Optimizing amount of straw for growing-finishing pigs - considering time spent in manipulative behaviour

Optimering av halmmängd till slaktgrisar med hänsyn till tiden spenderad i manipulativt beteende

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Photo: Jos Botermans

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Abstract

In support to a decision to be made by the Swedish central competent authority on a minimal amount of straw for conventional growing-finishing pigs, a study using 168 pigs provided 7 different amounts of straw (20, 40, 60, 80, 100, 200 or 300 grams/pig/day) was performed. The straw was provided either once or four times per day. Detailed behaviour observations were made using focal animal sampling and continuous recording for one hour between 9 and 10 am and again between 3 and 4 pm. The data analysis is presented in three ways: broken stick model, polynomial trend line and logarithmic trend line. No method was suitable on its own but the use of all the methods simultaneously was found to portray the data in the best way.

No significant differences were found when comparing pens provided with straw once or four times per day. The maximum time spent in manipulative behaviour towards straw could not be observed in the current study suggesting that the amount of straw needed for pigs to perform that behaviour at maximum is above 300g. The time spent in manipulative behaviour directed towards straw was increased over 10% ranging up to 27% in all the pens receiving over 200g of straw per day compared to the range from 4-22% in pens receiving 20-100g of straw. Meanwhile, the time spent in redirected behaviour was decreased below 5% in all the pens receiving over 200g of straw per day. 200g is also the value received when using the broken stick model for data of redirected behaviour from all the pens.

Sammanfattning

Den mängd halm som behövs för att grisar i konventionell produktion i Sverige ska kunna utföra så mycket manipulativt beteende mot halm som möjligt samtidigt som förekomsten av omriktat beteende mot artfränder är så liten som möjligt diskuteras i följande studie. Resultaten kan sedan ligga till grund för beslut från den svenska myndigheten angående halmmängder till grisar i Sverige. 168 grisar gavs 7 olika mängder halm (20, 40, 60, 80, 100, 200 eller 300 gram / gris / dag) uppdelade i en eller fyra givor per dag. Detaljerade kontinuerliga beteende observationer gjordes med fokal djurs sampling under en timme mellan klockan 9 och 10 och igen mellan 15 och 16. Data presenteras med hjälp av tre metoder: broken stick modellen, polynom trendlinje och logaritmisk trendlinje. Ingen av metoderna passar bra nog att användas individuellt men genom att använda alla metoderna tillsammans kan data beskrivas på ett bra sätt.

Resultaten visar inga signifikanta skillnader mellan boxar som gavs halm en eller fyra gånger per dag. Förekomsten av manipulativa beteenden tycks öka med ökande mängd halm. Vid tilldelning av över 200 g halm så utförs manipulativa beteende mot halm över 10% av tiden i alla boxarna. Dessutom spenderades mindre än 5% av tiden i omriktade beteende i alla boxar som fick mer än 200g av halm per dag. 200g är även det värde som observerades i de grafer av broken stick modellen där alla boxar inkluderades oberoende av hur många gånger de fick halm.

1. Introduction

In the pigs natural environment the animals spends a big part of the day in exploratory behaviour and in search for food (Stolba & Wood-Gush, 1989, cited in Studnitz et al, 2007). The behaviour of rooting and digging in the ground is very strongly motivated in the pig. The motivation to perform this exploratory behaviour is not decreased even after the dietary requirement has been fulfilled through feeding (Studnitz et al, 2007). If this behaviour cannot be performed, the pig may instead begin to perform abnormal behaviour as a substitute to the exploratory behaviour. These behaviours, such as tail biting, are not wanted because they can for example damage the skin of the pigs, which in turn has implications to the animal welfare (Fraser et al, 1991, cited in Studnitz et al, 2007 & EFSA, 2007).

In the animal welfare legislation (Jordbruksverket, 2010a) the provision of straw is mentioned in chapter 3, 7 § as: *"... bedding product shall be given in such quantities so that they meet the pigs' needs for exploration and comfort...."*. The Commission Directive (2001/93/EC) states that: *''pigs must have permanent access to sufficient quantity of material to enable proper investigation and manipulation activities, such as straw, hay, wood, sawdust, mushroom compost, peat or a mixture of such, which does not compromise the health of the animals''*

The directive is made to meet the exploratory needs of the pigs and reduce abnormal behaviours directed towards pen mates, thus improving welfare. However, the provision of straw also affects the pig producers. When straw is provided it can clog the slats and drainage so that the removal of feaces is decreased. This increases the work for the animal keeper which involves extra costs for management of the pigs. Producing, handling and provision of high quality straw itself is also a substantial cost. Provision of low quality (moldy) straw can cause various health issues and reduce production, it is therefore important to manage the straw carefully. Studies have shown that the more straw that is provided for the pigs the more behaviour is directed towards the straw (Studnitz et al, 2007). The needs of the animals and the needs of the farmers are thus in conflict where the pigs need as much straw as possible and the farmers want to provide the pigs with as little straw as possible.

Neither the Commission Directive nor the Swedish animal welfare regulation mentions the amount of straw that ought to be provided. Furthermore, the amount of straw that is needed to keep the pigs satisfied and the minimum amount of straw that reduce the abnormal behaviour directed towards pen mates has not been investigated. So, the purpose of this study is to analyse the behaviour of pigs given different amounts of straw with a further purpose to provide a basis for directions concerning the minimum amount of straw needed for growing-finishing pigs in insulated, conventional housing systems. This is mainly done using the broken stick model which result in a point (c-value) in the data where the increase in the provision of straw no longer affects behaviour.

The following questions were asked:

- Will the provision of straw several times per day decrease the prevalence of redirected behaviour?

At what point does:

- the increased provision of straw no longer increase the prevalence of the behaviour manipulating straw?
- the increased provision of straw no longer decrease the prevalence of redirected behaviour towards pen mates?

The hypothesis is that provision of straw several times per day will result in more manipulative behaviour directed towards straw and less behaviour directed towards pen mates. Furthermore, the more straw that is provided the more manipulative behaviour towards straw will be performed and less redirected behaviours will be performed.

2. Background

2.1 Swedish pig production and animal welfare laws

The European commission provides directives and regulations concerning pig production in the EU but the pig producers across the countries also have to follow the national regulations provided by their national competent authority. This national legislation need to include the minimum requirements from the legislation decided in the EU but it can also include national legislation. Sweden has included a few extra rules leading to a more strict animal protection law compared to many countries in the EU. The legislation is being seen as a basis of "the Swedish concept" (LRF, 2005) which includes for example:

- Provision of bedding material to allow pigs to behave naturally.
- Banning of tail docking.
- More space allowance.

Pig producers in Sweden produced around 263,5 million kilos of pig meat during 2010 (Jordbruksverket, 2010b). The production is based on piglet producing herds and growing/finishing herds holding about 160000 sows and their offspring (Statistiska centralbyrån, 2010). The pig houses are usually simply built, both insulated and un-insulated. The choice of housing is dependent on the production type and whether piglets, sows, dry sows or growing-finishing pigs are being kept there. After weaning, pigs are usually kept in groups of 8-10 until slaughter when they are 6-7 months old and weigh approximately 115 kg.

Sows and dry sows are usually loosely housed in groups on deep straw litter but pens for growing-finishing pigs are usually divided in two parts, one lying area with concrete floor and a dunging area with slatted floor (Figure 1). The slatted floors are used for many reasons. They save time because the pigs clean the pen themselves by pressing the feaces down the slats when they move around. So the slatted floors result in cleaner and more hygienic pens which reduce the risk of infections such as enteric disorders or Salmonella. However the risk of clogging the drainage below the pig pen is increased with provision of straw. There is also a higher risk of respiratory lesions in pigs housed on slatted floors and pigs tend to prefer solid floors to slatted floors because of the negative effect on the legs and feet (EFSA, 2005). Consequently there is a conflict between the importance of straw for the wellbeing of the pigs and the willingness of the farmers to minimize the amount of straw.

Figure 1. Conventional growing-finishing pen.

Photo: Rebecka Westin.

2.2 What is animal welfare?

Governments, researches and the public may all have different opinions on what animal welfare actually means, the opinions are influenced by for example philosophical and cultural views. Although there are many definitions and the following quotes are usually used as guidance of animal welfare.

Brambell (1965)
"Welfare is a wide term that embraces both physical and mental well-being of the animal. Any attempt to evaluate welfare, therefore, must take into account the scientific evidence concerning the feelings of the animals that can be derived from their structure, functions and also from their behaviour."

Duncan (1996)
"Welfare depends on how the animal feels."

Blood (2007)
"Animal welfare means the avoidance of abuse and exploitation of animals by humans by maintaining appropriate standards of accommodation, feeding and general care, the prevention and treatment of disease, and the assurance of freedom from harassment, and unnecessary discomfort and pain."

Broom (1996)
"The welfare of an animal is its state as regard to its attempts to cope with its environment"

OIE, 2010a (The world animal health organization)
"Animal welfare means how an animal is coping with the conditions in which it lives. An animal is in a good state of welfare if (as indicated by scientific evidence) it is healthy, comfortable, well nourished, safe, able to express innate behaviour, and if it is not suffering from unpleasant states such as pain, fear, and distress. Good animal welfare requires disease prevention and veterinary treatment, appropriate shelter, management, nutrition, humane handling and humane slaughter/killing. Animal welfare refers to the state of the animal; the treatment that an animal receives is covered by other terms such as animal care, animal husbandry, and humane treatment".

OEI describe their organization as: "the intergovernmental organization responsible for improving animal health worldwide". OIE recommend different principles, such as the five freedoms, in their work towards better animal welfare (OIE, 2010b).

2.2.1 The five freedoms

An investigation led by Roger Brambell of how farmed animals should be kept was commissioned by the United Kingdom government in 1965. The investigation resulted in basic guidelines for farm animals which later was elaborated and termed the five freedoms (Bousfield (2010)):

1. Freedom from thirst and hunger - by ready access to fresh water and a diet to maintain full health and vigour.
2. Freedom from discomfort - by providing an appropriate environment including shelter and a comfortable resting area. (including thermal comfort, (Welfare quality, 2009))
3. Freedom from pain, injury, and disease - by prevention or rapid diagnosis and treatment.
4. Freedom to express normal behaviour - by providing sufficient space, proper facilities and company of the animal's own kind.
5. Freedom from fear and distress - by ensuring conditions and treatment which avoid mental suffering.

In the current study, the definition of welfare is used where physical and mental aspects are considered and the five freedoms are used as the base in assessing welfare. The freedom from pain, injury, and disease is represented by the prevalence of redirected behaviour in the current study and the freedom to express normal behaviour is represented by the prevalence of manipulating straw.

2.3 What do pigs need?

Pigs are omnivorous animals, in the wild they roam over large areas and spend a big part of their awake hours searching for food and exploring the environment. A study made by Stolba & Wood-Gush (1989) (cited in Studnitz et al, 2007) show that pigs in semi-natural environment spend 52% of the day grazing and 23% of the time moving around. The pig explores the environment by rooting, sniffing, biting and chewing different items, these different elements are performed regardless of the purpose of the exploring behaviour (Studnitz et al, 2007). Pigs are generalists, which mean that they eat a wide range of feed sources including: grass, fruit, berries, seeds, nuts, roots, grubs, insects, worms, carrion and small animals such as frogs and rodents (Baxter, 1989, Virgós, 2002 & Jensen, 2002). The pig's snout is very adapted to that way of finding food. It can lift logs and dig in the soil to find roots or seeds but it is also very sensitive, the olfactory system is very advanced in pigs (Jensen, 2002).

The rooting behaviour is very important for pigs and studies show that indoor kept pigs will start to root immediately when provided with access to soil. It also seems like the longer pigs are housed without the ability to root, the more they will perform the behaviour when given access to rooting material (Studnitz et al, 2007). Jensen (2002) also states that the rooting motions will be performed even if the pigs are kept on concrete floor. The behaviour seems to be linked with novelty which was showed by Haskell et al, (1996a) (cited in Studnitz et al, 2007) when pigs rooted more if there was a possibility of finding new items to root in. Both performing the exploratory behaviour as such and reaching the goal, for example finding food, are important parameters of a behavioural need. Pigs will work for access to straw and they will explore the environment even if they are familiar with it, for example the pen. Pigs can continue to explore until the motivation to perform another behaviour get stronger, for example hunger or tiredness (Studnitz et al, 2007). A study made by Beattie & O'Connel (2002) showed that the highest prevalence of exploratory behaviour is performed when feed is not present in rooting material which suggests that exploratory behaviour is performed regardless of its capacity to still hunger.

Two types of exploratory behaviour can be observed, consumatory behaviour and exploratory behaviour termed contrafreeloading (Studnitz et al, 2007). The consumatory behaviour involves the search for food until hunger is reduced. Growing-finishing pigs are usually fed ad libitum right up till a few weeks before slaughter when feeding may be restricted. This restrictive feeding, which involves different levels of hunger, has in many studies increased the prevalence of exploratory behaviour. However the motivation to perform this behaviour is not eliminated with ad libitum feeding. The pig might still not be provided with sufficient essential nutrients or the feed may be too finely minced, in that case the chewing part of the consumatory behaviour is not satisfied and exploratory behaviour is stimulated (Studnitz et al, 2007).

Pigs seem to be able to associate rooting behaviour with feed which makes them stop performing the behaviour when there is no more feed to be found. When feed is placed in

spent mushroom compost rooting behaviour is decreased. Most rooting behaviour was performed when no feed was found, suggesting that the behaviour is performed regardless if it results in stilled hunger (Beattie & O'Connel, 2002).

The other type of exploratory behaviour is generally called contrafreeloading which means that pigs will often work for feed even if it is provided. This phenomenon is thought to contradict theories of optimal foraging where animals thrive to forage as efficiently as possible to get as much energy from feeding in the fastest way possible (Alcock, 1997). One explanation of contrafreeloading is that it involves an advantage for the animal to gather information about the environment. The pigs roam over wide areas in search for feed exploring even sub-optimal feeding places, however the environments is constantly changing and a sub-optimal feeding place today might be an optimal feeding place in the future (Inglis et al, 1997). So exploring the environment is a natural way of finding feed sources and it is important for the pig's fitness.

2.4 The importance of straw

The housing of pigs today is usually simple and delivers few opportunities of experiencing new things. The exploratory behaviour however, is still being performed which shows that the motivation to perform these behaviours is strong and pigs will work hard to be able to root (Studnitz et al, 2007). When the environment is barren some pigs redirect their exploratory behaviour towards pen mates (redirected behaviour) and for example belly nosing which is a rooting movement on the belly of another pig, or tail biting can occur. The behaviours involve decreased welfare in many ways. First of all, the behaviours are abnormal and occur when the normal behavioural needs of the pigs are not met. Secondly, the behaviour can cause injuries to the receiving pig (Fraser et al, 1991, cited in Studnitz et al, 2007 & EFSA, 2007). The provision of straw is a well studied mean of reducing redirected behaviour towards pen mates concluded in a review by Studnitz et al. (2007). The provision of straw appears to be more successful in reducing redirected behaviour than for example supplying more space. Pigs housed at only 0.5 m² with the access of straw still performed less redirected behaviour compared to pigs housed at 2.3 m² with no access to straw (Beattie et al, 1996 cited in Studnitz et al, 2007).

Studies show that the more straw that is provided, the more exploratory behaviour is directed towards the straw and not the pen mates (Munsterhjelm et al. 2009). Amounts of up to 2 kg of straw still show a proportional increase in exploratory behaviour directed towards straw and decrease in redirected behaviour (Arey, 1993, cited in Studnitz et al, 2007). A summary the results on the effects of straw from the review by Studnitz (2007) can be seen in table 1.

Table 1. Summary of results on the effect of straw. Studnitz et al. (2007)

Material	**Behaviour**	**Effect**
Peat + straw at the same time	Exploratory behaviour redirected towards penmates	↓
Straw, bark chips and braches	Behavioural repertoire	↑
Straw	Exploratory behaviour redirected towards penmates	↓
Straw	Exploratory behaviour redirected towards penmates	↓
Straw flow	Exploratory behaviour redirected towards penmates	↓
	Exploratory behaviour redirected towards equipment	↓
Straw+beam+branches	Exploratory behaviour redirected towards penmates	↓
1/2 bucket of straw for 10 pigs	Exploratory behaviour redirected towards penmates	=
Straw from dispenser	Tail biting	↓
↓	Behaviour decreased	
↑	Behaviour increased	
=	Behaviour unaffected	

The review also included a comparative study between different rooting materials when straw was used as the base material. The other materials were then ranked according to their influence on exploratory behaviour. The following materials were ranked above straw: peat, mushroom compost, sand, sawdust, wood shavings, branches, beets, and silage (Studnitz et al, 2007). Different properties, such as length of straw can also affect the exploratory behaviour of pigs. For example, chopped straw is not as manipulatable as full length straw and pigs provided chopped straw performed more redirected behaviour compared to pigs provided with full length straw. Chopped straw is thus not recommended to use for growing-finishing pigs, however the choice of chopped straw is still better than no straw at all (Day et al, 2008).

The provision of straw is beneficial in a lot of ways. It does not only act as a substrate to explore that reduces redirected behaviour, it can also increase growth rate and average daily gain (Morgan et el, 1997, Munsterhjelm et al, 2009, Peeters et al, 2006) while it also provides the pigs with warmth and comfort.

2.4.1 The aim of the study

Evidence has been shown of the positive effects of straw on time spent in manipulative behaviour towards straw and redirected behaviour. The aim of the current study is to observe the occurrence of both the behaviours and find the optimal amount of straw for growing-finishing pigs with both behaviours in mind. I.e. the minimum amount of straw that provides the pigs with enough straw to be able to perform sufficient manipulative behaviour, furthermore reduce the prevalence of redirected behaviour.

