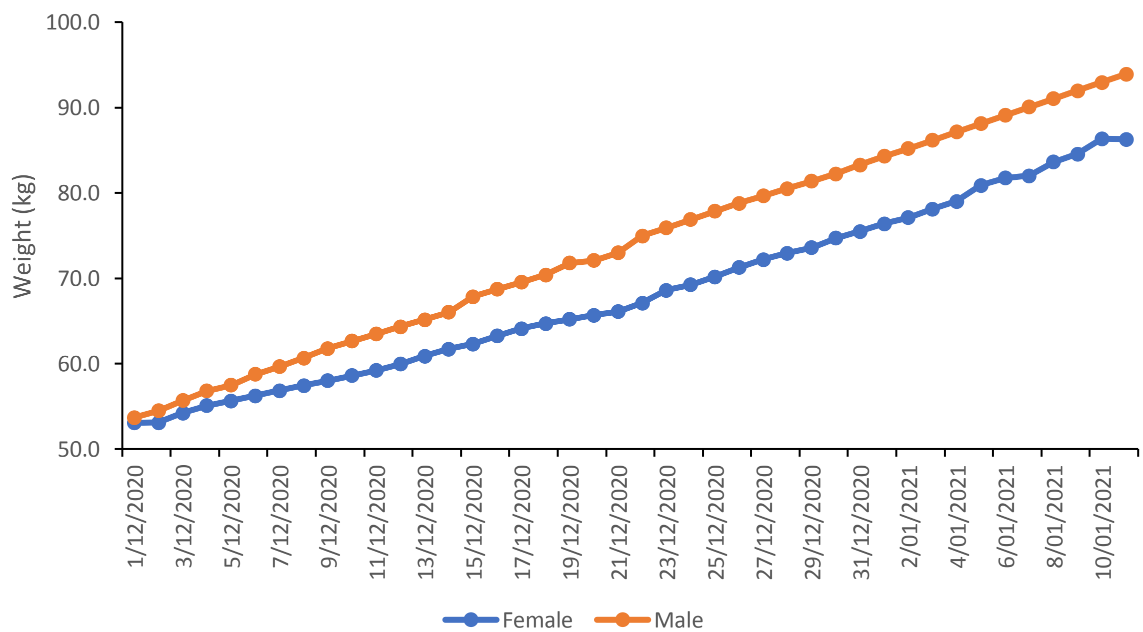

Figure 11: Batch 2 Predicted daily weights for male and female pigs from two different pens.

The male and female pigs in Batch 2 (Figure 11) appeared to grow reasonably steady with the male pigs growing faster than the female pigs.

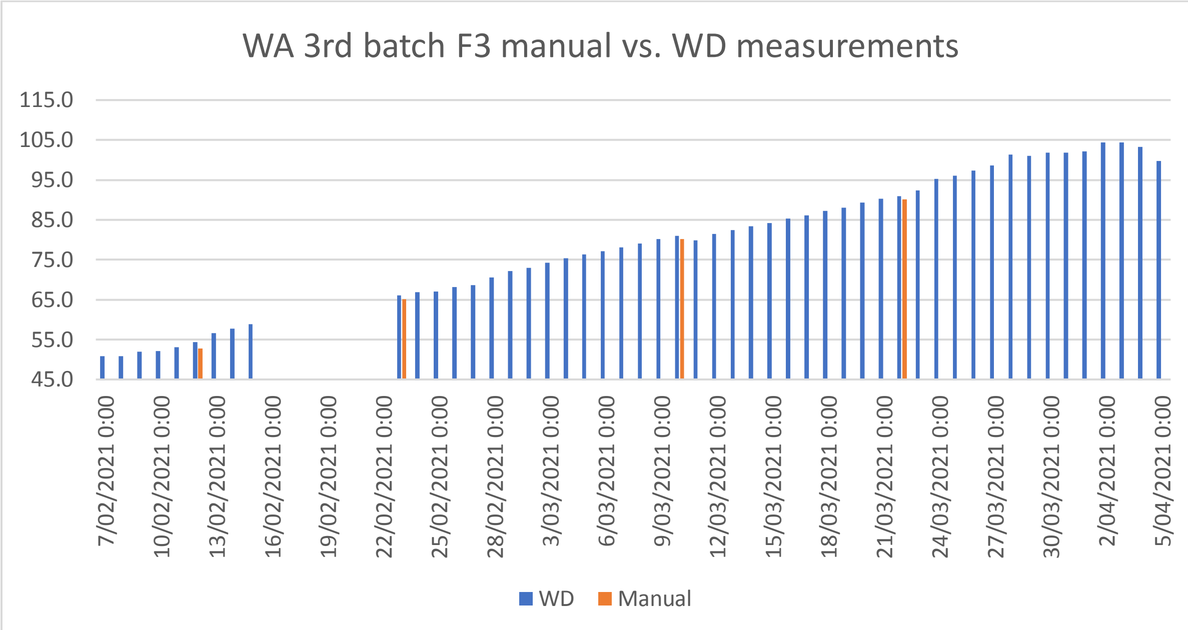

Figure 12: Batch 3 F2/3 data in 2021 from the WA farm (male pigs).

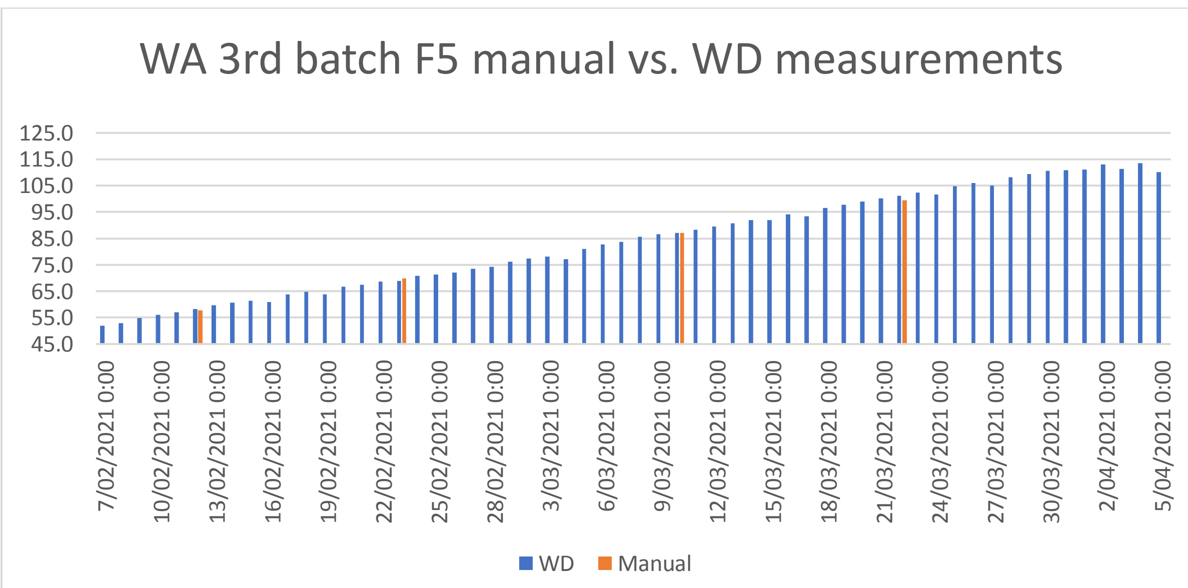

Figure 13: Batch 3 F5 data in 2021 from the WA farm (female pigs).

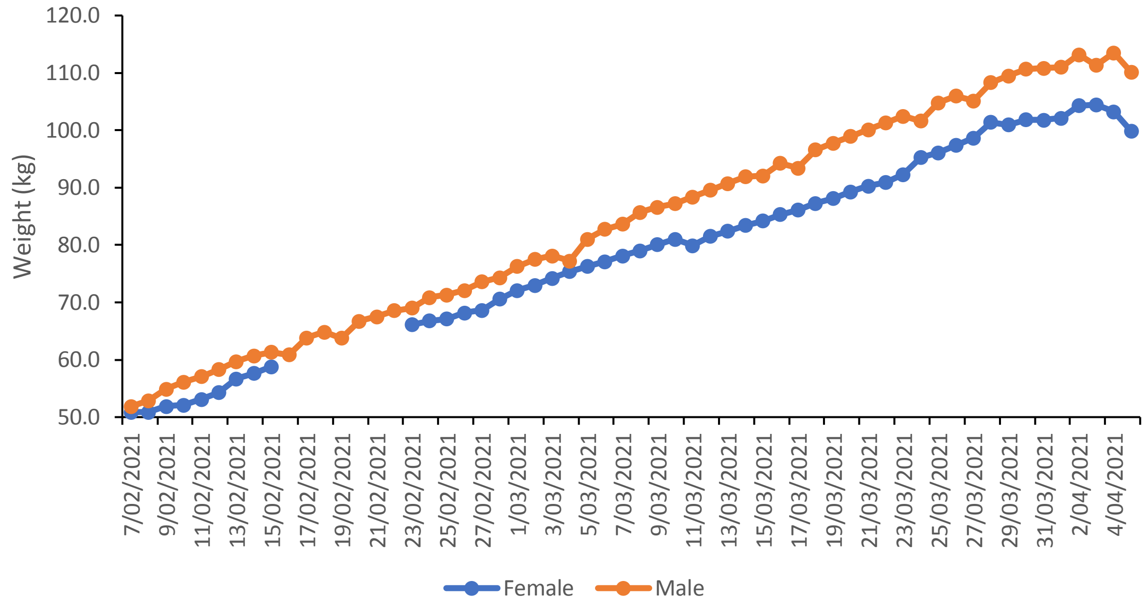

Figure 14: Batch 3 Predicted daily weights for male and female pigs from two different pens.

In Batch 3 there was an issue with the Weight-Detect™ unit and it was subsequently replaced. The downturn in weights at the end of the measurement period occurred as the heavy pigs were removed from the pens. There were some dips in growth rate for both the male and female pigs indicating possible issues within the pen hindering the maximum growth capacity of the pigs.

The data from the Weight-Detect™ units was analysed to predict the weights of the pigs and then compared against the data obtained from manually weighing the pigs (Table 1 and 2).

Table 1. Descriptive statistics associated with the measurement errors of average pen weights (kg) recorded on the farms (combined dataset) during the experimental period.

Descriptive statistic	Error (kg)[a]	Error (%)[b]	Comments
maximum	2.00	3.0	The largest difference (between the measured and predicted weights) observed was 2 kg or 3%. This was very close to the expected ±1.5 kg differences (i.e. that is normally due to feed, water consumption and due to the timing of faeces, urine release).
minimum	0.15	0.2	The smallest difference (between the measured and predicted weights) observed was 0.15 kg or 0.2%. This was an unusually small difference.
average	1.02	1.4	Average error value was very encouraging

[a] Difference between measured and predicted weights expressed in kilograms

[b] Difference between measured and predicted weights expressed as percentage of body weights of pigs

Table 2: Liveweight predicted by the Weight-Detect™ against liveweight obtained by manual weighing.

	WD (kg)	Manual (kg)	Ratio of WD:Manual
Batch 1 - female			
07/10/20	62.3	62.7	1.006
21/10/20	75.4	76.6	1.016
03/11/20	88.3	89.8	1.017
Batch 1 – male			
07/10/20	68.2	67.6	0.991
21/10/20	82.8	83.1	1.003
03/11/20	99.7	100.9	1.012
Batch 2 - female			
04/12/20	55.1	53.7	0.975
15/12/20	62.3	63.1	1.013
30/12/20	74.7	75.8	1.015
11/01/21	86.3	87.4	1.013
Batch 2 - male			
04/12/20	56.8	57.6	1.014
15/12/20	67.9	69.8	1.028
30/12/20	82.3	83.8	1.019
Batch 3 - female			
12/02/21	54.3	52.1	0.971
23/02/21	66.1	65.0	0.974
10/03/21	81.0	80.2	0.990
22/03/21	90.9	90.1	0.992
Batch 3 - male			
12/02/21	58.3	57.8	0.991
23/02/21	69.0	69.9	1.012
10/03/21	87.2	87.1	0.998
22/03/21	101.3	99.5	0.982

Lin's concordance correlation coefficient was also used to calculate how well the Weight-Detect™ unit was predicting the pig weights compared to the manual weighing. The overall correlation was 0.997 with the 95% confidence interval being 0.992 (lower) and 0.999 (upper).

Overall good results have been obtained over the experimental period, indicating the reliability of the measurements of the Weight-Detect™ instrument (Black *et al.*, 2016). However, throughout the trial it was recognised (often anecdotally and not necessarily directly connected to the current study) that there are a number of factors influencing the precision of the weight predictions on farms generally. These influencing factors will be discussed below together with a **major communication problem that was also encountered during the study**.

Factors limiting predictive precision

A number of factors, such as (1) animal behaviour, (2) camera placement and (3) farm management will influence predictive precision. ***Animal behaviours*** will have influence on predictive precision as the precision is based on even sampling of the animals in the pen. If smaller or larger animals are disproportionally represented in the images, obviously the obtained average pen weights (APWs) will be skewed in some way (Tscharke and Banhazi, 2013; Lind *et al.*, 2005). Thus, measurements undertaken in pens housing smaller number of animals (less than 35-40 animals per pen) are more likely to return incorrect measurements due to the fact that in smaller pens, even a few unusually behaving animals will have a major impact on the measurement precision. In larger pens (above 40 pigs per pen) the impact of individual animal behaviours will be 'diluted' by the predictable behaviours of a larger number of pigs. Surprisingly on this farm very good precision was achieved, despite the low pig numbers in the pens.

Correct ***camera placement*** is important in terms of ensuring appropriate and even visual sampling of the animals. Contrary to the general belief this is not best achieved by placing the camera above the feeder, as previous studies demonstrated that placing the camera close to the feeders can actually increase sampling skewedness (Tscharke and Banhazi, 2013). The best camera placement is specific for each given pen. It is unfortunate that previous publications downplayed the importance of even sampling of pigs and for a long period of time it was assumed that even sampling will naturally occur in pig pens (Schofield, 1990; Schofield, 1992). This is now proven to be incorrect and therefore the importance of correct camera installation location cannot be overemphasised. It appears that in the WA pens the cameras were placed in a best possible position **due to the dedication of the WA staff who undertook the installation work**.

The ***management of farms*** is also very important in terms of influencing the precision of the instruments. It is important that the team undertaking the monitoring is routinely informed about any management changes, such as removal/addition of pigs in the pens, any work tasks undertaken in the pens, as the disturbance of pen population could have a detrimental impact on precision (Korthals, 2001; Doeschl-Wilson *et al.*, 2005). The disturbance of pigs in the pen will change the sampling rate and sampling distribution and thus will have an influence on precision. Thus, these matters will need to be taken into consideration when explaining sudden changes in weights. Obviously, the addition or removal of pigs to the pen will have a very significant influence on the average pen weights generated by image analysis-based systems, such as the Weight-Detect™ instruments. **It was very helpful that the WA farm staff reliably completed the mobile phone-based data collection procedures (PLFEvent) that significantly helped the research team with data interpretation**.

The importance of realistic expectations and correct interpretations of results

In addition, the correct interpretation of results obtained will influence their usefulness on farms. For example, if the animals are sold in a number of smaller batches at the end of the growth period, the associated sudden changes at the very end of the growth curve should not be interpreted as the 'fault' of the monitoring system or as a 'fault' of the management but as a normal consequence of disturbed pen population. In commercial pens we often seen a destabilization of weight after a number of pigs are sold, as the behaviour of the few pigs in commercial pens can be very unpredictable. Thus, under commercial conditions, after the partial removal of the pen population, the obtained data should be viewed and interpreted with caution. This does not mean that the weight prediction system is wrong, but this reflects the natural consequences of population disturbance that yet remains to be fully understood. However, on this WA farm the results of some of the weight measurements just before marketing were much better than expected. When only a few animals remain in the pens, measurements typically become unreliable, due to the previously explain behaviour influence on measurements. On this WA farm, some of the late growth stage measurements remained surprisingly stable, **indicating little disturbance of the pigs left behind in the pens during this experimental period**.