3. Material and methods

3.1 Animals and housing

The study was made by the department of Rural Building and Animal Husbandry (Alnarp) in collaboration with the Department of Animal Environment and Health (Skara). The pigs in the current study were kept at the research farm Odarslöv in conventional insulated buildings, in pens with slatted floor (figure 1b). A total of 168 growing-finishing pigs divided in three rounds with 14 groups of 4 in each round were used. All of the pigs were housed in the same place, they were of the same gene material ((LRxY)xH), cared for by the same keeper, provided the same type of straw (chopped to lengths ranging from 10 mm to 100 mm) during similar climatic circumstances. The observations were carried out during different parts of the year, the first round was done in December, the second in April and the third in August. The average temperature inside the pig house was 15.8°C, 19.4°C and 23.0°C in rounds 1, 2 and 3 respectively. The feed was provided in troughs and the amount was provided according to the SLU feeding norm (Simonsson, 2006) and it was the same for all pigs during the entire study. The groups were subjects to different treatments including:

- 7 different amounts of straw (20, 40, 60, 80, 100, 200 or 300grams/pig/day)
- Straw rationed once daily (10 am) or divided in four times per day (10 am, 12am, 2pm and 4pm)

Thus 14 different combinations were studied. Those groups that received straw four times per day were placed closest to the door with a wall separating them from the groups which only received straw once daily to minimize the effect of one group to the other.

Figure 1b. Pens from the research farm Odarslöv. Screen shot from the computer program used to observe behaviour.

3.2 Behaviour observations

3.2.1 Preparations in the pig house

Seven weeks after the pigs were placed at Odarslöv the pigs were video recorded using the TVCCD 180 from Monacor (Monacor, 2011). Four groups of pigs were recorded simultaneously during 24 hours (2 groups provided with straw once/day and 2 groups provided with straw 4 times /day). Then the video camera was moved to the next group of pens, until all the groups had been recorded. The cameras were infrared sensitive but some lighting was on during the night. The recordings were then used to observe the behaviour of the pigs according to the ethogram in table 2.

Table 2. Ethogram

Behaviour variables	**Definition**
Resting	Lying, standing, sitting without performing other behaviour
Walking	Taking steps without performing other behaviour
Eating	Nose in feed trough
Drinking	Manipulating water nipple
Manipulating straw	Nibbling/rooting/biting on floor
Manipulating environment	Nibbling/rooting/biting on surface above ground level
Fence contact	Interaction/sniffing/biting/pawing one or more pigs in adjacent pen
Aggression	Two or more pigs in the same pen are fighting by oral contact
Riding	A pig is mounting another pig
Nibbling	A pig nibbles another pig
Belly massage	A pig is massaging another pig´s belly/side with a visible vertical movement
Tail biting	A pig is biting/touching/sucking another pig´s tail
Ear biting	A pig is biting/touching/sucking another pig´s ear
Other	Behaviour not included in ethogram

Feeding took place at 8.30 am and at 2.30 pm. The behaviour was observed in detail by one observer using focal animals sampling and continuous recording for one hour between 9 and 10 am and again between 3 and 4 pm. At the time of observations, the observer did not receive any information about which treatment each pen was subjected to. The observations were done after feeding with the assumption that the pigs would be extra motivated to perform manipulative behaviour after feeding. Furthermore, if the pigs do not get substrate to manipulate they would perform redirected behaviour instead.

Some days the animal keepers entered the pig house to provide straw before 10 am or 4 pm. When this occurred the observations were done one hour prior to the time of entrance. I.e. if the animal keeper entered at 16.47 then observations were done from 15.47-16.47 that day. This was done so that behaviour was not affected by any outside occurrences. Therefore, before any observations were done the time of entry of the animal keeper was noted. There was also one incident where the feeding was delayed by one hour. This resulted in a disrupted pattern in feeding and handing of straw which is important for the unity of treatments. Thus

the pens affected were removed, removed observations were classified as “missing values”. Behaviours can also be classified as missing values if it cannot be differentiated with certainty because lack of vision. Certain postures make it difficult to differentiate behaviours, for example when a pig is lying down but is still active with its snout on the ground a clear distinction of actual manipulation is necessary for the behaviour to be noted as “manipulate straw”. If this does not occur the behaviour is noted as missing value.

All four pigs in the pen served as focal animal once during the hour of observation. The first focal animal was observed between minute 0-15 and the second focal animal between minute 15-30. The same procedure was carried out for the final two focal animals in the group so that the observations were taking place in a continuous time frame. If observations would be carried out during the same time period for all the pigs some behaviours could be overestimated since they affect more than one animal.

When a starting time had been decided the focal animals were chosen at random. At the first picture frame the observer assigned the pigs numbers ranging from 1-4. The positions of the pigs where noted. The order in which the pigs should be observed was then randomly picked with the ”Research Randomizer” by Urbaniak & Plous (2011). The position of the first pig was already noted so the second pig was followed by fast forwarding the tape until 15 minutes had passed then the position of the pig was noted. The tape was rewind and the third and fourth focal animal was followed until 30 and 45 minutes had passed respectively before positions were noted. This was done so that the observations could be done easily, just changing focal animal every 15 minutes.

3.2.2 Observations

The observations began with following the first focal animal and every time the animal changed its behaviour a note was made in the data sheet (in Microsoft Office Excel 2007). Only behaviours that were carried out by the focal animal were noted, not those directed towards the focal animal by others. This was done to reduce overestimation of social behaviours. The video program displayed the live time of the recordings and when a behaviour was terminated the video was paused. The time and the type of behaviour were noted. When a change of focal animal was done the behaviour bout was terminated exactly after 15 minutes. The actual start of the behaviour bout from the following focal animal was not taken into consideration; it began right after the time was up for the last focal animals. This means that the bout lengths of the behaviours are not accurate for 3 behaviours during the hour (when the change of focal animal was made). The actual bout lengths showed in results can also be misleading if a "missing value" was noted in the middle of a behaviour. For example if one pig was "resting" and another pig stood in such a way so that the observer did not get a clear view of the behaviour of the focal pig, then the time of the impaired vision was noted as a missing value. Even if the pig in theory could be "resting" throughout the "missing value" the notation will still cause a termination of the behaviour. Thus a "resting" behaviour bout could be counted as two even though the pig did not actually change its behaviour.

Bout describes a certain behaviour repertoire and the length of that behaviour. In the current study one bout is the time spent in one behaviour without any interruptions of other behaviours from the ethogram except "walking" or "resting". This means that a behaviour bout was counted as one if it was carried out with an interruption of either "walking" or "resting" of a maximum of 5 seconds. I.e. if an animal was manipulating straw, lifted its snout from the ground and started to walk for 4 seconds before it lowered its snout to the ground again, the time spent walking was not noted and the whole period was noted as "manipulate straw".

3.3 Data processing

When the observations were done, the data sheets looked like the example in table 3. The column “time” is the onset of behaviour. The “behaviour” column describes the codes to each behaviour, explained to the right. The time spent in each behaviour is calculated by subtracting the first time with the second etc. The total time spent, frequency and mean value of bout lengths of every behaviour, including the standard deviation of mean were then calculated.

Table 3. Data sheet used to collect behaviour data.

Time	**Behaviour**	**Time spent**		
09:01:47	N	00:01:47	Walking	W
09:01:55	W	00:00:08	Resting	RE
09:02:11	FC	00:00:05	Eating	E
09:02:16	W	etc	Drinking	D
09:04:05	N		Mani. Straw	MS
09:04:13	MS		Mani. Env.	ME
09:04:21	ME		Fence cont.	FC
09:04:54	N		Aggression	A
09:04:58	W		Riding	RI
09:05:13	D		Nibbling	N
09:07:24	FC		Belly massage	BM
09:07:29	W		Tail bite	TB
09:07:31	ME		Ear bite	EB
			Other	O

The behaviour “riding” was removed because no incidence of that behaviour was recorded during the hours of observations. The behaviours “nibbling”, “tail bite” and “ear bite” is combined into “redirected behaviour” which is the term used in the following text. Note that the behaviour belly massage is not included in the term redirected behaviour in the current study because of its connection to suckling motivation and weaning age (Weary et al, 1999 & Widowski et al, 2008).

The statistical analysis was made using multiple linear regressions in SAS; the program was used to see if there were significant differences between the pens receiving straw once or four times per day. The rest of the statistics were done in a descriptive manner using the broken stick model and charts with trend lines in Microsoft office: Excel 2007.

Originally, the broken stick model was planned to be the only method used to evaluate the data. It was considered because of its possibility to give one value on the minimal amount of straw to growing-finishing pigs. This value represents the point where an increase in the provision of straw no longer affects the behaviour further. It could also represent the basic data needed for the competent authority to make decisions about the provision of straw in pig production in Sweden. The use of trend lines in charts from Microsoft office: Excel 2007 was used because of the uncertain results received from the broken stick model.

4. Results

4.1 Statistical models

4.1.1 Broken stick model

The broken stick model was used to find the point where the amount of straw did not affected behaviour further. The data was run through the program MatLab (Mathworks Inc.) which created a chart with a trend line. Optimally, the trend line should increase/decrease in the beginning to then slope out at a breaking point (c-value). MatLab is programmed to find the best possible breaking point within the range of the data.

4.1.2 Excel: Polynomial trend line

The use of excel charts with insertion of trend lines proved sufficient enough to discuss the results as trends. The polynomial trend line with two dimensions is only used to find a possible minimum/maximum. It cannot be used to view the distribution of the data since it assumes that the data is distributed according to a quadratic equation even though it may not be.

4.1.3 Excel: Logarithmic trend line

A logarithmic trend line is used to see the actual trend of the data. It is the best choice when looking at data which increases/decreases quickly in the beginning to then level out. This was the case in the current study. The minimal amounts of straw can be discussed as approximate numbers looking at the area around the trend line where it starts to level out.

Even though no significant differences was found between pens provided with straw once or four times per day, small differences can be found for some behaviours observing the charts and using descriptive statistics. The differences can still be interesting to discuss. So, when discussing differences between pens provided with straw once and four times per day the observations are done from watching the charts.

4.1.4 R-square values

The r-squared value explains how well the equation of the trend line describes and approximates the real data. Sometimes this is called “the fit”. R-squared is ranging from 0-1 and the closer to 1, the better the fit. The r-square values of the charts from the current study are very low, ranging from 0,000-0,300 which means that the trend lines can only explain up to 30% of the variation in the data. The r-square values of the polynomial trend lines appear to be somewhat bigger than for the logarithmic trend lines. This suggests that the polynomial trend line describe the data better than the logarithmic. Overall since the r-squared value is so low, regardless of the method used, the lines cannot be considered a true description of the data.

4.2 Behavioural observations

4.2.1 Manipulating straw

4.2.1.1 Broken stick

In the broken stick model the behaviour manipulating straw resulted in an "inverted stick" for pens provided with straw once (figure 3a) and four times (figure 3b). An inverted line suggests that the breaking point is located somewhere outside the range of the study. MetLab is programmed to find the best point in the data. When the best point is located outside of the range of the study the program will find the next best thing inside the range which results in the inverted line. The c-values (breaking point) in both charts are located at 100g of straw.

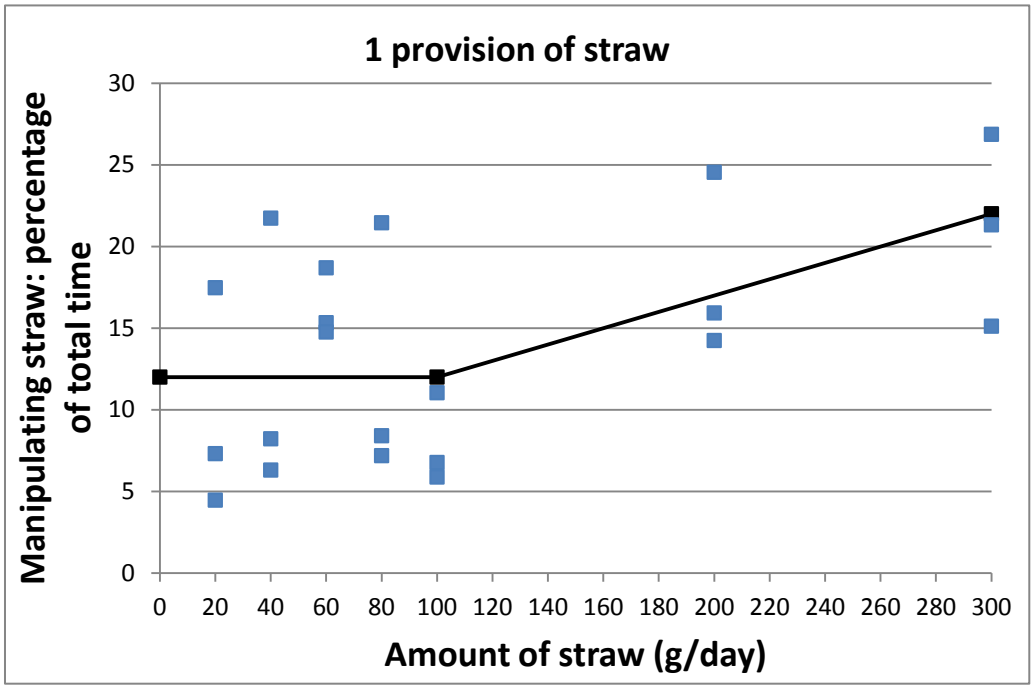

Figure 3a. Broken stick model for manipulate straw in pens receiving straw once per day.

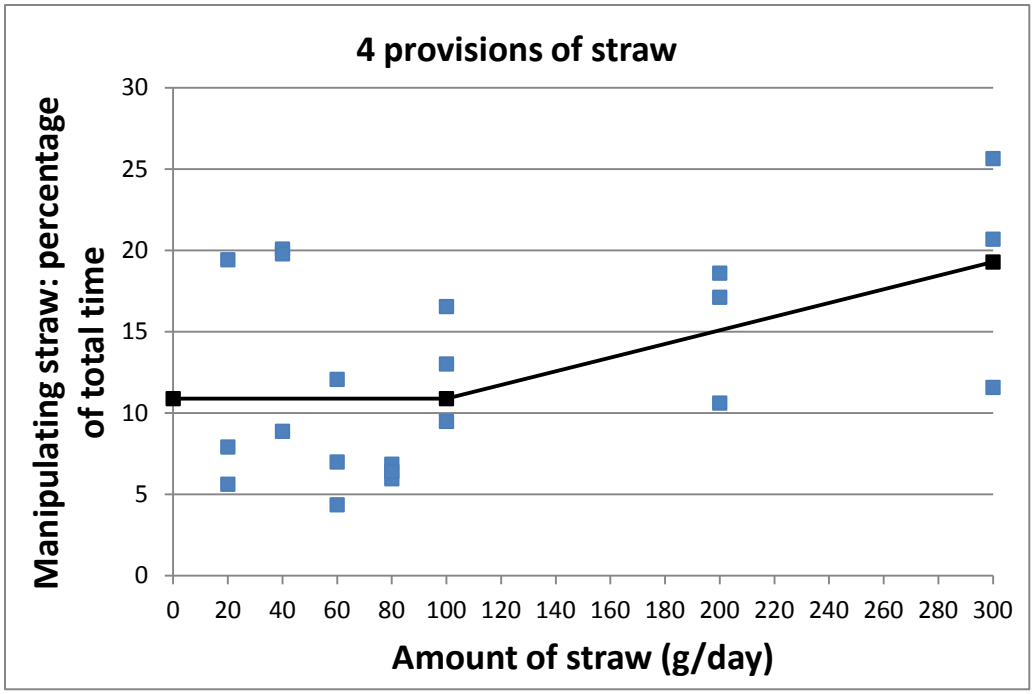

Figure 3b. Broken stick model for manipulate straw in pens receiving straw four times per day.

No significant differences were found between pens provided with straw once or four times per day concerning the behaviours manipulating straw and redirected behaviour. The data was run trough SAS (originally Statistical Analysis System, SAS Institute Inc) and resulted in p-values ranging from 0.4112-0.7696. Therefore, new analyses were done where the treatments were combined i.e. there were six pens per amount of straw instead of three. The chart showing the behaviour manipulating straw did not change, showing an inverted line with a c-value at 100g of straw and a maximum at 300g (figure 4).

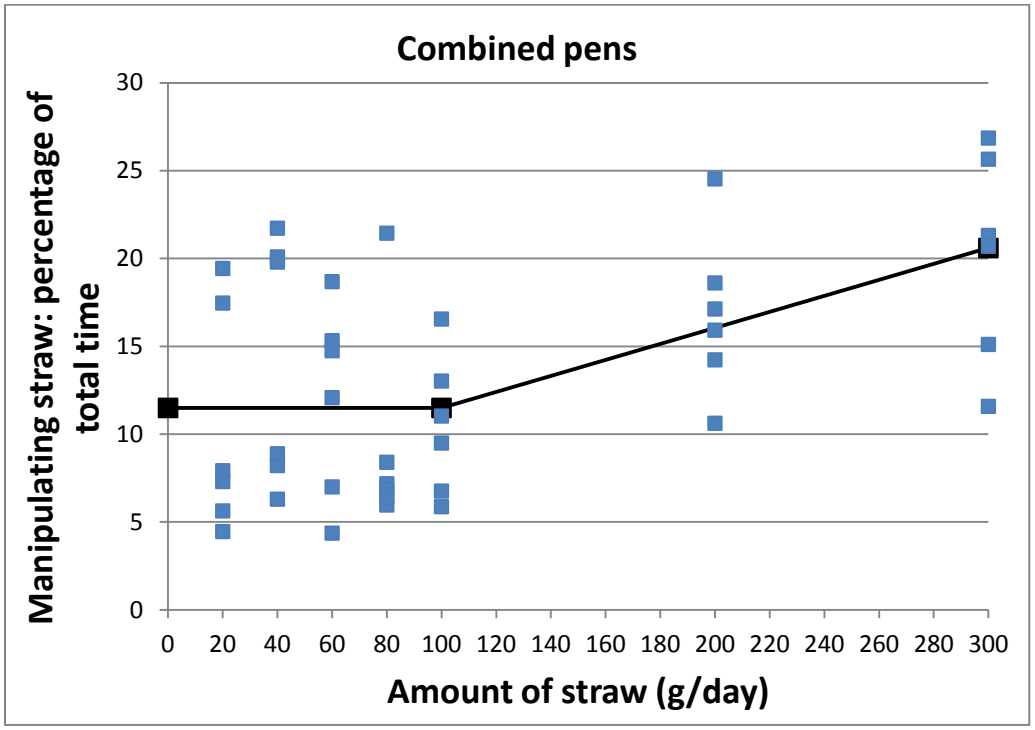

Figure 4. Broken stick showing manipulating straw from combined data of pens which received straw once or four times per day.

4.2.1.2 Polynomial trend line

The polynomial trend lines of the behaviour "manipulate straw" shows a maximum at 300g of straw/day for both the morning (figure 5a) and the afternoon (figure 5b) observation (possibly rising even further if higher amounts of straw would have been tested during this study).

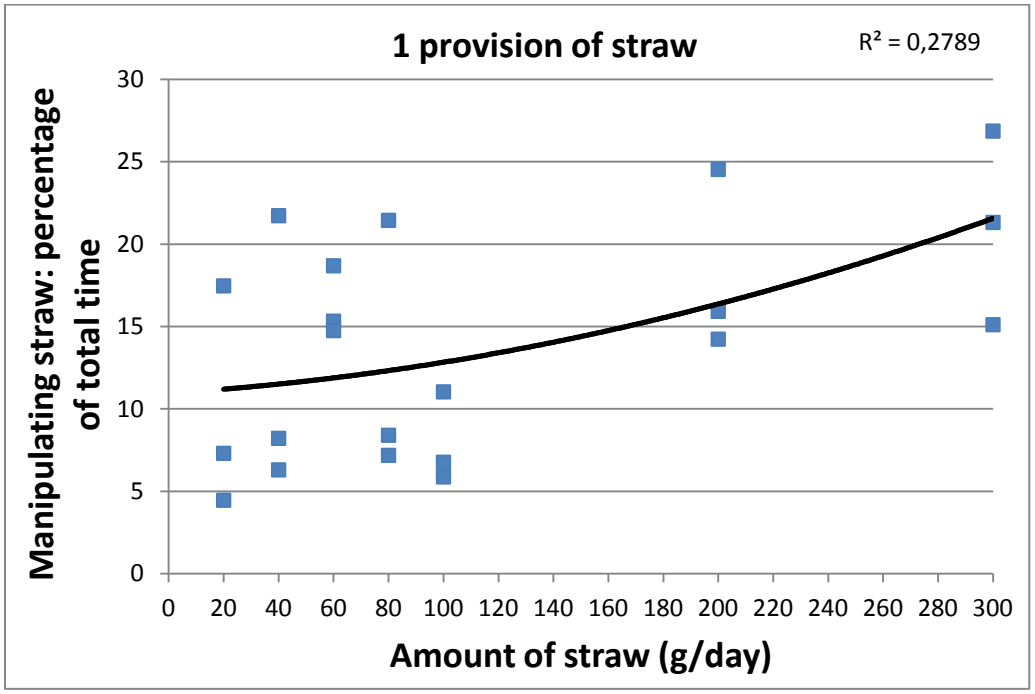

Figure 5a. Percentage of time spent manipulating straw in pens provided with straw once per day.

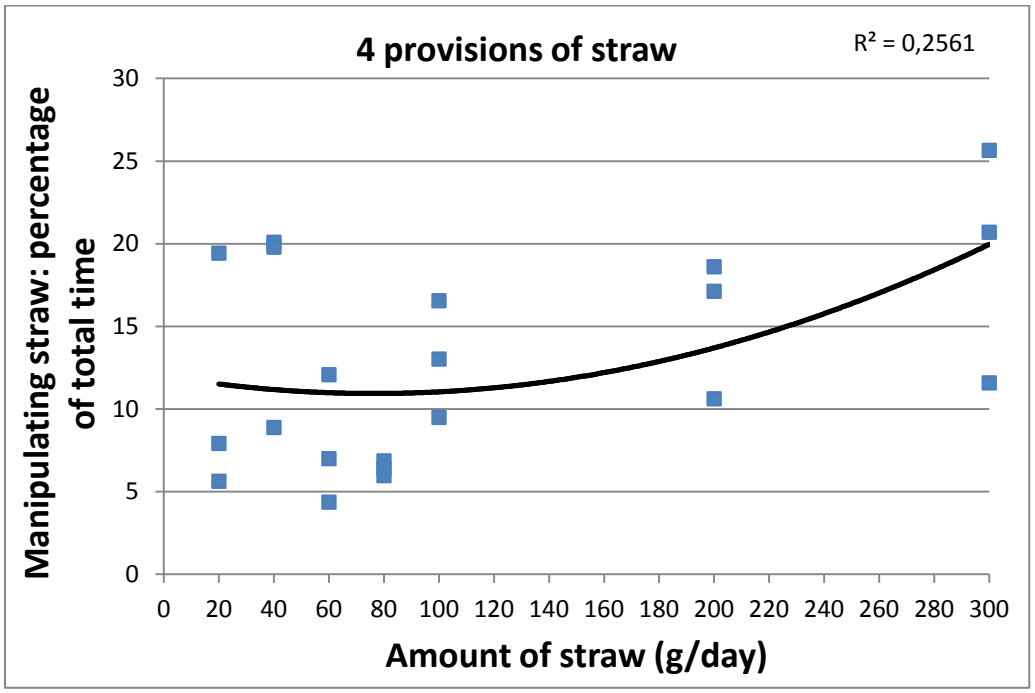

Figure 5b. Percentage of time spent manipulating straw in pens provided with straw four times per day.

When combining all the pens, the polynomial trend line starts to increase somewhere around 100g of straw and continues to increase till it reach maximum at 300g (figure 6).

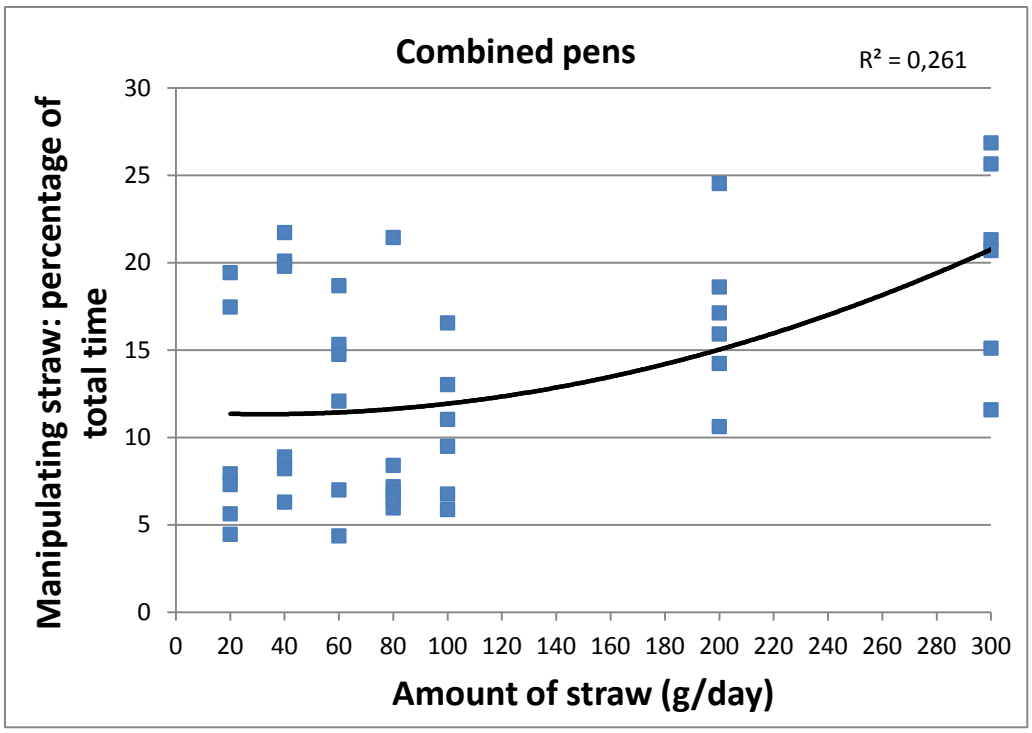

Figure 6. Polynomial trend line showing manipulating straw from combined data of pens which received straw once or four times per day.

4.2.1.3 Logarithmic trend line

The logarithmic trend lines show that the time spent manipulating straw is increased with increased provision of straw (figure 7a-7b). Only very small differences are observed when comparing pens provided with straw once or four times per day. A small increase in frequency (figure 7c-7d) and bout lengths (figure 7e-7f) can be observed when straw is provided once and four times per day.

A difference can be seen when observing the time spent in manipulative behaviour in pens given straw 200-300g per day. For all those pens, manipulative behaviour directed towards straw occurs over 10% of the time. Data also seem to be less spread compared to the pens which received 20-100g of straw per day.

Changes in temperature during the different rounds could affect the behaviour of the pigs however no significant differences in manipulative behaviour towards straw was found when comparing the rounds.

When combining data from all the pens, the behaviour manipulate straw increases with increasing amounts of straw (figure 8)

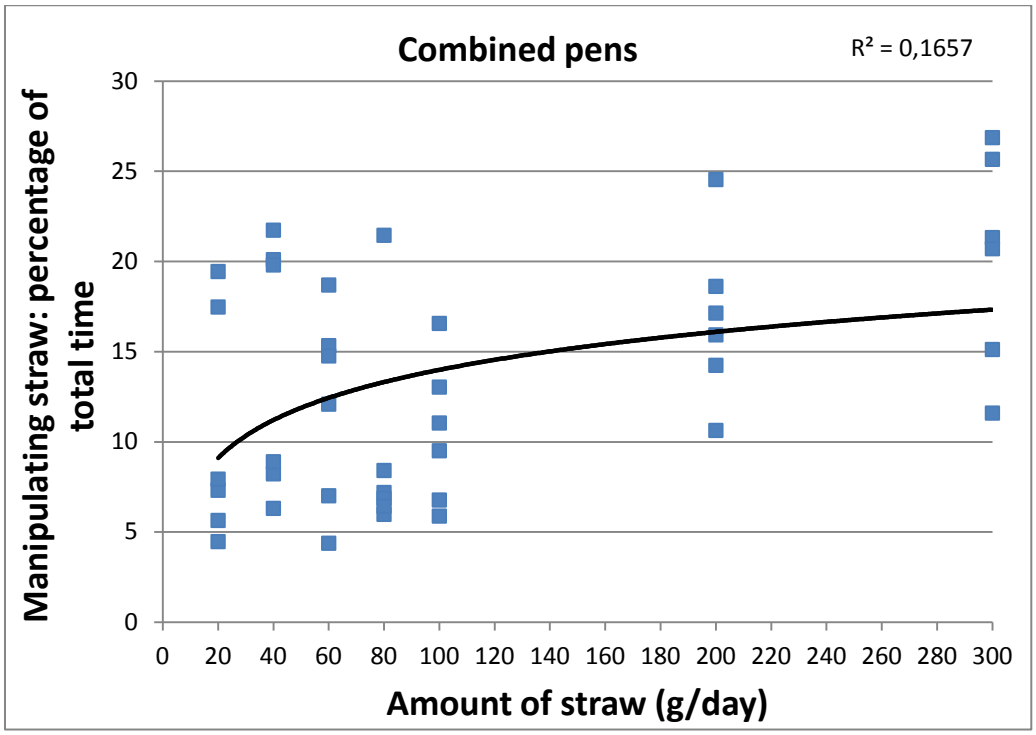

Figure 8. Combined data concerning manipulating straw from pens provided with straw once and four times per day.

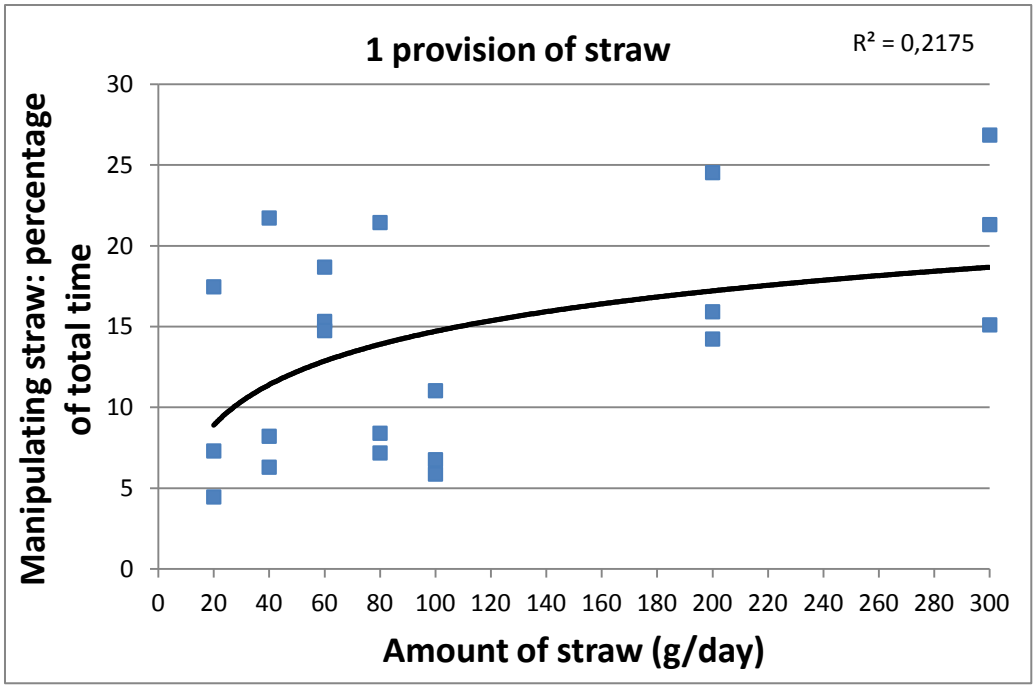

Figure 7a. Percentage of time (R-square: 0,217) spent in manipulate straw behaviour in pens provided with straw once per day.

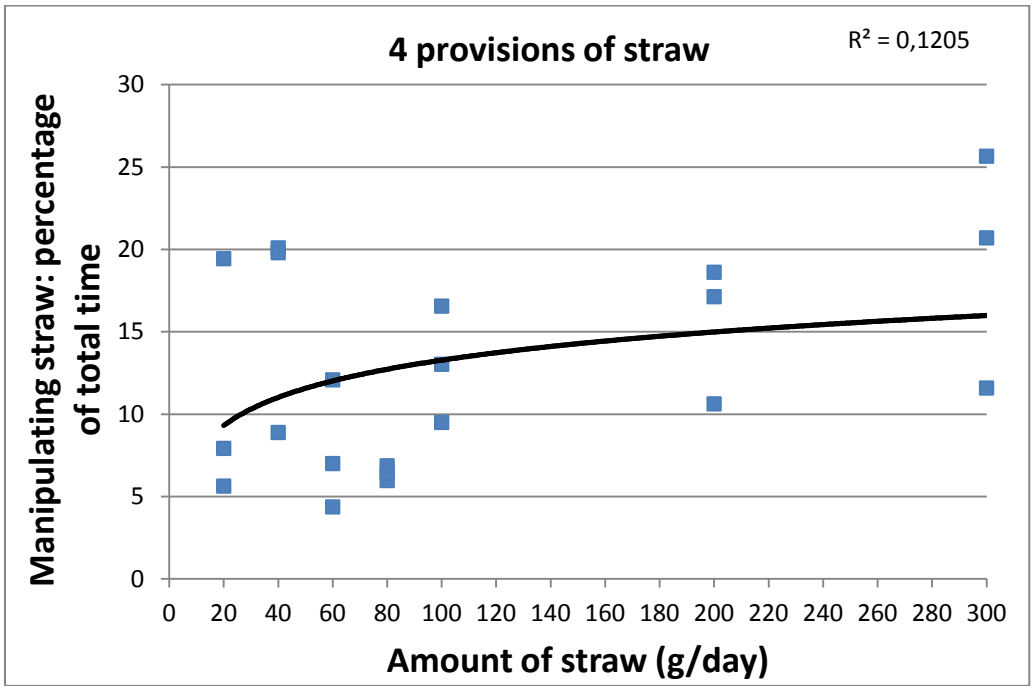

Figure 7b. Percentage of time (R-square: 0,120) spent in manipulate straw behaviour in pens provided with straw four times per day.

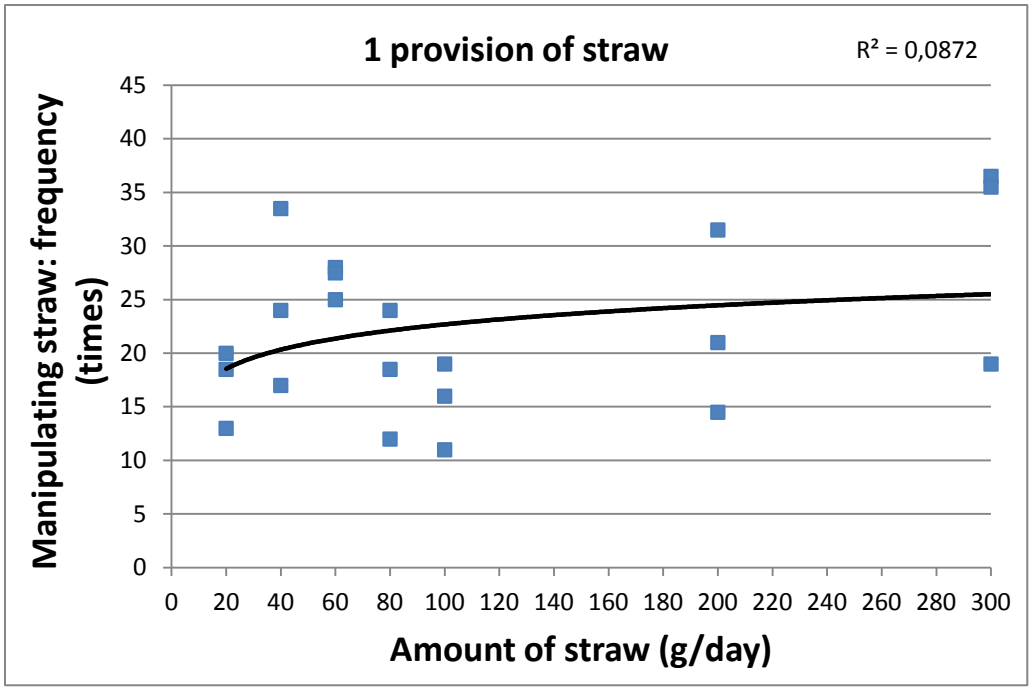

Figure 7c. Frequency of time (R-square: 0,087) spent in manipulate straw behaviour in pens provided with straw once per day.