The importance of communicating realistic expectations to end users cannot be overemphasised (Artmann, 1999). Due to the reality of the commercial environment, many companies tend to over-promise not just in terms of weight detection precision but generally in terms of what PLF can achieve on farms for producers. This is understandable but counterproductive in terms of long-term product acceptance. Therefore, clearly communicating the reasons for a certain level of imprecision to users is important. For example, it has been demonstrated before that even the timing of the release of urine and faecal materials can account for as much as 0.5-0.7 kg fluctuation in body weight per grower pig (Banhazi, unpublished). In addition, the timing of feed and water intake can add another fluctuation in body weight. **Thus, ±1-2 kg differences in body weight are absolutely acceptable, indeed expected.** This level of precision is actually comparable with weighing precision achieved on commercial farms usual manual scales. Any claims suggesting a greater level of precision that can be achieved consistently with camera-based systems should be treated with caution.

However, the main benefit is definitely not the simple measurement of the body weight, but the documentation of the shape of the growth curve that gives producers an understanding of periods of inefficiencies. The proper utilisation of collected information is to look for trends within the dataset and identify and resolve reappearing problems, such as a dip in the growth curve due to diet change or change in health conditions. If producers use the collected information to identify and resolve these problems, their return on the investment can be significant. It is also obvious that long term monitoring will yield more benefits, as long-term trends can be observed, such as reappearing weight loss in relation to certain diet change points (Pedersen and Madsen, 2001; Niemi *et al.*, 2010). In the monitored WA pens the **growth rate trends were "uneventful",** meaning that by large very straight growth curves were documented throughout the growth cycles. Thus, very few opportunities (if any) were identified for further improvements on this particular farm due to the obviously well managed production environment. It was interesting to see that in Batch 3 Fitlet 3, after weighing events pigs reduced their growth rate by a small amount consistently (Figure 9).

On farm experiences with internet communication

Major problems were encountered on the study farm related to internet reliability. It was obvious that in Australia and also in Europe the reliability of internet connection on most farms are variable (Gray *et al.*, 2017). Internet problems are especially obvious in Australia and not just because the considerable distances and remoteness of many farms. In Australia, most livestock buildings are built using metal building components such as metal roofing and building frames. These metal building components tend to significantly reduce and interfere with internet signal strength within livestock buildings. In Europe, interference caused by metal building components are less of a problem, because more livestock buildings are built from bricks and mortar. Internet and connectivity issues on farms are serious problems and unfortunately not discussed extensively on public forums. Recent studies in Europe demonstrated that even larger companies struggle with maintaining reliable internet connections consistently in livestock buildings (Banhazi, 2021, unpublished). However, the lack of open discussions about these issues resulted in the development of unrealistic expectations by many PLF technology users. Open discussions about connectivity problems on farms would be needed in the future. For example, the most efficient antenna configurations that are not complicated to install, cost effective and able to enhance the reliability of on-farm connectivity are yet to be widely adopted. Currently a new antenna configuration is trialled on a number of farms by PLF Agritech staff that might prove to be useful for improving connectivity in livestock buildings (Figure 15).

Figure 15: New and more powerful antenna is being trialled on various farms by PLFAg staff.

An alternative satellite connection option was also evaluated, via providers such as "Active8me" (https://www.activ8me.net.au/internet/skymuster/). However, these arrangements would have had additional cost implications. Thus, this option was not pursued during this project.

On this farm the connectivity problem became so bad that routine download of collected data became impossible and only labour-intensive manual download was the only option to collect the recorded data. This made routine report generation impossible. Due to the previously mentioned and serious connectivity problems experienced on farms; new Weight-Detect^{TM} installations are only set up on farms that are able to guarantee locally enhanced internet connections or internet 'hot-spots'.

Cancellation of Enviro-Detect™ evaluation

In terms of the trial of the Enviro-Detect™, unfortunately factors outside of the control of project participants made it impossible to implement. Shortly after the initiation of the project (November 2020), Dr Banhazi personally brought an Enviro-Detect™ unit from Europe. However, for various valid reasons this unit could not be installed. Thus, the manufacturing of additional units was attempted, but the manufacturing efforts unfortunately coincided with the world-wide shortage of computer chips, as documented below. Thus, within the available project timeframe, it was simply impossible to manufacture the ED units on time.

The Conversation: global-microchip-shortage-is-covids-fault
The Guardian: global-shortage-in-computer-chips-reaches-crisis-point
Forbes: shortages-have-taken-a-chip-out-of-the-global-supply-chain
SCMP: global-semiconductor-shortage
CNBC: chip-shortage-is-starting-to-have-major-real-world-consequences
Harvard Business review: global-semiconductor-shortage

Additional attempts were made to salvage older units from Europe, but as it turned out all units were trialled on farms and hence it was not possible to bring them safely to Australia and install on the WA farm. Therefore, the installation and evaluation of the Enviro-Detect™ unit as part of this project was cancelled.

4 CONCLUSIONS

The Weight-Detect™ instrument proved to be able to collect information reliably on farms, but of course a number of other factors, such as placement of the camera, management of the farm and animal behaviour can all influence the results generated. In addition, a major internet communication breakdown prevented the regular, routine download of collected information. However, if PLF tools, such as continuous monitoring of pen weights, are properly implemented on commercial farms, the financial return on using such technologies could be significant. The need for the establishment of improved internet connections on farms was also identified during the project and will be explored in future planned studies.

5 ACKNOWLEDGEMENTS

The authors gratefully acknowledge the financial support provided by the Agricultural Produce Commission - Pork Producers Committee. The authors would also like to gratefully acknowledge the professional support provided by all project partners and by the participating livestock producer.

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Appendix 1: Example of report generated by Weight-Detect™

PLF
Agritech

Western Australia
2020 November 04

Weight Gain Report of Pigs

Created by PLF Agritech

November 4, 2020

Contents

1 Pen 2 F5

Data collected from Pen 2 F5 of the Western Australia farm from 2020 September 25 to 2020 November 04.

1.1 Summary

1.1.1 Weight

Table 1. summarises the growth performance (average daily gain, ADG) of pigs in this particular pen during the previous week. This will allow users of this report to identify the specific events associated with sub-optimal and/or better than expected growth performances of the pigs during the previous week. This weekly display will put a 'magnifying glass' over the growth curve of pigs, enabling producers to analyse the performance of pigs in detail and their management responses over the previous week.