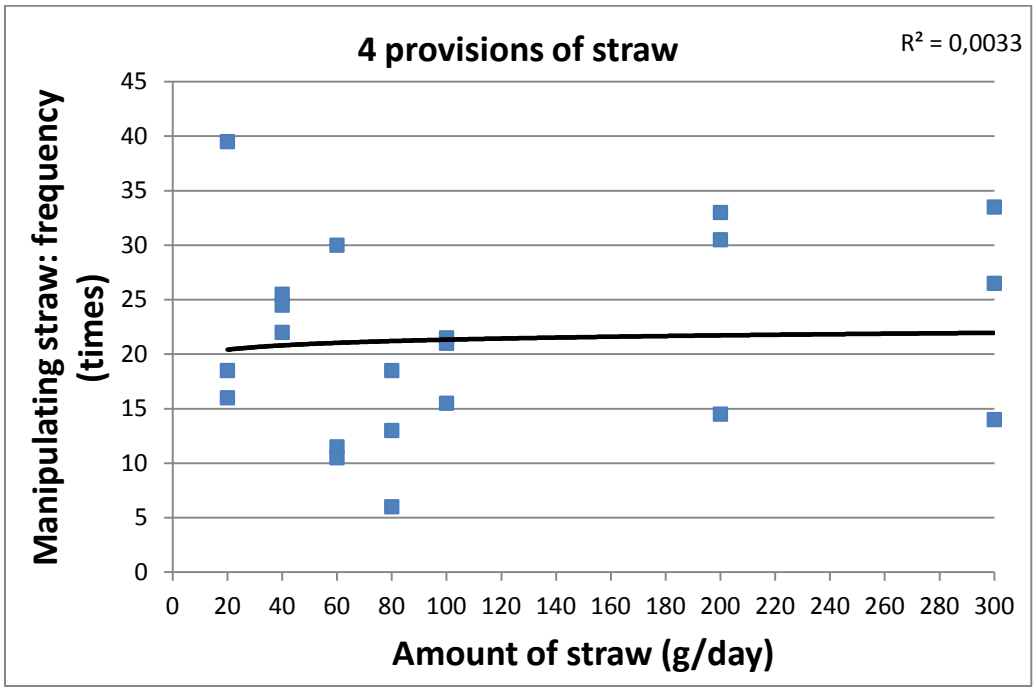

Figure 7d. Frequency of time (R-square: 0,003) spent in manipulate straw behaviour in pens provided with straw four times per day.

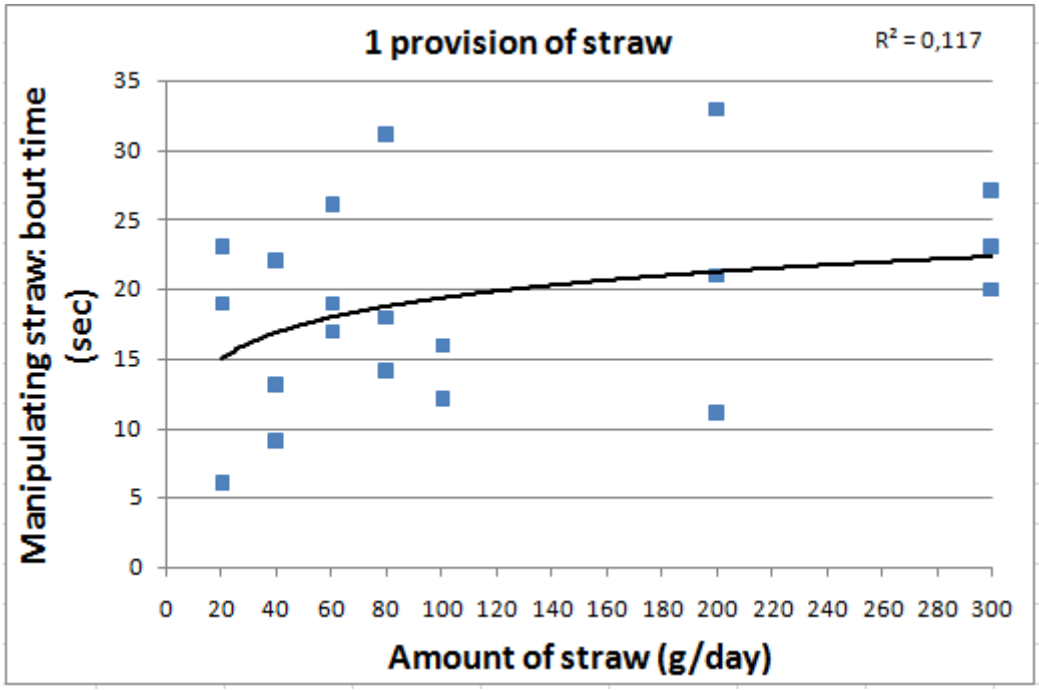

Figure 7e. Bout times (R-square 0,117) spent in manipulate straw behaviour in pens provided with straw once per day.

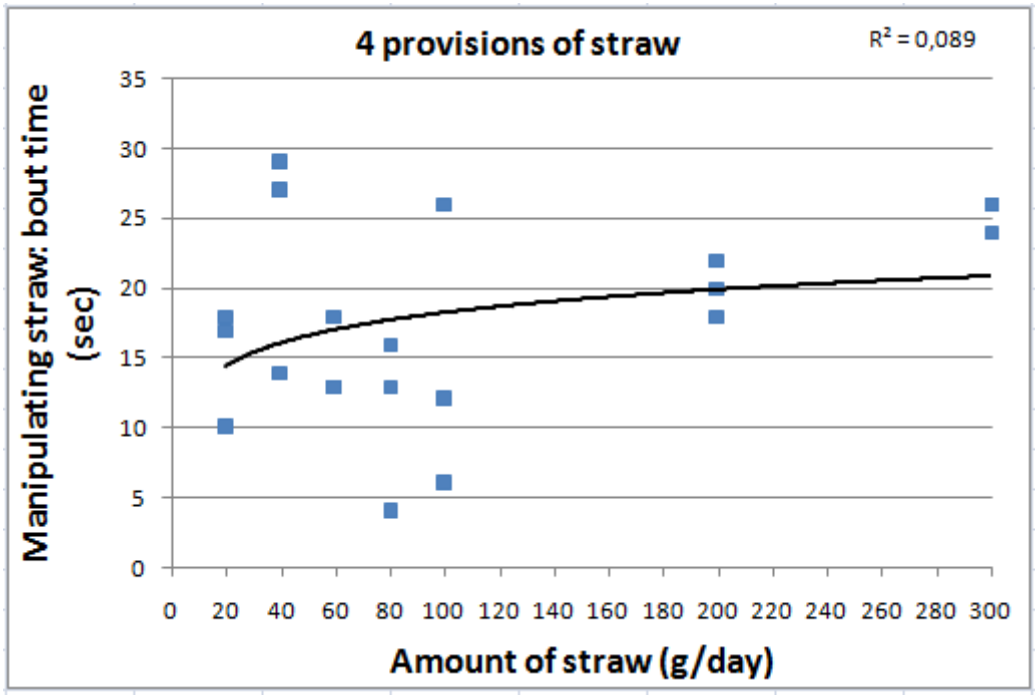

Figure 7f. Bout times (R-square 0,089) spent in manipulate straw behaviour in pens provided with straw four times per day.

4.2.2 Redirected behaviour

4.2.2.1 Broken stick model

In the broken stick the chart showing redirected behaviour from pens provided with straw once per day an inverted line is showed with a c-value of 100g of straw (figure 9a). However, the data contains one extreme value and the removal of that value changes the chart a great deal (figure 9b). The new chart is of the optimal sort and again shows a c-value at 100g of straw. However, the line should not change so drastically after the removal of one value which leads to the conclusion that variation might be too high for method to be trusted.

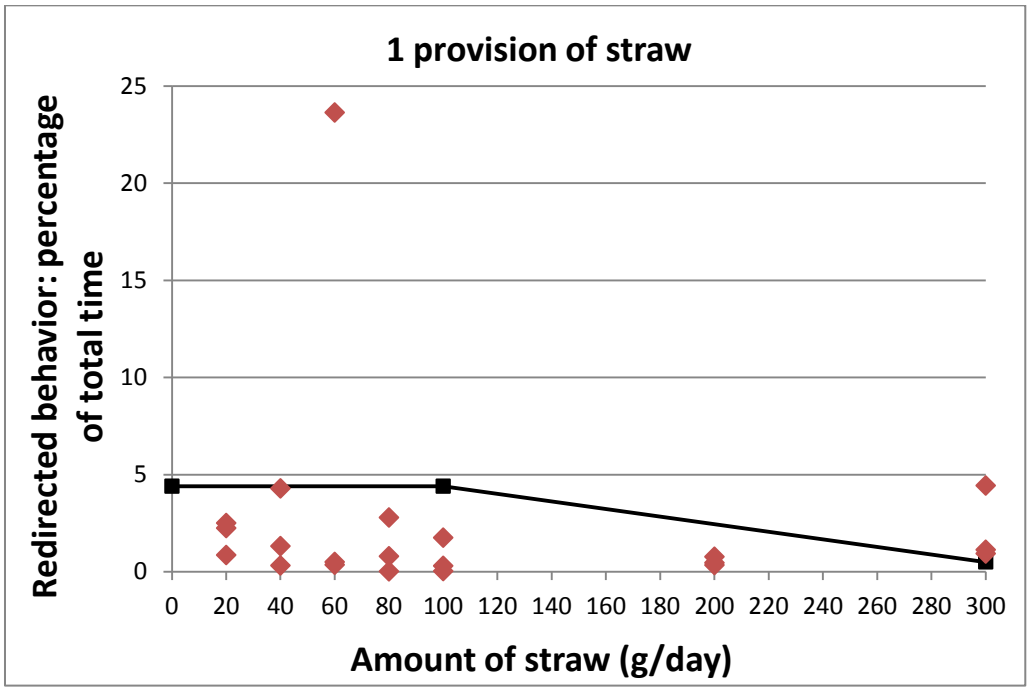

Figure 9a. Broken stick chart of redirected behaviour from pens that was provided straw once.

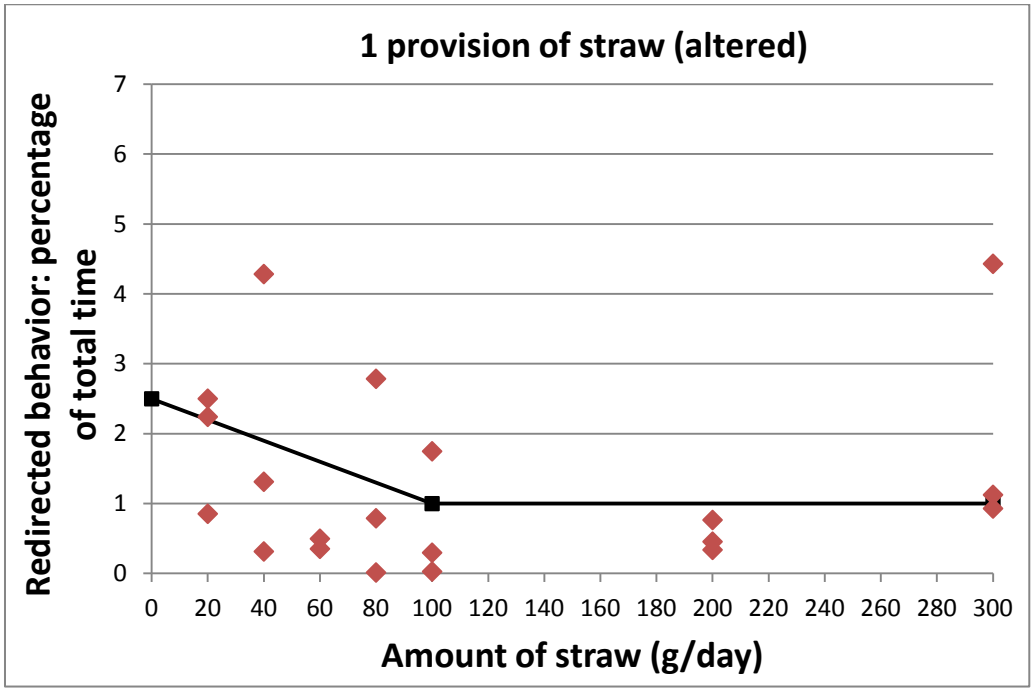

Figure 9b. Broken stick chart of redirected behaviour from pens that was provided straw once: the altered chart.

The charts showing redirected behaviour from pens provided with straw four times per day resulted in an optimal looking line with a c-value of 150g of straw (figure 10a). However two extreme values were present in the data and the removal of those two values inverted the line but the c-value remained the same (figure 10b).

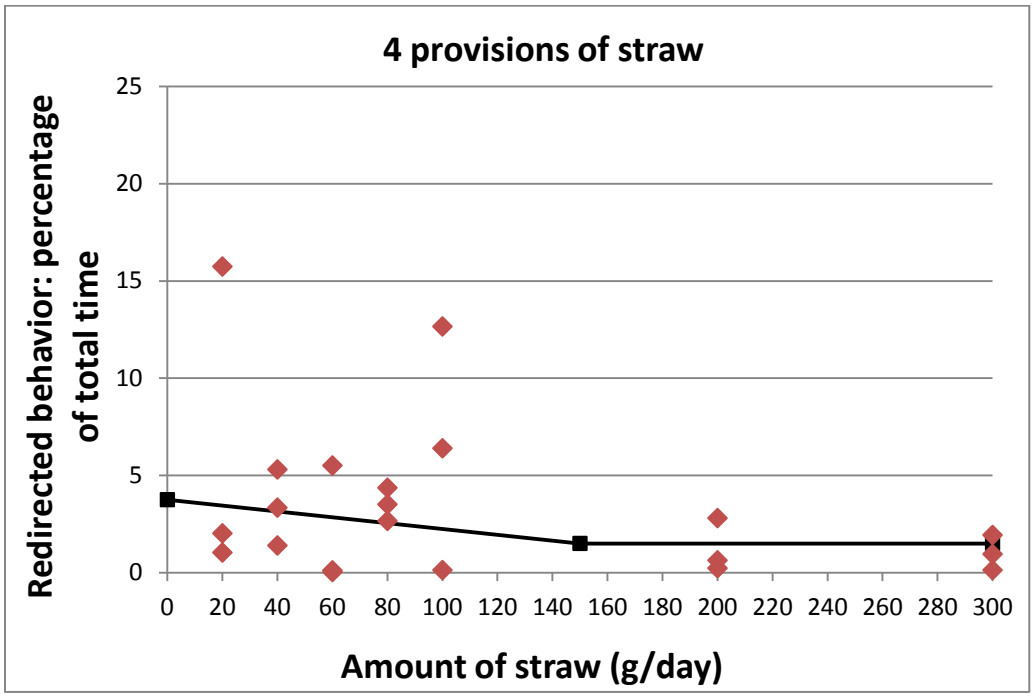

Figure 10a. Broken stick chart of redirected behaviour from pens that was provided straw four times per day.

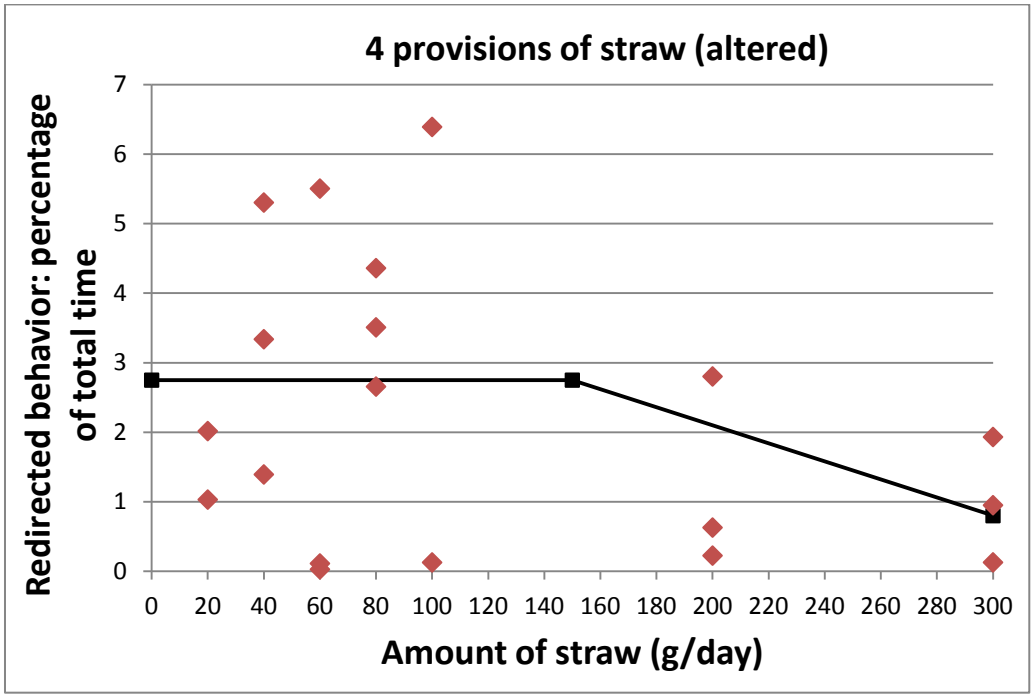

Figure 10b. Broken stick chart of redirected behaviour from pens that was provided straw four times per day: the altered chart.

When new charts was made with combined data concerning redirected behaviour using the broken stick model an optimal line was observed with a breaking point at 200g of straw (figure 11).

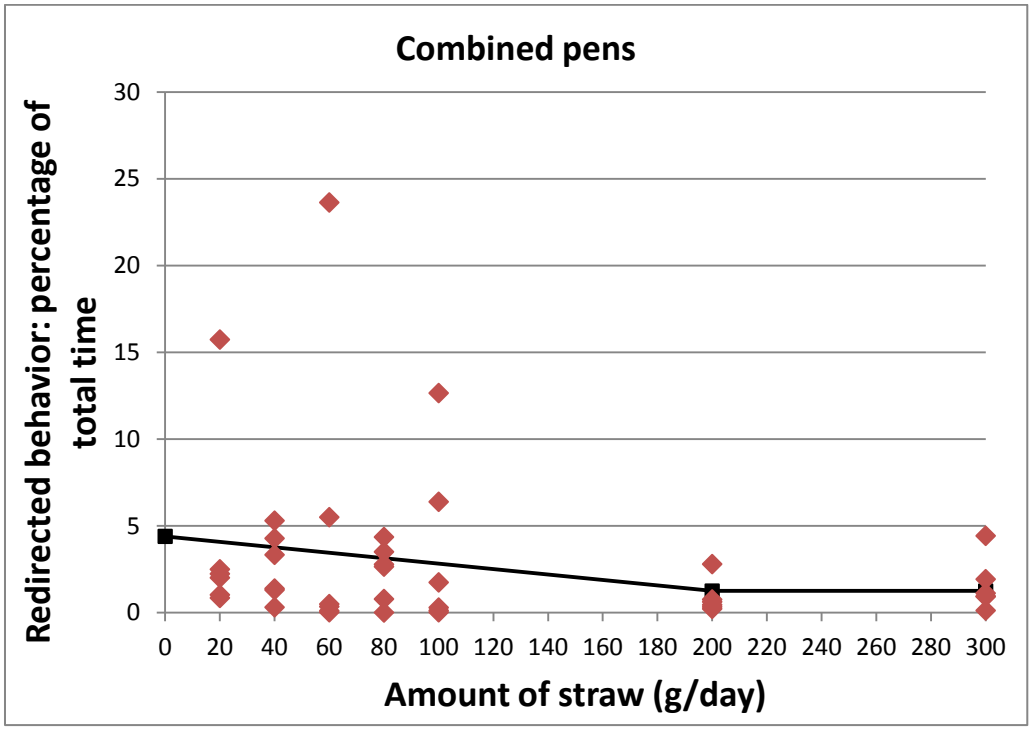

Figure 11. Broken stick concerning redirected behaviour from combined data of pens which received straw once or four times per day.

4.2.2.2 Polynomial trend line

The polynomial trend line shows a minimum around 200g of straw/day for pens provided straw once per day (figure 12a) and a minimum around 300g of straw for pens provided straw four times per day (figure 12b).

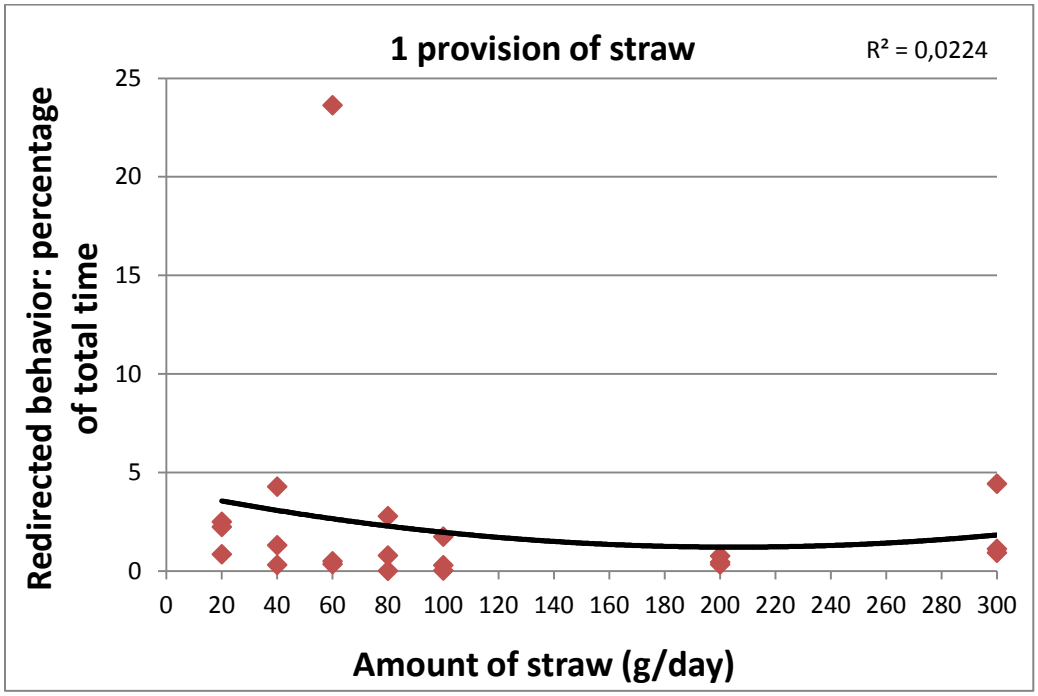

Figure 12a. Percentage of time spent in redirected behaviour in pens provided with straw once per day.

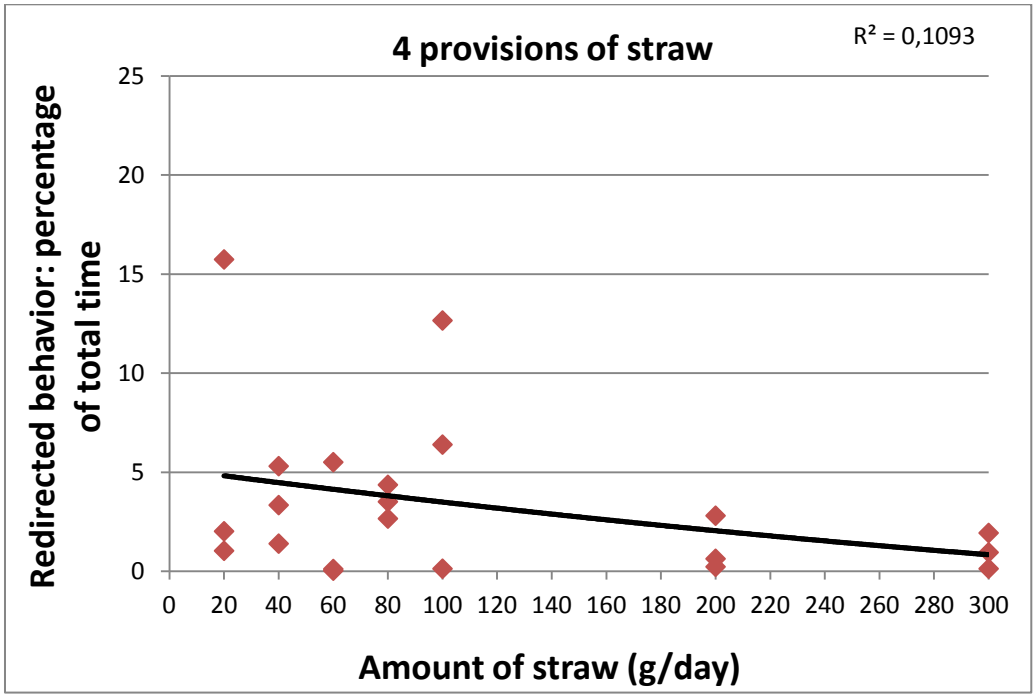

Figure 12b. Percentage of time spent in redirected behaviour in pens provided with straw four times per day.

When combining the pens, the polynomial trend line seem to level out somewhere between 100-200g of straw but the minimum is closer to 300g (figure 13).

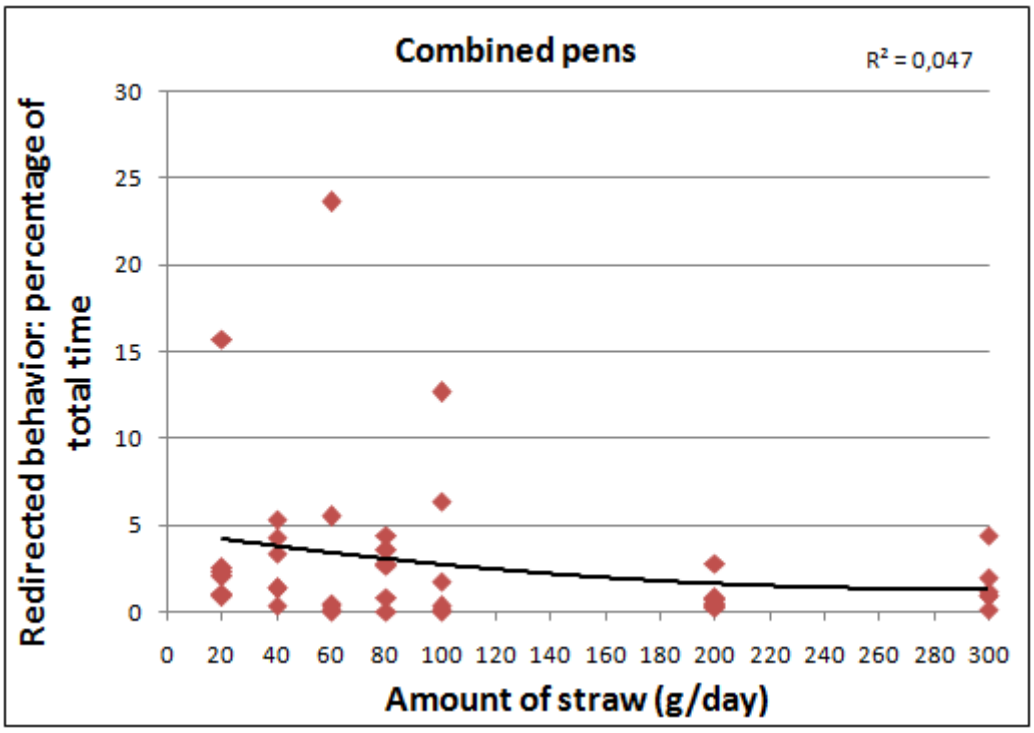

Figure 13. Polynomial trend line of redirected behaviour from combined data of pens which received straw once or four times per day.

4.2.2.3. Logarithmic trend line

The logarithmic trend lines show that time spent in redirected behaviour is reduced with increased provision of straw (figure 14a-14b). The decrease in redirected behaviour is smaller when straw is provided once per day compared to four times per day. The time spent in redirected behaviour is much higher in pens provided with smaller amounts of straw if the straw is provided four times per day instead of one. The same result is shown concerning frequency (figure 14c-14d) and bout lengths (figure 14e-14f), where the pigs spend longer periods of time in nonstop redirected behaviour in pens supplied with the smaller amounts of straw if the straw is provided four times per day. However, the higher straw provisions result in low prevalence of redirected behaviour in both treatments.

The variation between pens concerning both the time spent in redirected behaviour and bout lengths is higher when straw is provided four times per day. A high variation between pens can be seen throughout the current study which needs to be taken into consideration. The results can be showed as trends for the majority of the pigs in the study but there can be big individual differences.

When combining the data from all pens, the redirected behaviour decreases with increasing amounts of straw (figure 15).

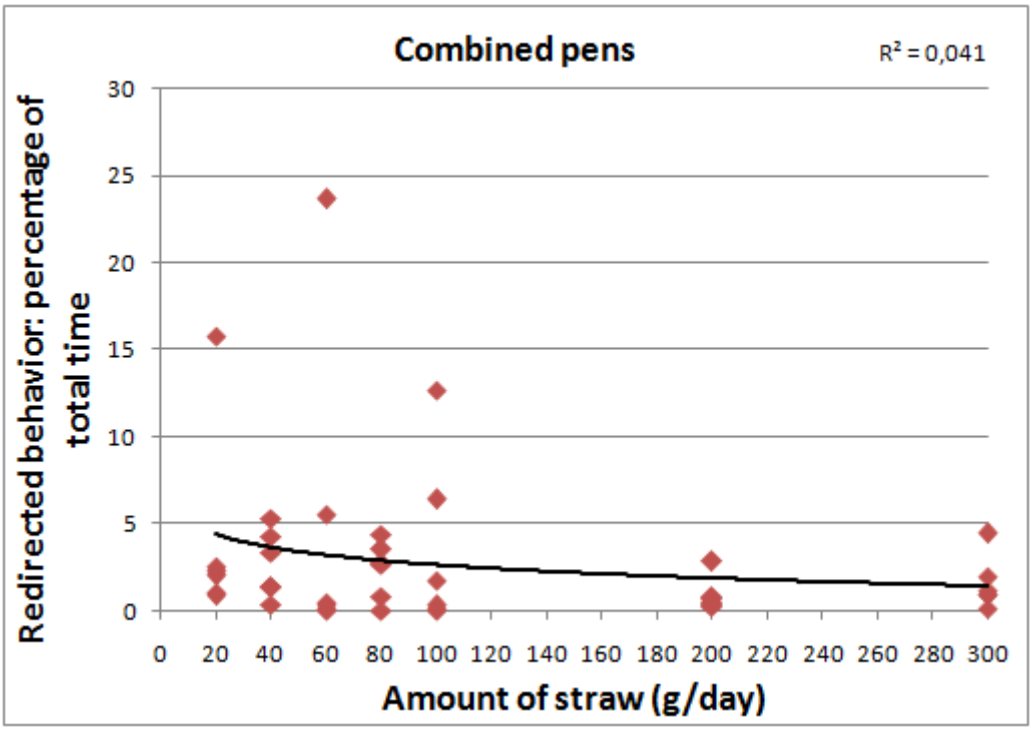

Figure 15. Combined data concerning redirected behaviour from pens provided straw once and four times per day.

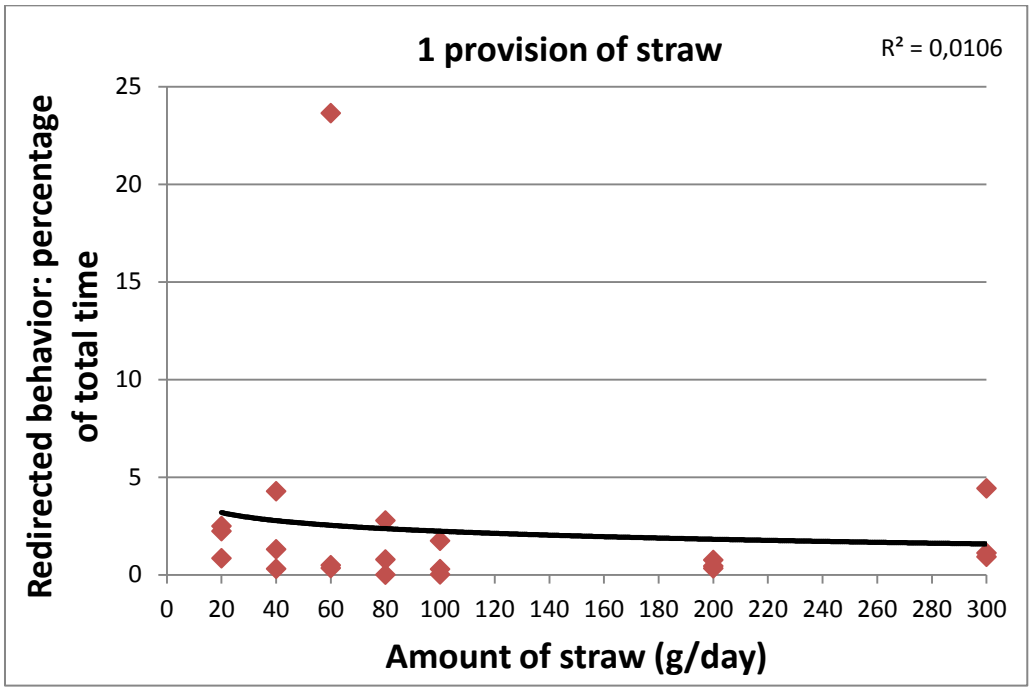

Figure 14a. Percentage of time (R-square: 0,010) spent in redirected behaviour in pens provided with straw once per day.

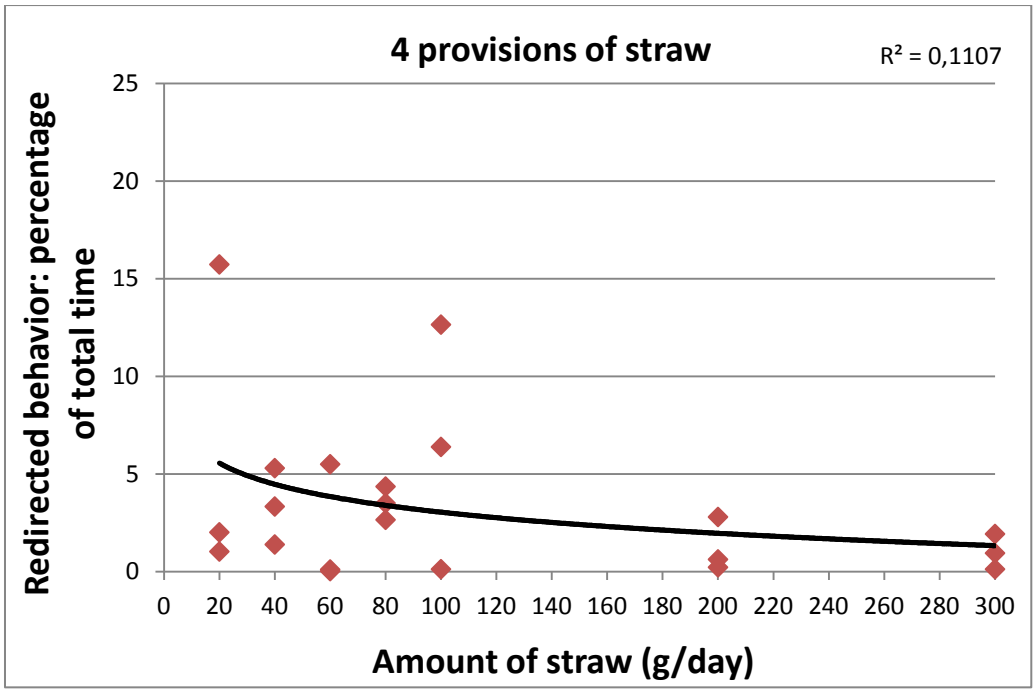

Figure 14b. Percentage of time (R-square: 0,110) spent in redirected behaviour in pens provided with straw four times per day.