Table 1: Summary (last week)

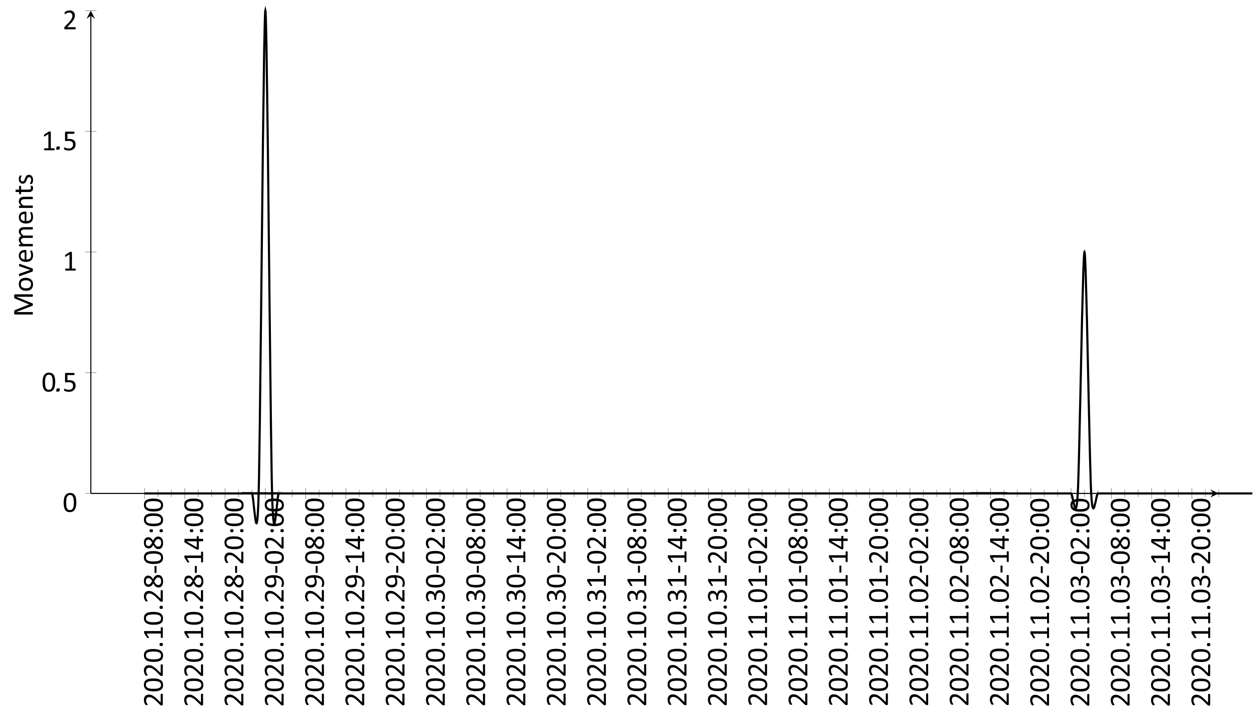
Days	Starting weight	Finishing weight	Weight gain	Growth rate
7	93.1 kg	100.4 kg	7.3 kg	1216.7 g

Table 2. summarises the growth performance (average daily gain, ADG) of pigs over the entire growth cycle. This will allow users of this report to identify general trends in relation to growth performance of the pigs in the whole growth cycle so far. This 'whole growth period' display will allow producers to have a 'helicopter view of the growth curve of pigs, enabling them to analyse the performance of pigs generally and their management responses over the whole growth cycle.

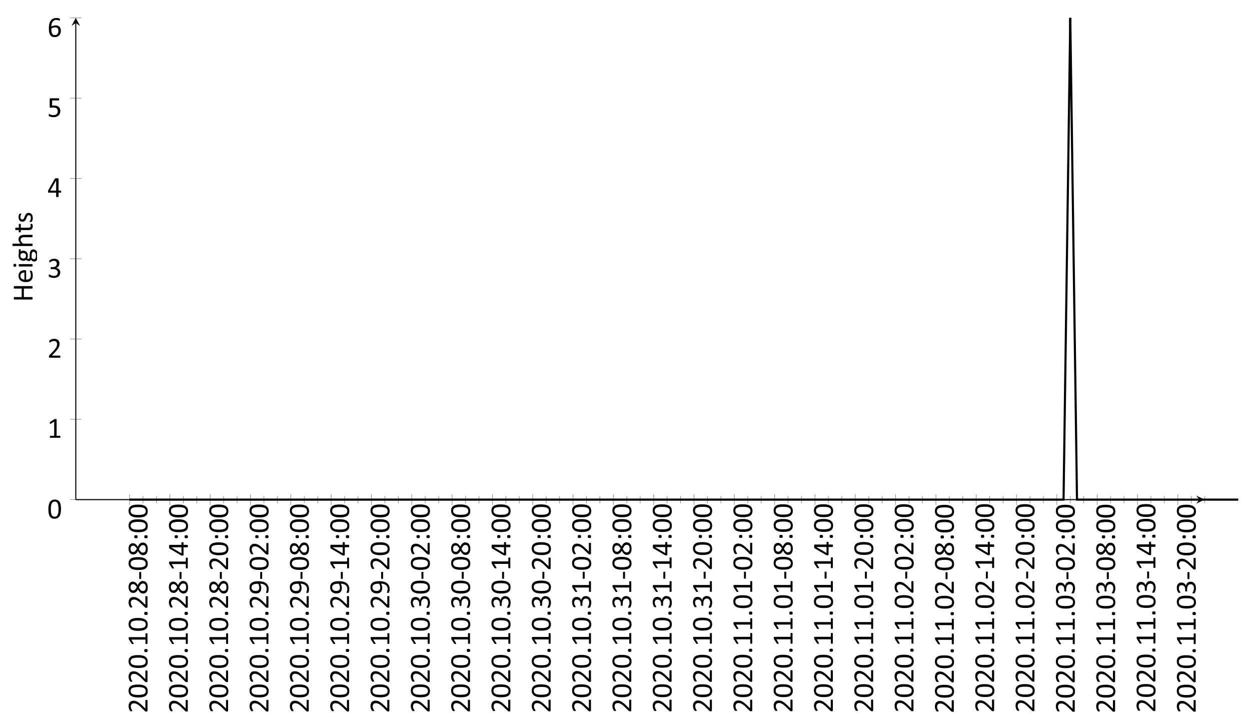
Table 2: Summary (weight gain period)

Days	Starting weight	Finishing weight	Weight gain	Growth rate
7	54.2 kg	100.4 kg	46.2 kg	1183.5 g

1.1.2 Movements last week



1.1.3 Heights last week



1.2 Weight Measurements

1.2.1 Actual status

Figure 1. provides a visual presentation of weight distribution within the monitored pen in terms of the percentage of pigs falling into different weight categories. This graph can be used by producers in a number of ways. First, it can be used closer to the end of growth cycle to predict the number of pigs within the pen that would be ready to be marketed at specific weight ranges. Throughout the growth cycle the graph can also help producers to assess the uniformity or lack of uniformity of pigs. Obviously, more pigs falling into a specific weight range will indicate a narrower weight distribution within the pen and thus more uniformity amongst the pigs. This will allow users of this report to focus on maintaining uniformity within the pen that has been demonstrated to be an important component of success in pig production (Black).