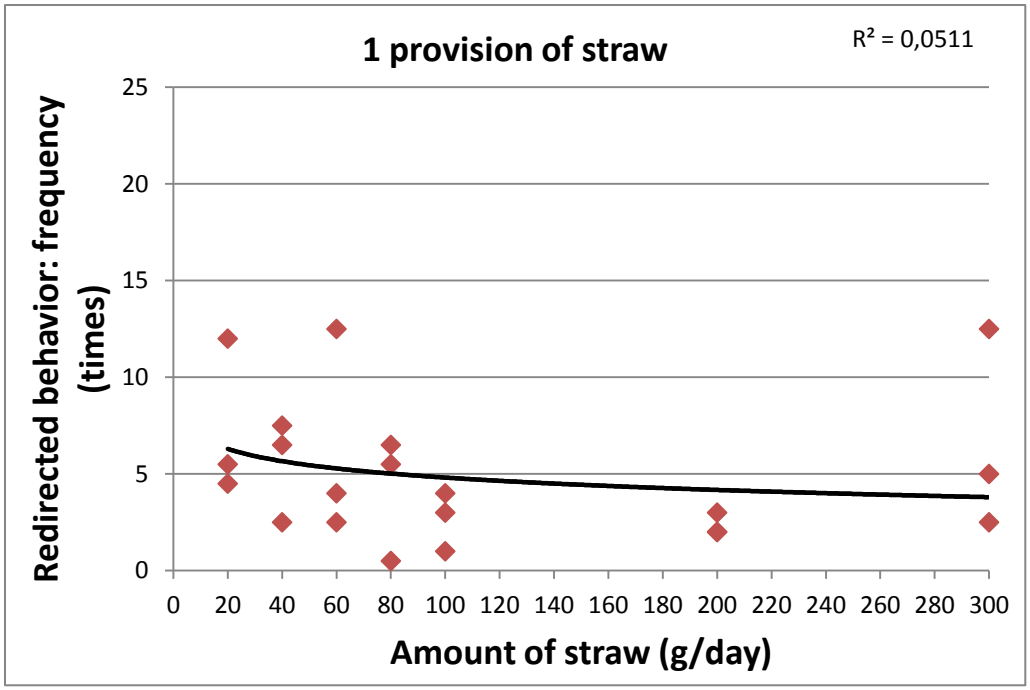

Figure 14c. Frequency of time (R-square: 0,051) spent in redirected behaviour in pens provided with straw once per day.

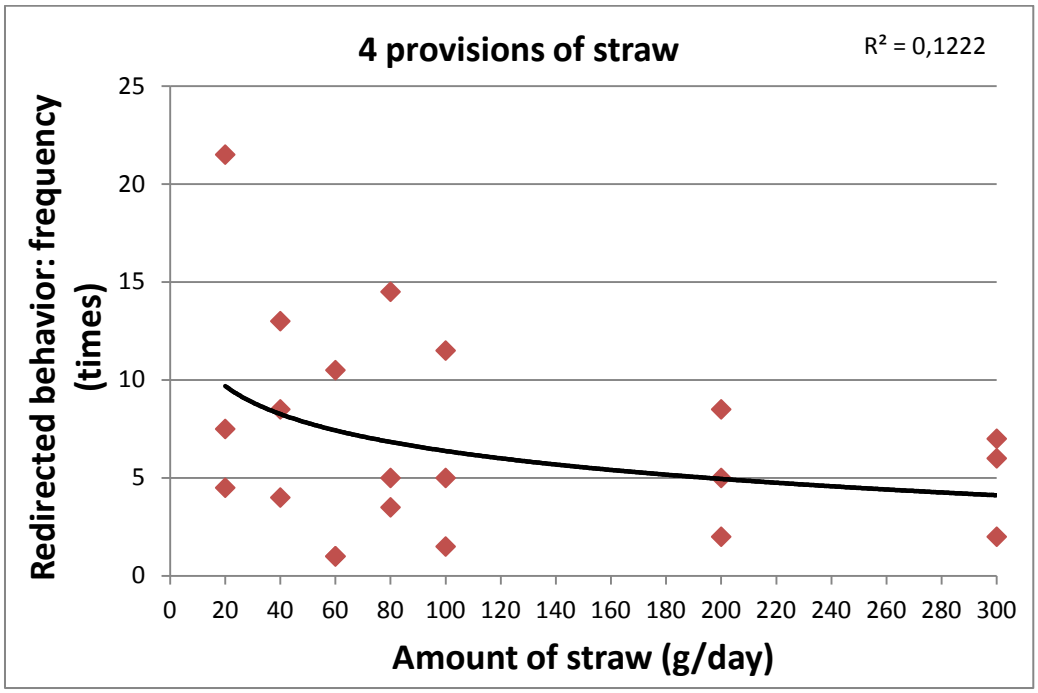

Figure 14d. Frequency of time (R-square: 0,122) spent in redirected behaviour in pens provided with straw four times per day.

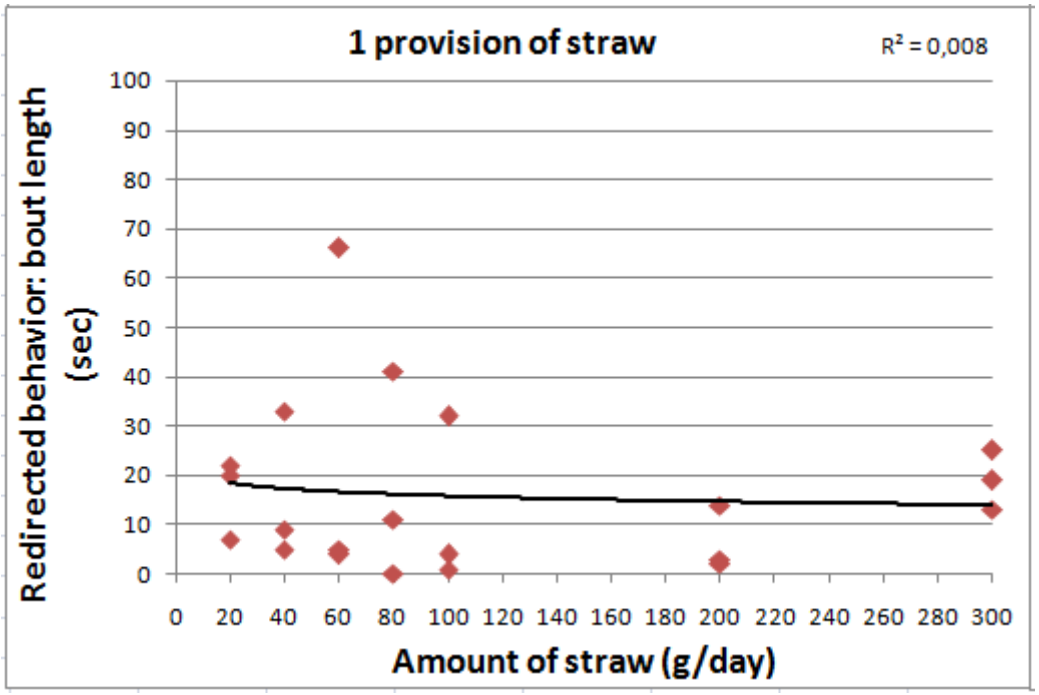

Figure 14e. Bout times (R-square: 0,008) of redirected behaviour in pens provided with straw once per day.

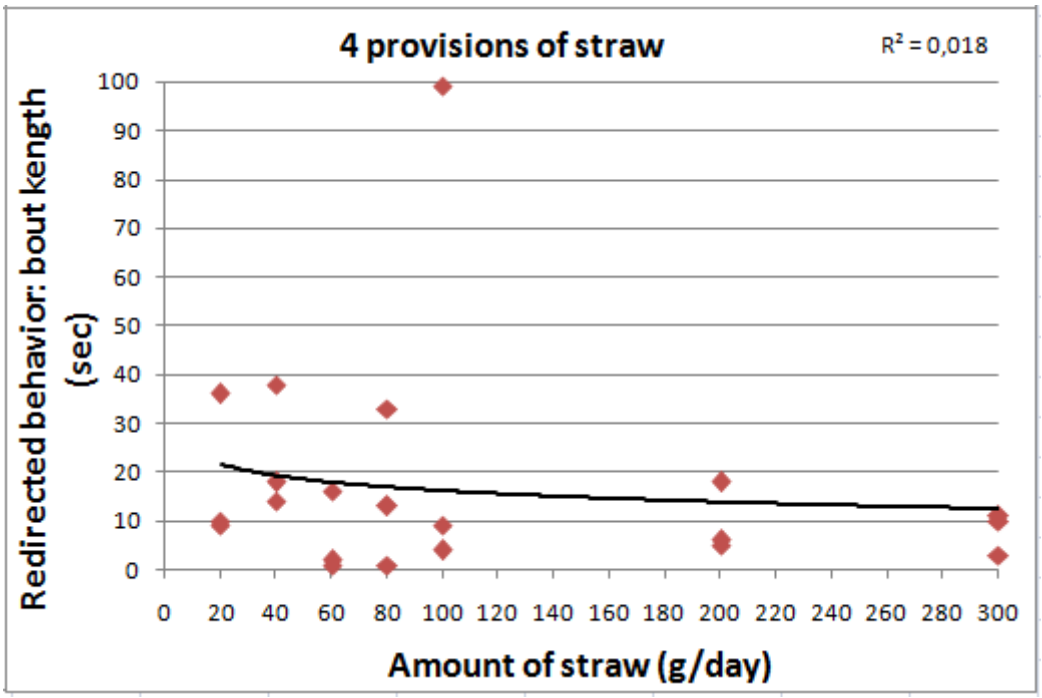

Figure 14f. Bout times (R-square: 0,018) of redirected behaviour in pens provided with straw four times per day.

4.2.3 Belly massage

The prevalence of belly massage is only presented with the logarithmic trend lines. Belly massage was not carried out in all pens so results are based on a lower amount of pens. Some of the r-squared values are still the highest values observed in the current study.

The main differences in belly massage behaviour was found when comparing pens that were provided with straw either once or four times per day. When straw was provided once per day, the time spent (figure 16a), the frequency (figure 16c) and the bout lengths (figure 16e) in belly massage behaviour was about the same regardless of amount of straw. However when straw was provided four times per day the belly massage behaviour increased with increasing amounts of straw for all parameters (time spent, frequency and bout lengths (figure 16b, 16d, 16f respectively).

When combining the data from all pens, the belly massage behaviour increases with increasing amounts of straw (figure 17).

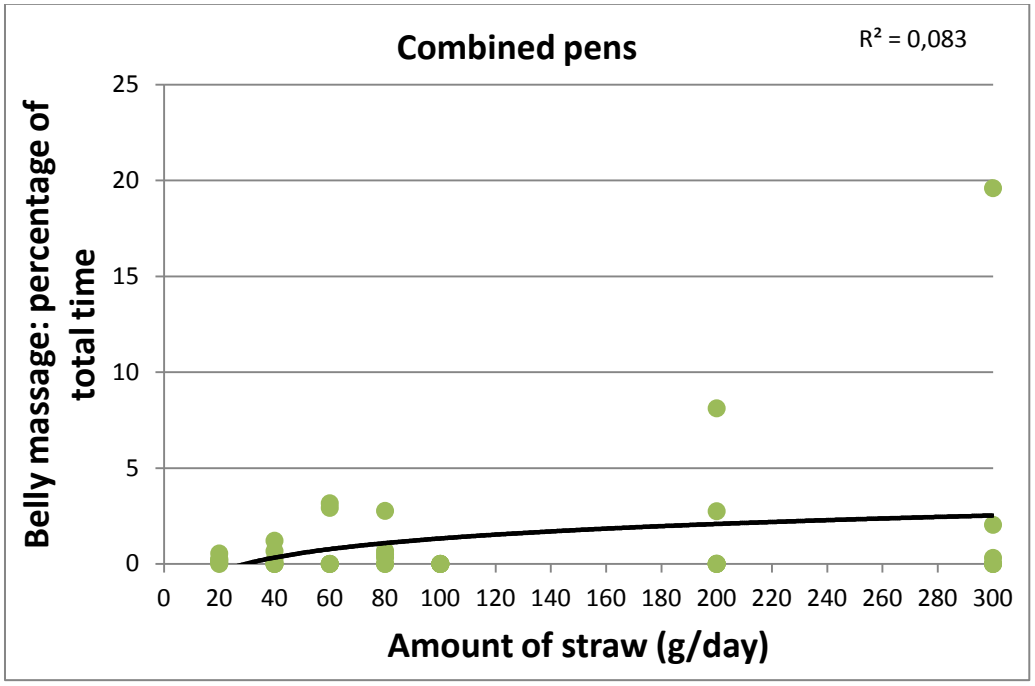

Figure 17. Combined data concerning belly massage behaviour from pens provided with straw once and four times per day.

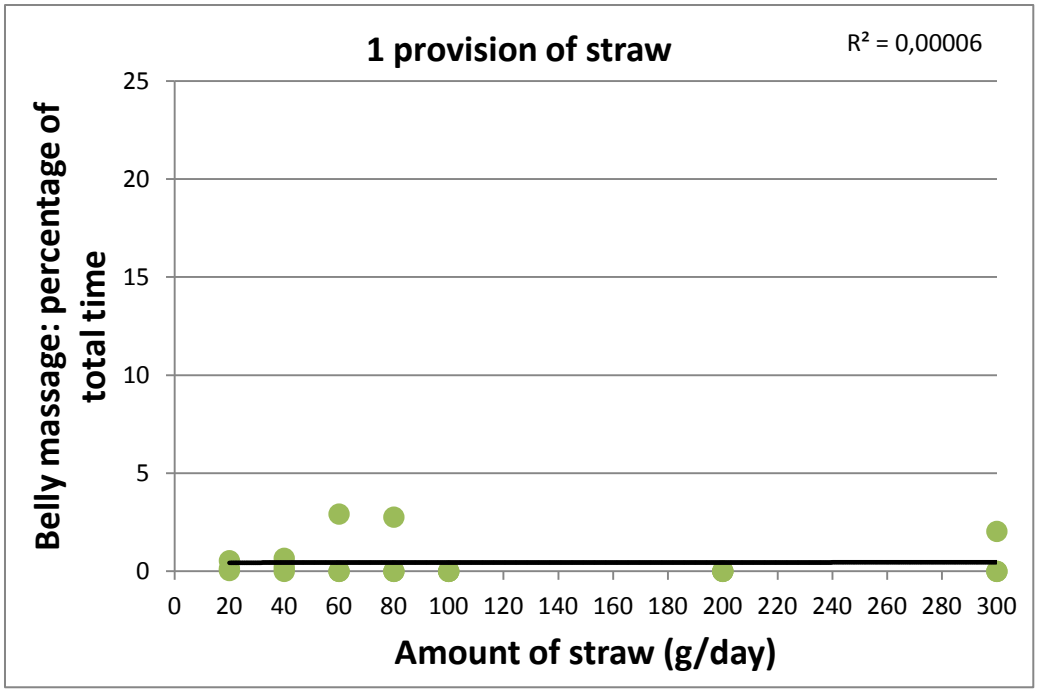

Figure 16a. Percentage of time (R-square: 0,00006) spent in belly massage behaviour in pens provided with straw once per day.

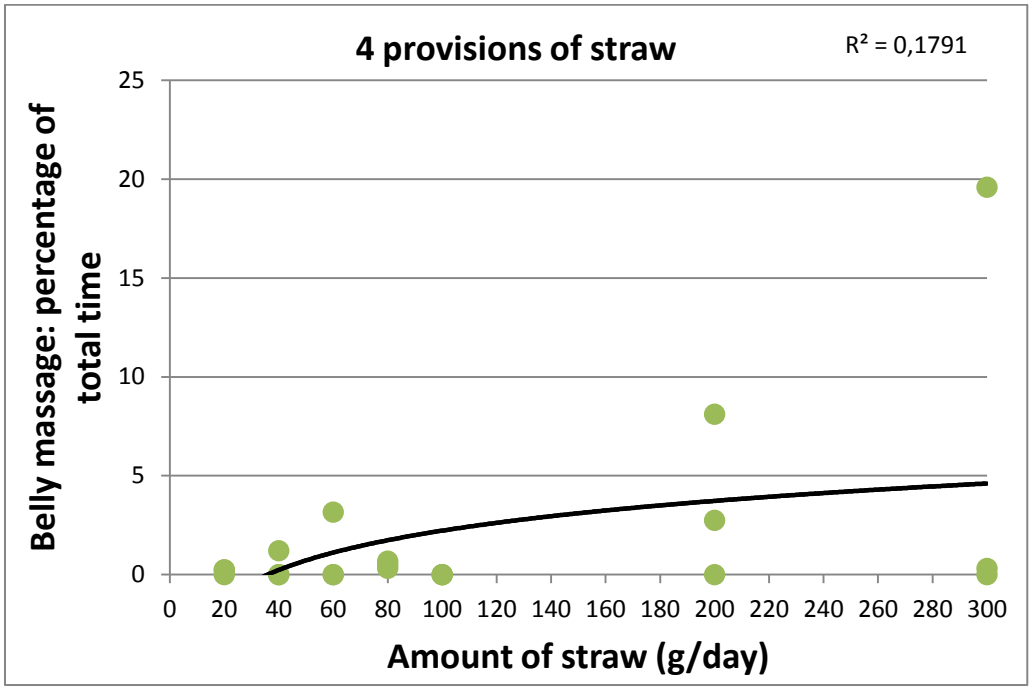

Figure 16b. Percentage of time (R-square: 0,179) spent in belly massage behaviour in pens provided with straw for times per day.