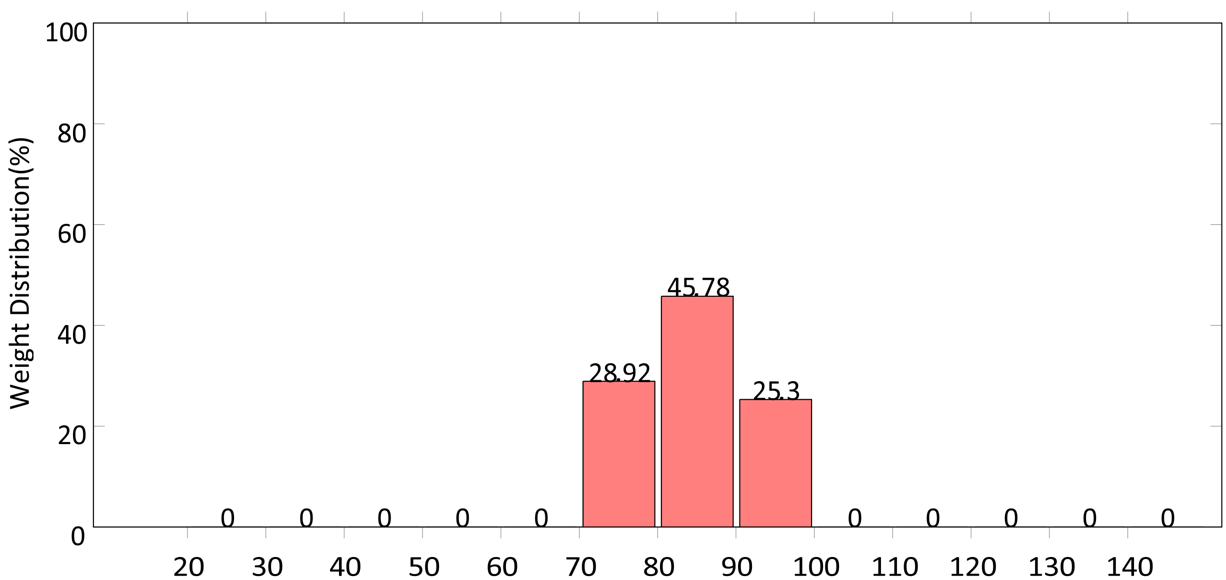


Figure 1: Weight Distribution

1.2.2 Last week

Figure 2. provides a visual presentation of the growth curve within the particular pen during the previous week. This will allow users of this report to identify the specific event associated with sub-optimal and/or better than expected growth performance of the pigs during the previous week. This weekly display will put a 'magnifying glass' over the growth curve of pigs, enabling producers to analyse the performance of pigs in detail and their management responses over the previous week. The peaks of growth curves might be associated with some positive management event (new feed introduced, vaccination etc) and the troughs might be associated with stressful events (such as the onsite of disease, out of feed/water event, incorrect introduction of new diet, thermal or suboptimal air quality stress etc.). It is worthwhile to try to associate the weekly events with the specific shape of the growth curve

and reduce the impact of negative event and strengthen the impact of positive management interventions.

On the last week the mean square error of the linear regression curve was: 6.44.

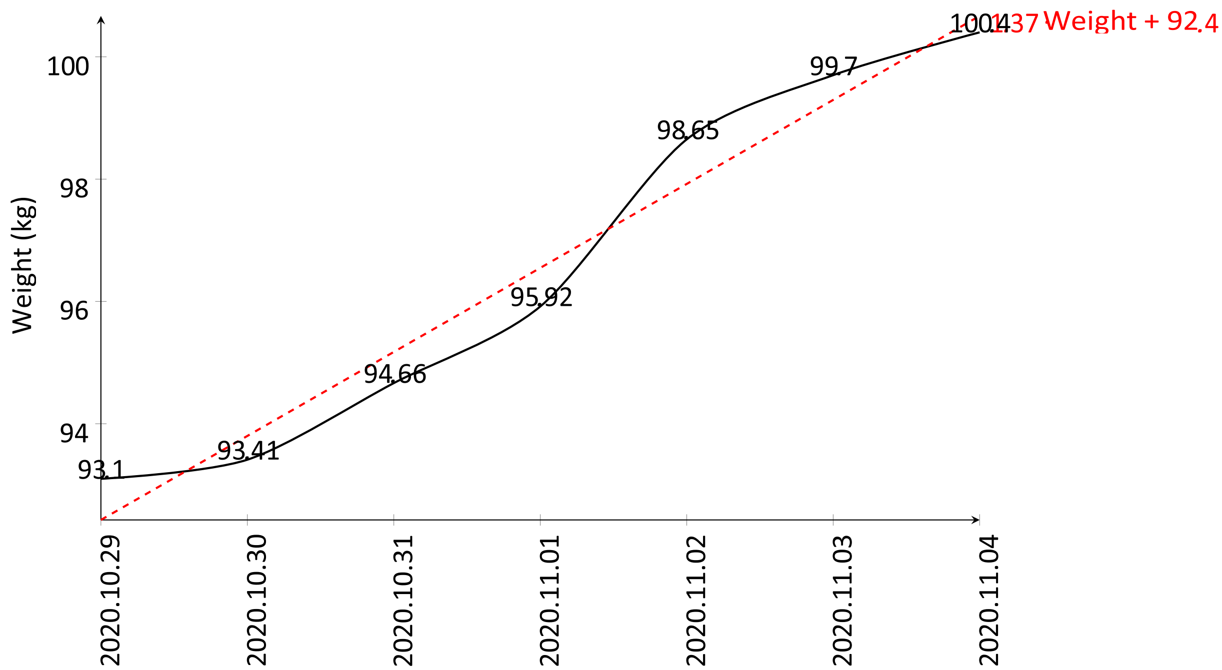


Figure 2: Weight gain (last week)

1.2.3 Weight gain period

Figure 3. provides a visual presentation of the growth curve within the particular pen during the whole growth cycle. This will allow users of this report to identify general management approach associated with the growth performance of the pigs during the whole growth cycle.
This will allow users of this report to identify general trends in relation to growth performance of the pigs in the growth cycle so far. This 'whole growth period' display will allow producers to have a 'helicopter view of the growth curve of pigs, enabling them to analyse the performance of pigs generally and their management responses over the whole growth cycle. As a general trend, it can be stated that the more even, straight is the growth curve, the more likely that the pigs are growing while maximising their generic potential and achieving the best performance within the specific circumstances i.e. housing, climate, diary and health conditions. Rugged, wavy growth curve indicates that pigs had to deal with set-backs within their cycle and probably not realising their full potential under the circumstances. If this is the case, management procedures have to be reviewed and management of these animals tightened to ensure that they do not have to suffer setbacks within their growth cycle.

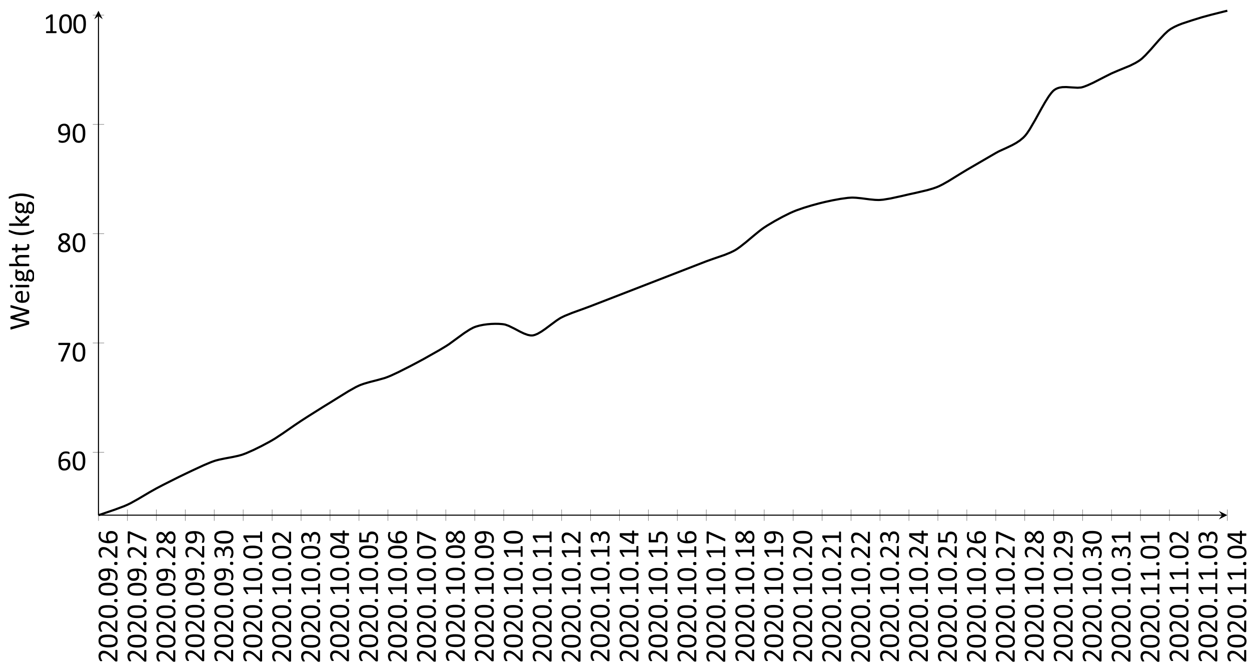


Figure 3: Weight gain (weight gain period)

1.2.4 Standard deviation of the daily measurements

Figure 4. provides a visual presentation of the changes in the Standard Deviation (SD) of the weights within the pen for the whole growth period. Larger the value, the less uniform of the weights is expected to be within the pen. Large SD (or UNIFORMITY INDEX) is an indication that the pigs in the pen are started to 'grow apart' and their uniformity is declining. On the other hand, if the UNIFORMITY INDEX is small (preferably below 5), it would indicate that the uniformity in the pen is good.