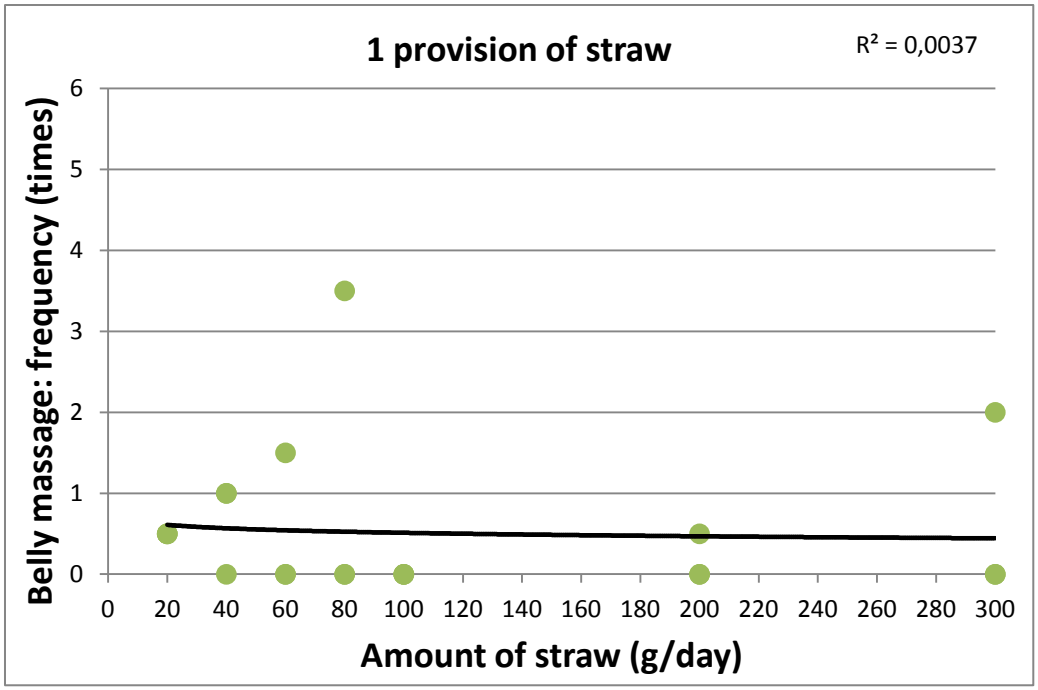

Figure 16c. Frequency of time (R-square: 0,003) spent in belly massage behaviour in pens provided with straw once per day.

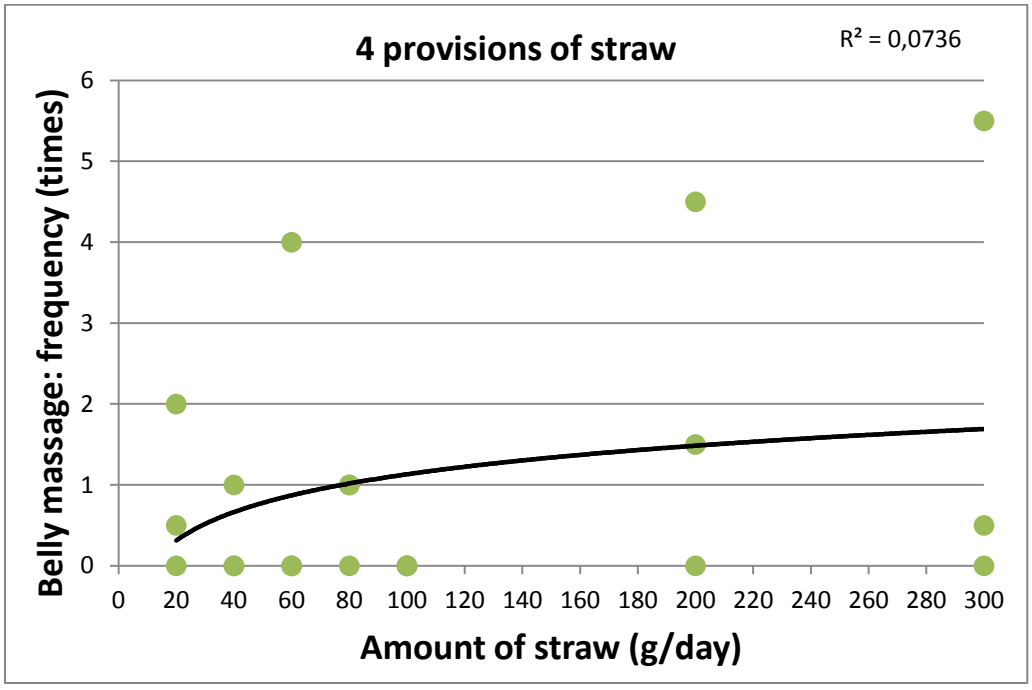

Figure 16d. Frequency of time (R-square: 0,073) spent in belly massage behaviour in pens provided with straw four times per day.

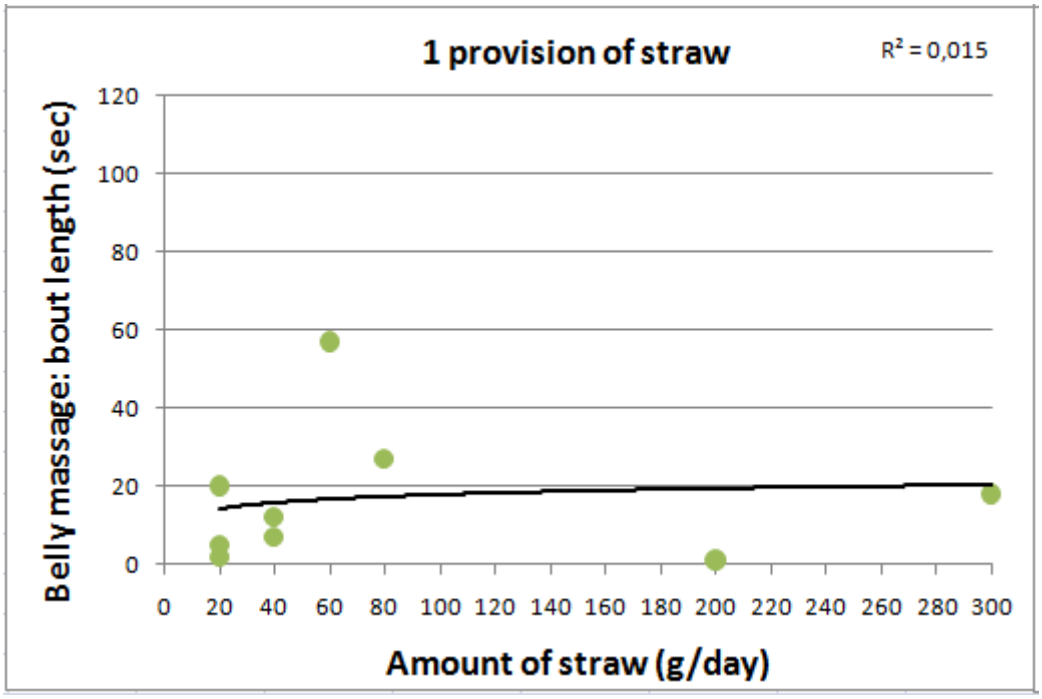

Figure 16e. Bout times (R-square: 0,015) of belly massage behaviour in pens provided with straw once per day.

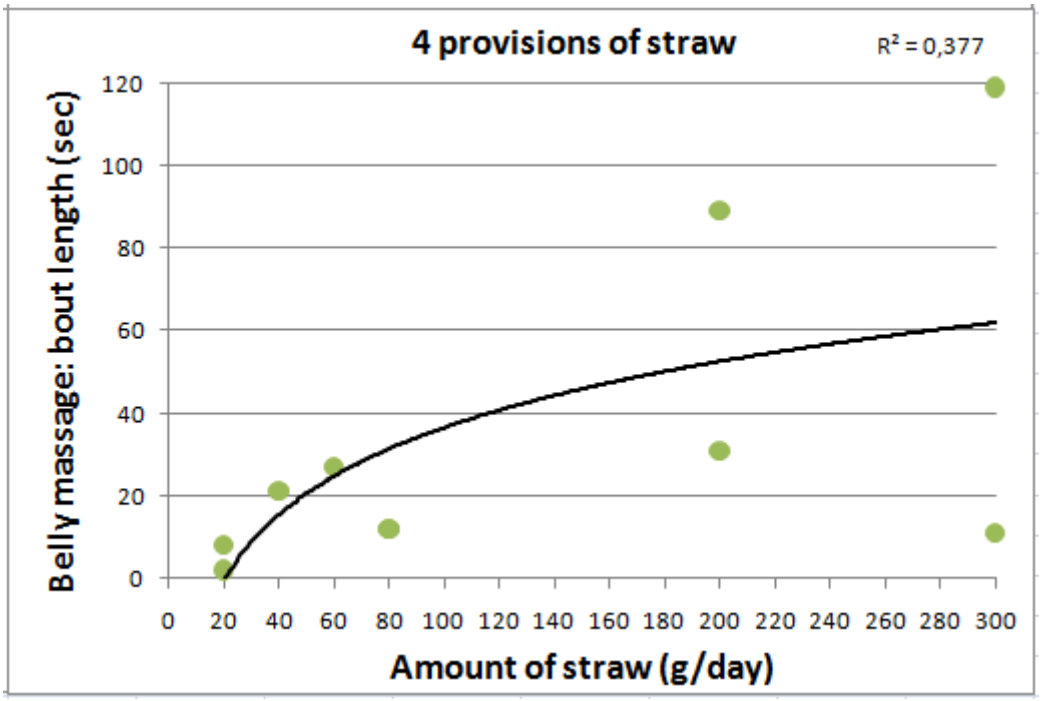

Figure 16f. Bout times (R-square: 0,377) of belly massage behaviour in pens provided with straw four times per day.

4.3 Activity

A difference in activity was observed comparing the morning and the afternoon observations. More time is spent in rest during the morning, in average 70,4 & 65,5% of the time (figure 18a & 19a) compared to 43,0 & 42,5 % in the afternoon (figure 18b & 19b). The time spent in each behaviour is quite similar comparing the morning and afternoon observation. Resting behaviour does not seem to be affected whether the provision of straw is made one or four times per day. There is a small reduction in resting time when the amount of straw provided is increased.

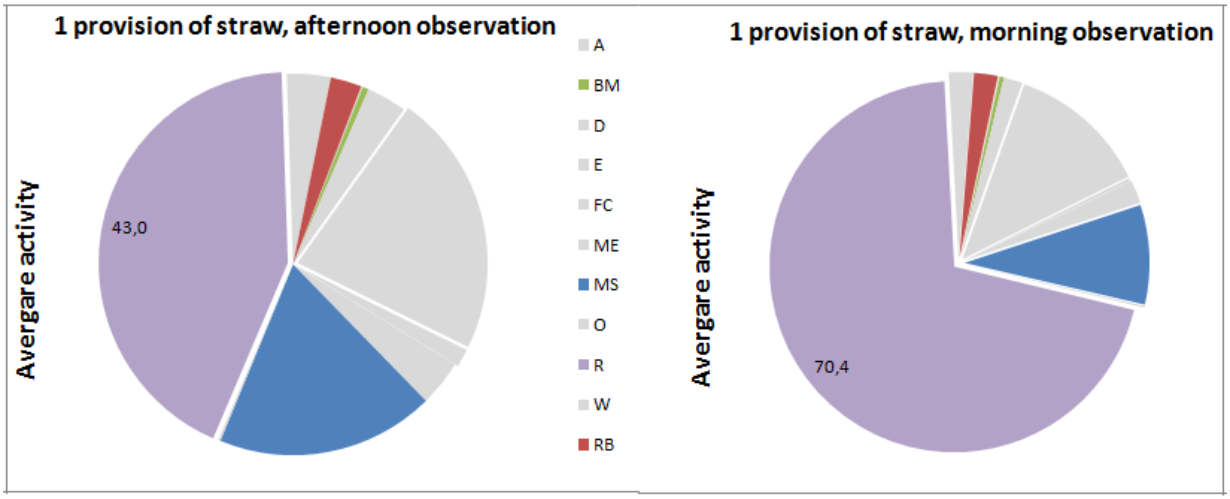

Figure 18a & 18b. Activity in morning and afternoon observation from pens provided straw once daily. A- activity, BM-belly massage, D-drinking, E-eating, FC-fence contact, ME-manipulate environment, MS-manipulate straw, O-other, R-resting, W-walking, RB-redirected behaviour.

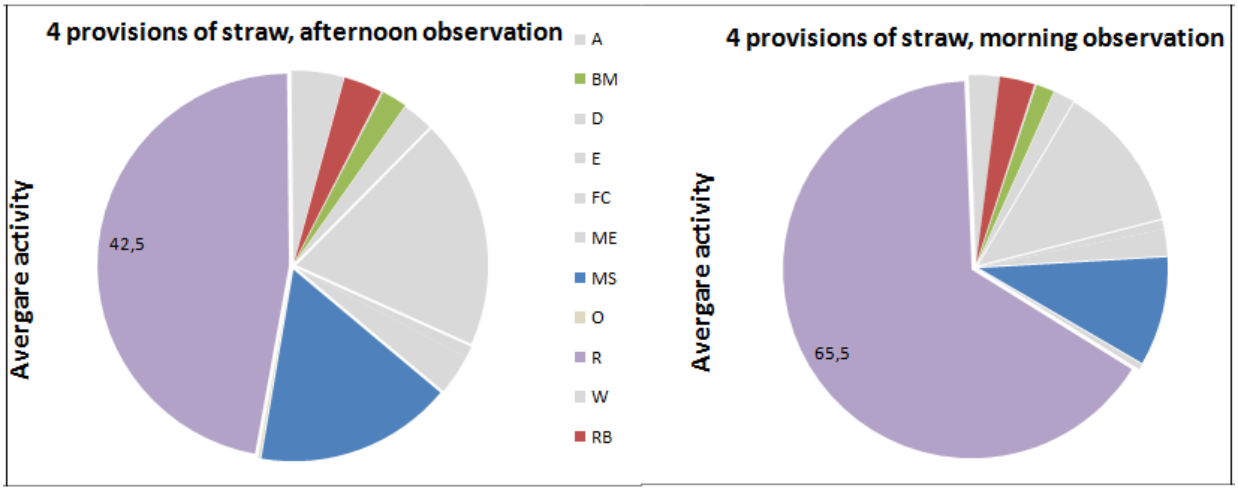

Figure 19a & 19b. Activity in morning and afternoon observation from pens provided straw four times per day. A- activity, BM-belly massage, D-drinking, E-eating, FC-fence contact, ME-manipulate environment, MS-manipulate straw, O-other, R-resting, W-walking, RB-redirected behaviour.

5. Discussion

5.1 Method

5.1.1 Validity

The pigs were housed at the research farm Odarslöv which differs in some ways compared to common conventional pig houses in Sweden. The pens are small and only four pigs are kept in each pen. No significant differences between group sizes have been found for behaviours such as activity or aggression according to Schmolke et al (2004) and Spicer & Aherne (1987). However production results may differ, live weight gain and average daily gain has been observed to decrease with increasing group sizes (Street & Gonyou, 2008 and Spicer & Aherne, 1987). The results from the current study which concern behaviour can thus be considered valid in the general term.

The different rounds were carried out in different months of the year which means that parameters like temperature and humidity differed between the rounds. No significant differences in behaviour were found between the rounds however, suggesting that the results from the current study are valid independent of temperature (at least if the indoor temperature ranges between 15 and 23 degrees Celsius).

5.1.2 Sampling methods

Using focal animals sampling and continuous recording worked out well. Some behaviours had very short bouts which could have been difficult to observe using other methods. These behaviours were mainly aggression and the behaviours included in the term redirected behaviour i.e. very important behaviours in this study. Continuous recordings, makes it possible to observe: "*sequences as well as frequencies of events, latency and duration of bouts"* stated by Martin & Bateson (1993). Method studies done by Altman (1973) further suggest that the focal animal sampling is the method to choose if managed correctly, "*it can provide relatively unbiased data relevant to a wide variety of questions about spontaneous social behaviour in groups"*. Martin & Bateson (1993) also states that the method is *"good for systematically sampling behaviours of all members of a group by determining order of observation prior to starting samples"* and using the method is also good for distinguishing behaviours carried out by or directed towards the focal animal.

5.1.3 Observations

The choice of noting only the behaviours carried out by the focal animal was made so that social behaviours should not be over represented. However, since the observations were only carried out for one hour per pen (the four pigs counting as one) the inclusion of behaviour directed towards the focal animal could give a better picture of the prevalence of redirected behaviour in the whole pen. Otherwise, the time spent observing each animal could be prolonged. If all the pigs in the pen would have been observed for one hour each, the variation would probably decrease and the results would have been more trustworthy. The observations were carried out during approximately five weeks by one observer, observing 8 hours per pen instead of 2 would take a considerably longer period of time. Perhaps the aid of programs like "The Observer" from Noldus (2011) which is an "event logging software for the collections, analysis and presentation of observational data" would ease the observations and reduce time spent observing. Furthermore, the provision of straw could be done once per day only since no significant difference was found when comparing pens provided with straw once or four times per day. Higher amounts of straw could be included since the behaviour "manipulate straw" was thought to have its maximum beyond the limits of the current study. Beforehand, the minimal amount of straw was thought to range between 20- and 100g. That is the reason for the smaller differences between the treatments up to 100g (20, 40, 60, 80, and 100). Since the results from the current study suggest that the minimal amount is around 200g or more, a new study would preferably include more treatment amounts around 200g for example: 100, 150, 175, 200, 225, 250, 300, 400g of straw.

The time for observations during the day were decided to take place as close to feeding as possible but still giving the pigs enough time to finish eating before the onset of the observations. During the first minutes of each observation the pigs were usually still occupied in eating behaviour which suggest that the time for observations and feeding should be further apart. Furthermore, the purpose of the current study was to study active behaviours, so it would be better to observe the pigs during the hours they spend most active. Studies of behaviour in pigs in semi-natural environments have showed that activity in pigs is increased between 9 am and 2 pm. Perhaps better times of observations would be around 10 am and 2 pm with feeding around 9 am and 1 pm.

5.2 Analysis of data

5.2.1 Broken stick model

For many behaviours an inverted line was observed in the broken stick charts and the removal of only one value changed the line drastically which questions the reliability of this method.

5.2.2 Polynomial trend line

The polynomial trend line is difficult to use, the reader might have a hard time interpreting it. The reason why this method was used was because of the insufficiency of the broken stick method. So in order to receive a minimum amount of straw needed to minimize the redirected behaviour, the polynomial trend line was thought to result in such a value. However the problem with this trend line is that it assumes that the data is fluctuating, creating a curve with ups and down even though the data might not fluctuate. So the trend line will always curve which do not always represent the true data. For example in figure 20 below, the minimum, value can be seen around 160g of straw. However, if conclusions are to be drawn from this chart, it is not logical to say that belly massage behaviour (in this example) is high in the beginning to then decrease to 160g and then increase again when more straw is provided. If belly massage is connected to the amount of straw then the prevalence of the behaviour should not increase suddenly after a minimum. So this method can only be used to get the minimum/maximum values and not to look at the actual distribution of the data which can confuse the reader.