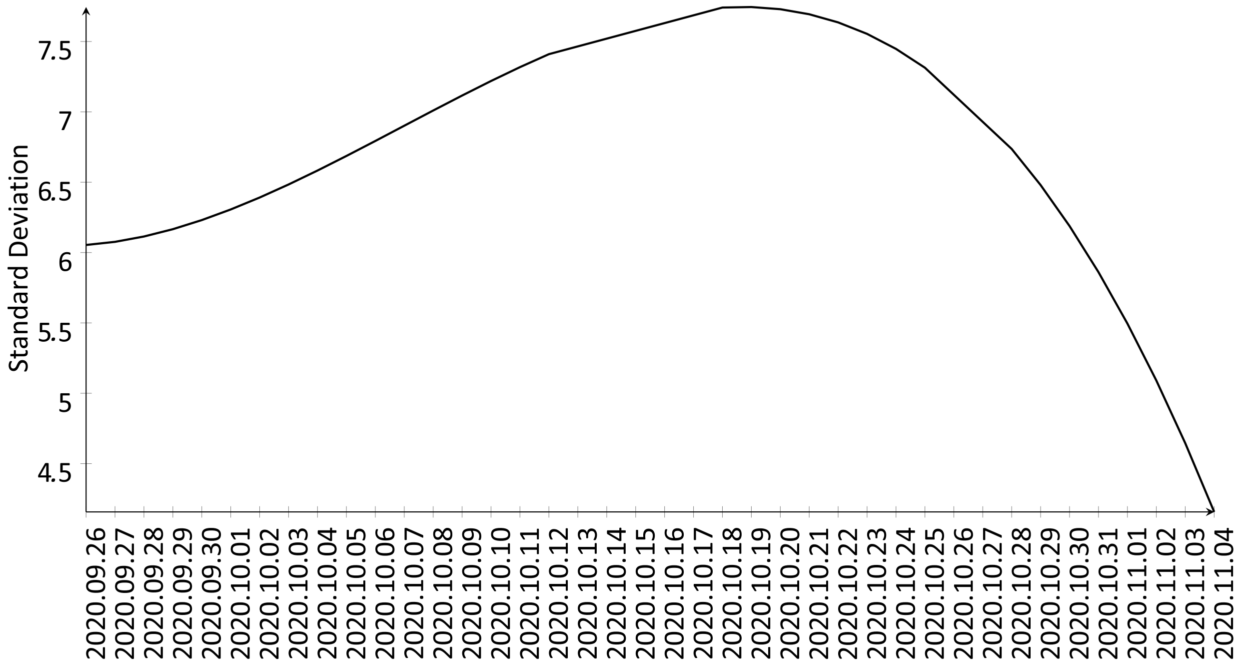


Figure 4: Deviation of daily measurements

2 Pen 1 F2

Data collected from Pen 1 F2 of the Western Australia farm from 2020 September 25 to 2020 November
04.

2.1 Summary

2.1.1 Weight

Table 3. summarises the growth performance (average daily gain, ADG) of pigs in this particular pen during the previous week. This will allow users of this report to identify the specific events associated with sub-optimal and/or better than expected growth performances of the pigs during the previous week. This weekly display will put a 'magnifying glass' over the growth curve of pigs, enabling producers to analyse the performance of pigs in detail and their management responses over the previous week.

Table 3: Summary (last week)

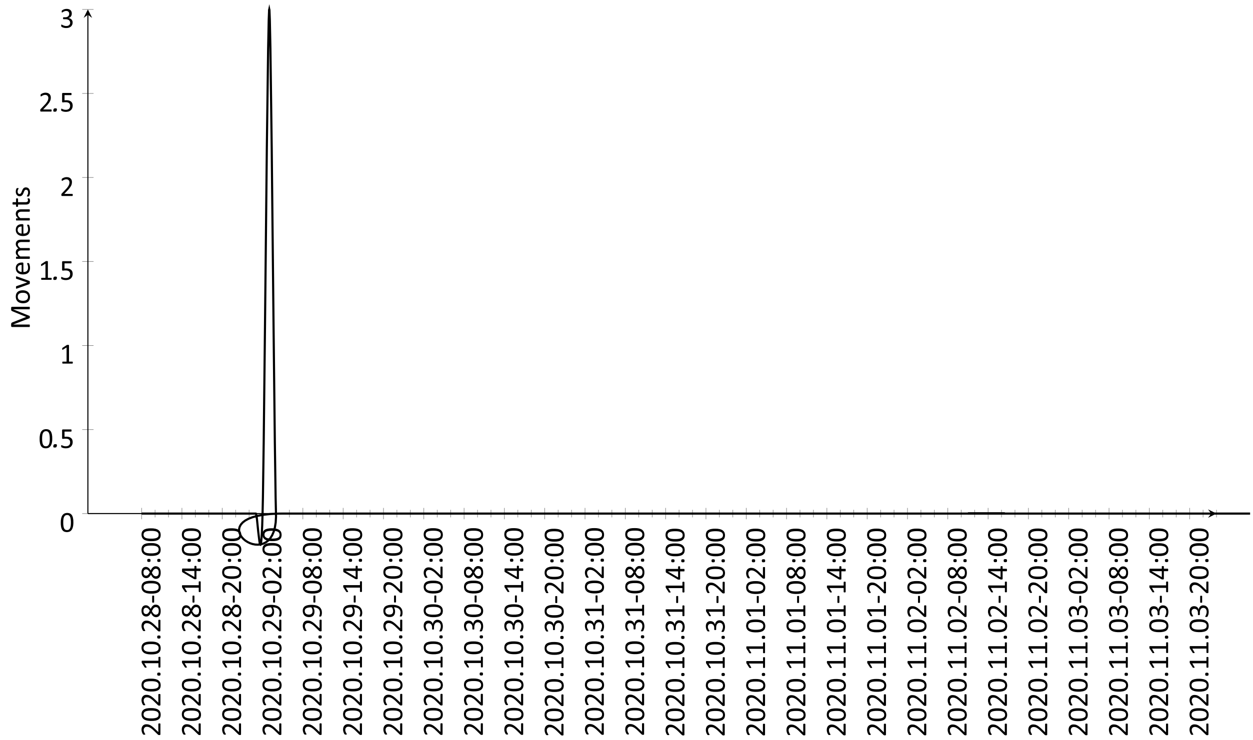
Days	Starting weight	Finishing weight	Weight gain	Growth rate
7	83.8 kg	89.3 kg	5.5 kg	916.7 g

Table 4. summarises the growth performance (average daily gain, ADG) of pigs over the entire growth cycle. This will allow users of this report to identify general trends in relation to growth performance of the pigs in the whole growth cycle so far. This 'whole growth period' display will allow producers to have a 'helicopter view of the growth curve of pigs, enabling them to analyse the performance of pigs generally and their management responses over the whole growth cycle.