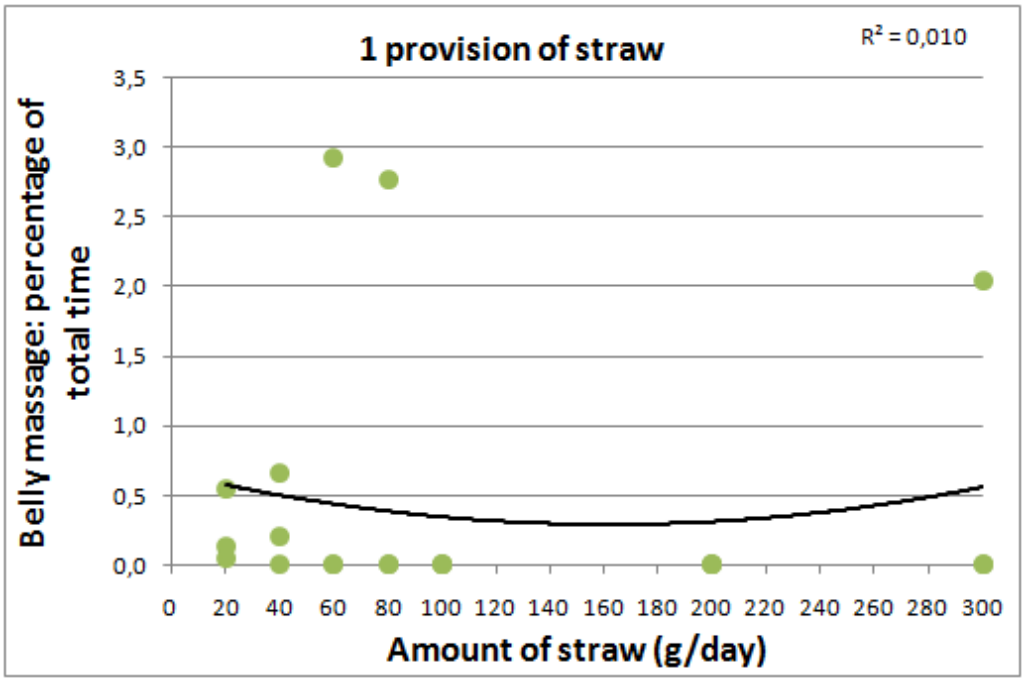

Figure 20. Example of a polynomial trend line (close up on figure 16a).

5.2.3 Logarithmic trend line

The logarithmic trend line is the base of the major results observed in the current study. The logarithmic trend line seems to represent the data in a good way and the following discussions are made on the basis of these lines. The r-square values however, are very low.

5.2.2.1 Comparison of broken stick model and polynomial trend line

When comparing the broken stick charts with the polynomial trend lines from the combined pen charts the two methods did not always find the same values. However the range of values used when observing the polynomial trend line was rather close to the one value received from the broken stick method (figure 16a-d). This further suggests that the polynomial trend line could work a substitute when no one value can be found using the broken stick model.

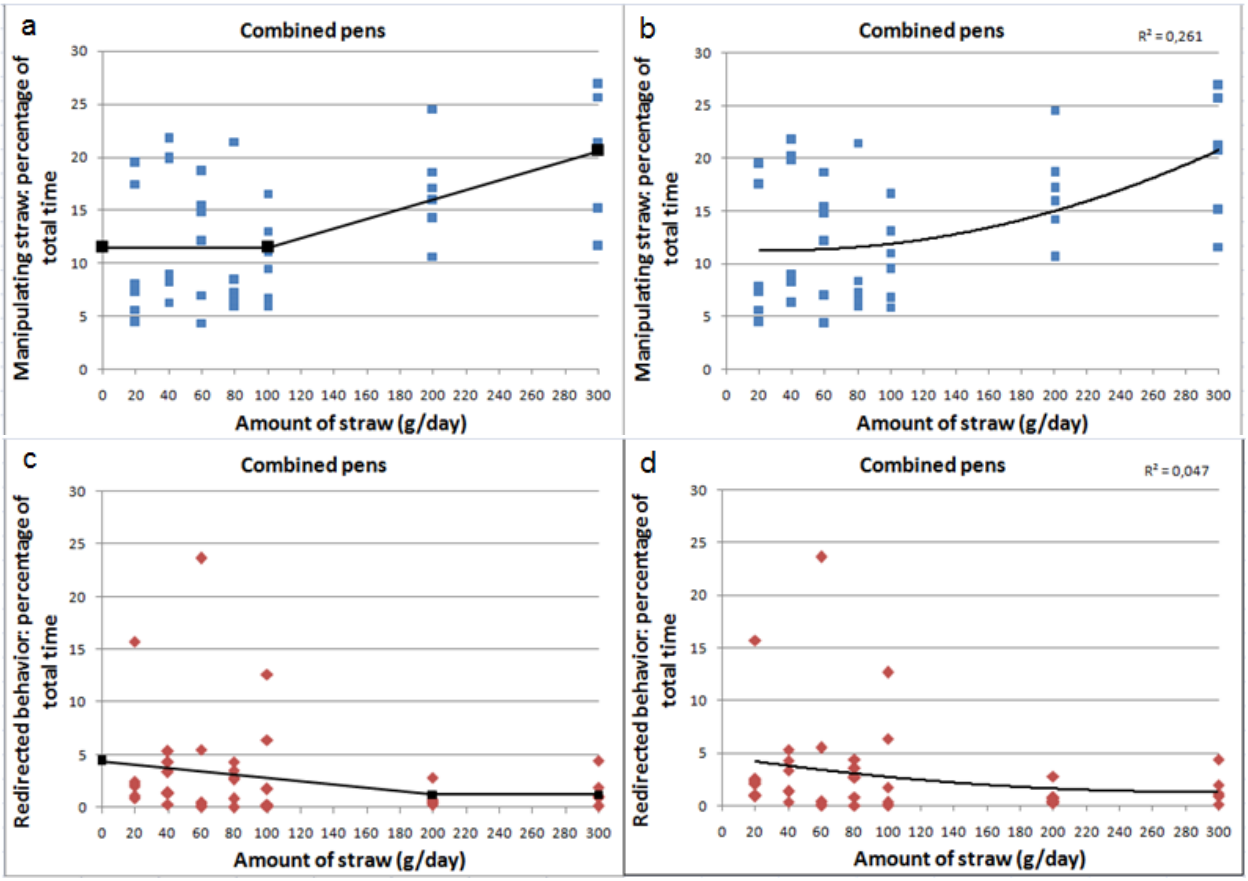

Figure 21a-21d. Comparison between broken stick (a & c) and polynomial trend line charts (b & d) for both the behaviours manipulating straw (a & b) and redirected behaviour (c & d).

5.3 Behaviour observations

5.3.1 Manipulating straw

In modern pig production, where the opportunity for pigs to root and graze is minimized, the provision of straw is an important factor for the wellbeing of pigs. Straw provide the pigs with the possibility to perform elements of their natural behaviour repertoire. The motivation to perform these behaviours is big and if the pig does not get substrate to manipulate, the pig will direct the manipulation elsewhere, for example towards pen mates. So, the more time that is spent on manipulating straw the less time is spent in redirected behaviour. The occurrence of the behaviour “manipulate straw” in the current study is thus a positive behaviour which should be carried out as much as possible.

The broken stick model proved insufficient in producing a valid breaking point inside the limits of this study. Several studies show that the provision of straw up to 2 kg per day (Arey, 1993) and above (Day et al. 2001) results in a proportional increase in explorative behaviour directed towards straw. This further leads to the conclusion that the amount of straw needed for pigs to perform a maximum of manipulative behaviour towards straw is beyond the 300g which is the maximum amount observed in the current study.

Even if no maximum was found in the current study, a clear distinction was observed when comparing the pens receiving 20-100g of straw and 200-300g of straw. The time spent in manipulative behaviour directed towards straw was increased over 10% ranging up to 27% in all the pens receiving over 200g of straw per day compared to the range from 4-22% in pens receiving 20-100g of straw. The data is also less spread from pens provided with over 200g of straw which means that more animals are affected similarly to the treatment.

5.3.2 Redirected behaviour

The hypothesis that the prevalence of redirected behaviour should decrease with increasing amounts of straw is accepted. For the broken stick method, when the pens were combined regardless of the provisions, a breaking point at 200g of straw was observed after when no further improvements were seen. Even though the accuracy of the method has been discussed, the amount seems probable. A clear distinction can be observed when comparing these pens with the ones provided with 20-100g of straw. The pigs from pens provided between 20-100g of straw spent 0-24% of the time in redirected behaviour. The variation in these pens is also big and for each amount of straw, at least one pen reach above 5%. However, all the pigs from pens provided over 100g of straw spent under 5% of the time in redirected behaviour and the data from these pens is more cohesive.

No significant differences between pens provided with straw once or four times per day were found. However, when looking at the charts the prevalence of redirected behaviour is higher when straw is provided four times per day compared to once per day. The percentage of time spent and bout lengths of redirected behaviour are also much higher in the pens provided with the smaller amounts of straw four times per day. This is interesting and contradictory to our hypothesis that the pigs should show less redirected behaviour if straw is provided several times. The hypothesis was based on studies showing that pigs will occupy themselves with manipulating fresh straw during a longer period of the day and that pigs are stimulated by novel objects (Studnitz et al, 2007).

The increase in redirected behaviour in pens with lower amounts of straw supplied four times per day could be explained by the increase in occasions when manipulative behaviour is stimulated. An onset of the manipulative behaviour repertoire is done repeatedly and without enough straw to manipulate, the pigs redirect the behaviour towards pen mates instead. However in the pens with higher straw provisions short periods of time is spent in redirected behaviour regardless if the provision of straw is done once or four times per day. One explanation for this phenomenon could be that the pigs are satisfied with the amount of straw provided and they have substrate enough to manipulate even if the onset of manipulative behaviour is done several times per day.

An inverted line was observed in charts showing the pens provided with straw four times per day and after the removal of the extreme values. This was not the case for the pens provided with straw once daily. This could mean that when straw is provided four times per day and the amount is smaller at every provision, a situation of competition can arise between the pigs to get access to straw. When smaller amounts are provided at a time, perhaps the bigger animals will be the ones who get access to the straw and the smaller animals will be dissatisfied. The dissatisfaction might lead to frustration and result in a higher prevalence of redirected behaviour compared to pigs that receive straw in bigger portions once daily. Since the line is inverted, it may suggest that the “true” breaking point is located outside of the range of the current study. If the provisions are divided in four, a bigger amount of straw per provision could be needed to satisfy all the pigs in the pen.

Few studies have been made comparing the provision of straw made once or several times per day. Zonderland et al., 2008 studied the act of tail biting after the provision of chains, rubber hose, straw given in a rack and straw given on the floor twice per day. The result show the biggest decrease in tail biting when straw is given twice daily. However the study did not focus on possible differences between the provisioning straw several times per day.

Hessel et al. 2006 studied the effect of multiple feedings on the behaviour of growing-finishing pigs. The results showed an increase in activity, time spent belly nosing and in aggressive behaviour in pigs which received feed nine times per day compared to three feedings. Furthermore were skin lesion scores higher on the pigs that received feed nine times suggesting that there is some frustration caused by the frequency of feeding. It is probable that the lower ranked animals do not get enough feed and as a result of that, they will take out their frustration on their pen mates in redirected behaviour.

5.3.3 Belly massage

The prevalence of belly massage is not in focus in the current study. However, some interesting results were found which deserves to be discussed. Prior studies have shown that belly massage is a behaviour associated with early weaning (Algers, 1984; Weary et al, 1999; Widowski et al, 2008). In a semi natural environment it has been showed that weaning occur somewhere between 60-100 days after farrowing (Newberry et al, 1985). However the motivators that start the behaviour are not fully understood. Aspects of social behaviour (Li & Gonyou, 2002), suckling motivation, stress, separation from the sow (Algers, 1984; Weary et al, 1999), feeding (Bruni et al, 2007) & drinking (Widowski et al, 2008) are all possible reasons for the onset of belly massage behaviour. The review written by Widowski et al (2008) describes the incidence of belly massage as a combination of the different factors. Young pigs are highly motivated to suckle and the lack of possibilities to do so might result in excessive drinking because of its resemblance to suckling. Excessive drinking will reduce time spent eating and increased feelings of hunger at an early age when the motivation to suckle is still high can bring the piglet to perform belly massage behaviour. If piglets are weaned after four weeks of age, when the motivation to suckle is probably diminished an increased feeling of hunger may trigger feeding behaviour instead. The time of solid feed intake varies between individual piglets ranging from day 10-28, at that time however the intake is very low. Around 20 days after farrowing the intake increase (Pajor et al. 1991). When the pig learns to eat solid feed the motivation to suckle will recline and also the prevalence of belly massage behaviour.

The pigs in this current study are weaned after four weeks but still perform belly massage behaviour, the overall belly massage behaviour also increased with increasing amounts of straw. This is not discussed in the review written by Widowski et al. (2008). However, the study claims that pigs which receive straw will perform belly massage to a lesser degree than pigs that do not receive straw at all (Widowski et al., 2008; Algers, B. 1984). Furthermore, pigs which receive substrate to root in will spend less time eating (Bench and Gonyou 2006, cited in Widowski et al., 2008). Finally, the occurrence of belly massage is reduced with increased time spent in foraging behaviour (Horrell and A'Ness 1996, cited in Widowski et al., 2008). The final statement is not in agreement with the results from the current study. A possible explanation could be that if a pig spend more time manipulating straw it will spend less time eating and perhaps get more motivated to eat. If the pig is not able to settle the motivation to eat, for example as a result of low rank, the motivation to perform belly massage could increase. Belly nosers tend to be the smaller animals (Torrey and Widowski 2006a, cited in Widowski et al., 2008) which could be the case in this study. The smaller individuals which do not receive as much feed because of low rank will perhaps perform the belly massage behaviour. Because the number of individuals used in this study is low, this one individual will have a big impact on the mean values of the pen. Even though growing pigs are fed ad libitum some pigs might still be hungry. Pigs want to eat together and if the lower ranked animal does not have the possibility to eat with the other and is unwilling to eat at other times, it will remain hungry. Hunger can motivate pigs to perform exploratory behaviour.

5.4 Activity

More time was spent in rest during the morning observations. This is an unusual result when compared to the natural diurnal rhythm of pigs. A study made by Wood-Gush et al (1990) showed that pigs usually spend the dark hours in rest and begin to activate themselves around 9 am to rest again around 1-2 pm. The morning observations were carried out around 9 am just when the pigs are about to activate themselves and the afternoon observation was made around 3 pm which is after the activity has declined. So there should not be a big difference between the two observations. Since there is a difference both in pens given straw once and four times per day, the possibility that the provision of straw has influenced this difference is low.

5.5 Variation

A high variation between pens can be seen throughout this study which needs to be taken into consideration. The results can be showed as trends for the majority of the pigs in the study but there were sometimes big individual differences. The big variation in the data may have many explanations. One explanation could be that the number of pigs observed is too small which means that one animal with divergent behaviour will have a great affect on the results. Four observations per pen instead of one could result in a more accurate picture of the behaviours performed in each pen. However it would not be possible during the course of this work because of the time needed for such a task. Another explanation could just concern the fact that pigs are individuals and all of them might not behave in the same way even if they are subjected to the same treatment. However differences in variation can be seen when comparing pens provided with different amounts of straw. The higher amounts resulted in decreased variation and more animals behaved similarly.

The behaviour “eating” can have less accurate numbers because of the limits made in the ethogram. The description of the behaviour is: snout in/over trough because of the difficulty to differentiate whether or not the pig was actually eating or doing something else when it had its snout in the trough. However in the later rounds the pigs had a habit of resting in the trough, perhaps because of the higher temperature in the stables when these rounds where videotaped. Even though they were resting, the snout was placed in the trough and the behaviour was noted as “eating” leading to an overestimation of this behaviour for those pens. This fact does only involve the behaviours resting and eating so there is no effect on the comparison between redirected behaviour and the manipulation of straw.

Finally, there could be an effect of the observer on treatment; biased decisions could be made when a behaviour is difficult to assess. However, the amounts of straw provided to the different pens were not known to the observer at the time of the observations.

5.6 Further research

During the course of this study thoughts have been made about what the results actually mean. How can we be certain that an increased manipulative behaviour towards straw is a sign of good welfare? Why is only the redirected behaviour considered signs of poor welfare and not the manipulative behaviour towards straw, can that behaviour not be caused by stress? Furthermore, can the behaviour cause stress? Small signs of increased redirected behaviour were found in pens receiving straw four times per day so the provision of straw and the possible struggle for substrate that arises between pen mates could cause stress. It would be interesting to study the physiological stress response, e.g. the presence of stress metabolites such as cortisol and heart rate as parameters in the same type of study.

If higher demands are set on the provisions of straw for pigs it does not only affect the welfare of the pigs but also the economic situation of the farmers. The provision of more straw is costly and the increased cost of straw could seem intolerable for the Swedish farmers due to the economic situation in the Swedish pig production today. It would be interesting to see if an increased provision of straw can decrease the costs in other parts of the production. From the current study the prevalence of redirected behaviour is decreased with increasing amounts of straw, i.e. the pigs do not perform as much ear bite, tail bite or nibbling. These behaviours can damage the receiving pig in various ways and degrees. The damages might in some cases need treatment, which also involves a great cost for the farmer. If a study can show that the extra cost that the extra straw involves is comparable with the decreased costs as a result by the lower prevalence of damages to the pigs, the farmers might find it easier to accept the new laws.

The increase in straw also involves the problem with clogged slats and drains. A certain barrier, separating the lying area and the dunging area might stop some straw from entering the drainage. So the effect of different types of barriers should be interesting to study in the future.

6. Conclusions

300g of straw, which is the highest amount of straw included in the current study, is probably not enough for pigs to perform manipulative behaviour to maximum extent. The provision of at least 300g of straw would increase time spent in manipulative behaviour and thus to a better extent satisfy exploratory motivation. However, the minimum amount of straw needed to decrease time spent in redirected behaviour to a minimum level seems to be 200g of straw. These results suggest that 200g of straw per pig and day is the minimum amount necessary for pigs in conventional pig production in Sweden to be able to perform manipulative behaviour and to decrease redirected behaviour.

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