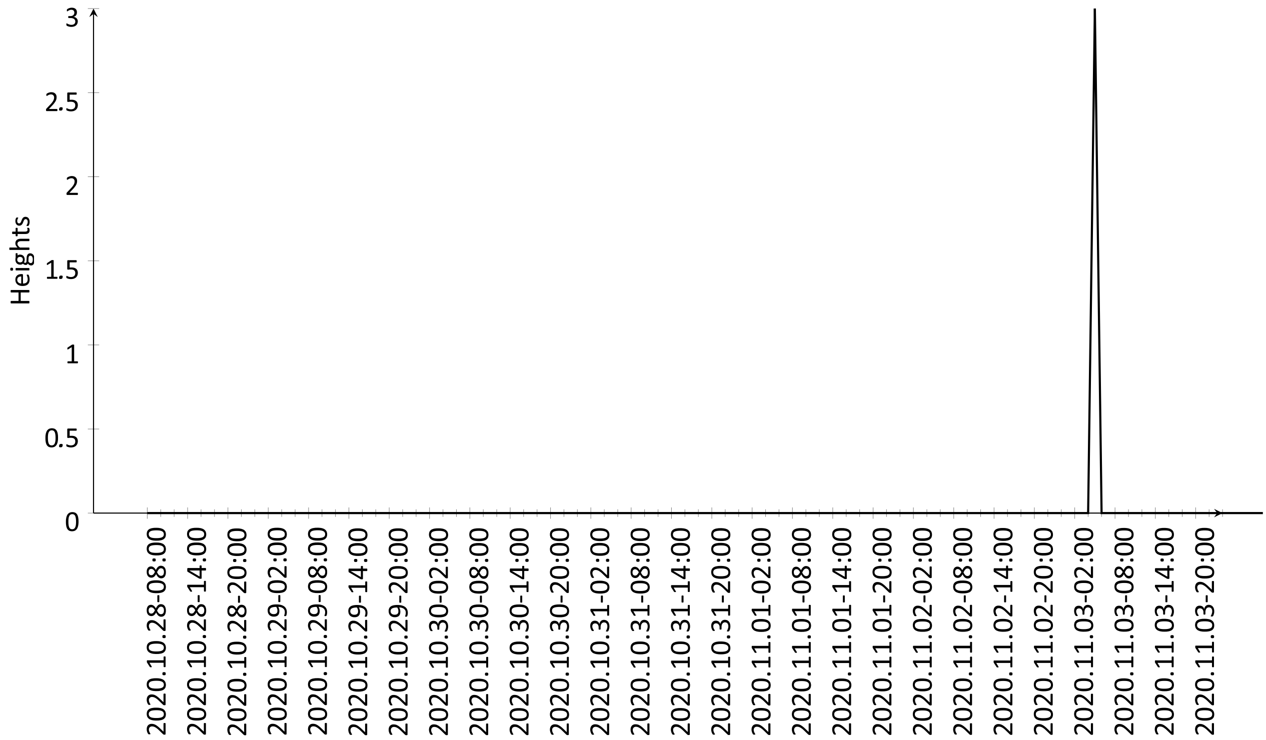
Table 4: Summary (weight gain period)

Days	Starting weight	Finishing weight	Weight gain	Growth rate
35	53.7 kg	89.3 kg	35.6 kg	1047.2 g

2.1.2 Movements last week



2.1.3 Heights last week



2.2 Weight Measurements

2.2.1 Actual status

Figure 5. provides a visual presentation of weight distribution within the monitored pen in terms of the percentage of pigs falling into different weight categories. This graph can be used by producers in a number of ways. First, it can be used closer to the end of growth cycle to predict the number of pigs within the pen that would be ready to be marketed at specific weight ranges. Throughout the growth cycle the graph can also help producers to assess the uniformity or lack of uniformity of pigs. Obviously, more pigs falling into a specific weight range will indicate a narrower weight distribution within the pen and thus more uniformity amongst the pigs. This will allow users of this report to focus on maintaining uniformity within the pen that has been demonstrated to be an important component of success in pig production (Black).

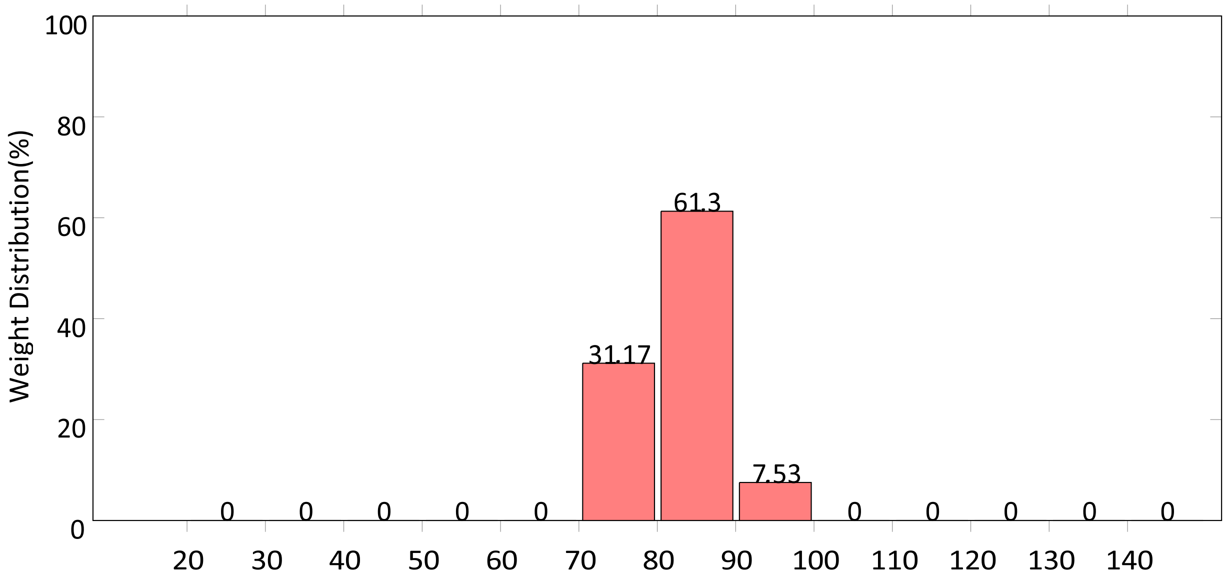


Figure 5: Weight Distribution

2.2.2 Last week

Figure 6. provides a visual presentation of the growth curve within the particular pen during the previous week. This will allow users of this report to identify the specific event associated with sub-optimal and/or better than expected growth performance of the pigs during the previous week. This weekly display will put a 'magnifying glass' over the growth curve of pigs, enabling producers to analyse the performance of pigs in detail and their management responses over the previous week. The peaks of growth curves might be associated with some positive management event (new feed introduced, vaccination etc) and the troughs might be associated with stressful events (such as the onsite of disease, out of feed/water event, incorrect introduction of new diet, thermal or suboptimal air quality stress etc.). It is worthwhile to try to associate the weekly events with the specific shape of the growth curve and reduce the impact of negative event and strengthen the impact of positive management interventions.

On the last week the mean square error of the linear regression curve was: 3.92.

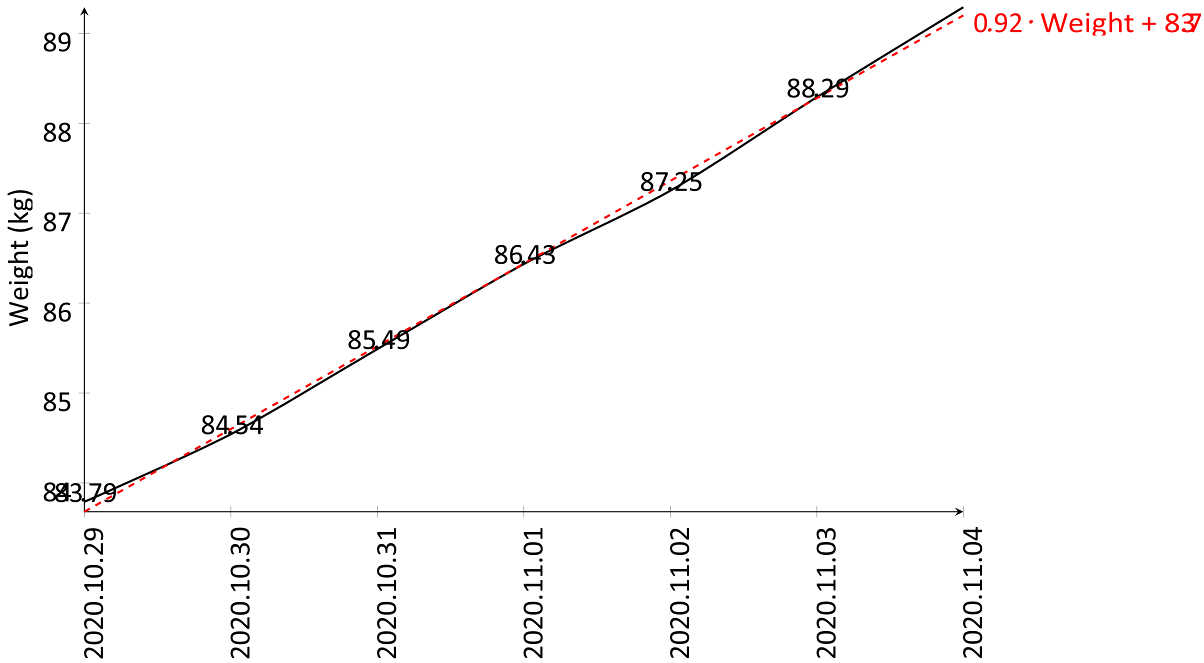


Figure 6: Weight gain (last week)

2.2.3 Weight gain period

Figure 7. provides a visual presentation of the growth curve within the particular pen during the whole growth cycle. This will allow users of this report to identify general management approach associated with the growth performance of the pigs during the whole growth cycle.
This will allow users of this report to identify general trends in relation to growth performance of the pigs in the growth cycle so far. This 'whole growth period' display will allow producers to have a 'helicopter view of the growth curve of pigs, enabling them to analyse the performance of pigs generally and their management responses over the whole growth cycle. As a general trend, it can be stated that the more even, straight is the growth curve, the more likely that the pigs are growing while maximising their generic potential and achieving the best performance within the specific circumstances i.e. housing, climate, diary and health conditions. Rugged, wavy growth curve indicates that pigs had to deal with set-backs within their cycle and probably not realising their full potential under the circumstances. If this is the case, management procedures have to be reviewed and management of these animals tightened to ensure that they do not have to suffer setbacks within their growth cycle.

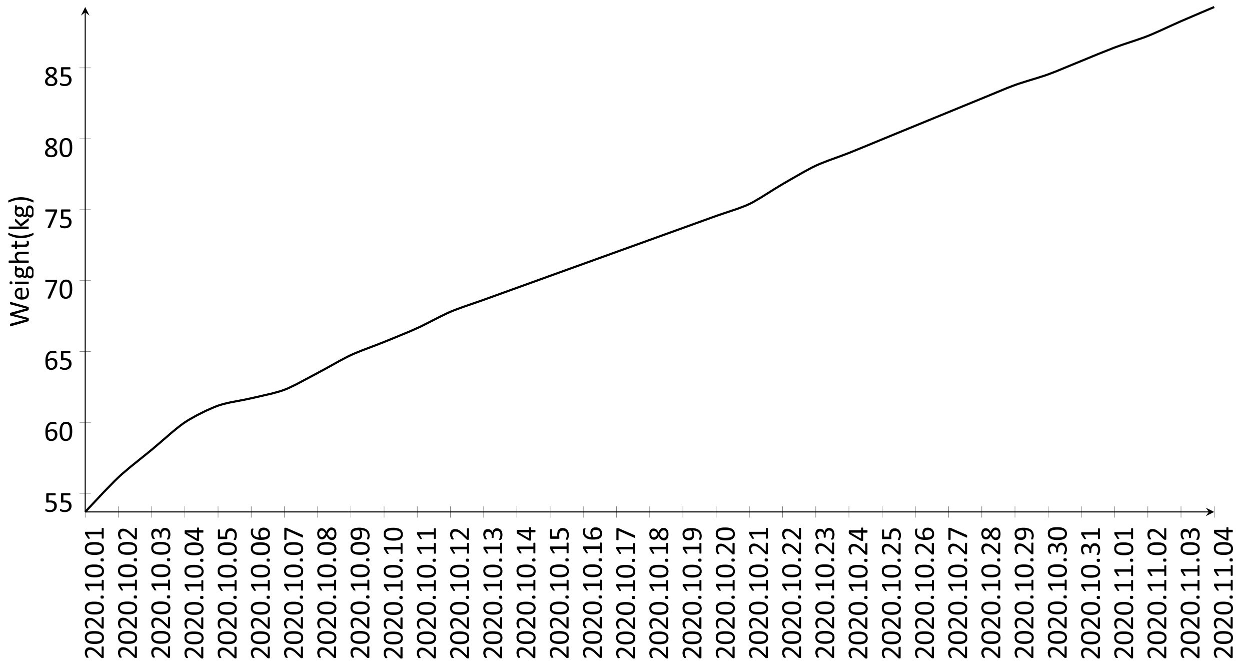


Figure 7: Weight gain (weight gain period)

2.2.4 Standard deviation of the daily measurements

Figure 8. provides a visual presentation of the changes in the Standard Deviation (SD) of the weights within the pen for the whole growth period. Larger the value, the less uniform of the weights is expected to be within the pen. Large SD (or UNIFORMITY INDEX) is an indication that the pigs in the pen are started to 'grow apart' and their uniformity is declining. On the other hand, if the UNIFORMITY INDEX is small (preferably below 5), it would indicate that the uniformity in the pen is good.

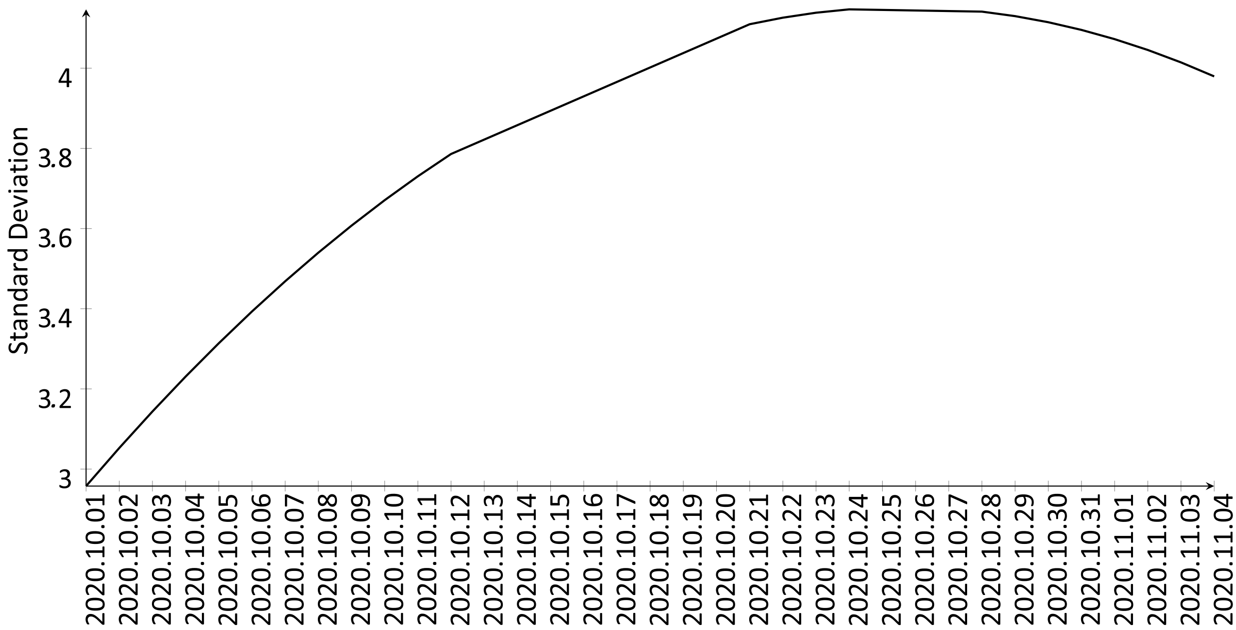


Figure 8: Deviation of daily measurements