

Economic Analysis and Discussion Of Automatic Sorting Technology

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Introduction

This document analyzes the Automatic Sorting Technology that is being developed by Farmweld®. This analysis evaluates economic returns that producers may realize from this technology. Limited data is available for some of these analyses. Future research will define the economic advantages. In all analyses, a 1000-head feeder pig to finish barn with a slaughter weight of 270 lb and slaughter price of \$0.45 per lb was used. The economic value or cost reduction is given per head, per 1000-head, and annualized per barn (2.6 turns).

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AST ADVANTAGES

1. Ability to increase percentage of pigs sold in the matrix
2. Ability to optimally manage Paylean®
3. Improved pen utilization
4. Trim loss
5. Feed savings
6. Decrease in deads and downers
7. Sorting labor
8. Lower death loss during the growing phase due to absence of sorting and mixing
9. Loading labor
10. Decrease labor in cleaning and washing barns and transport vehicles
11. Slaughter trailer waste reduction
12. Plant Waste
13. Ability to monitor growth rate and average daily feed intake
14. Animal welfare
15. Meat quality
16. Miscellaneous
 - a. Data capture
 - b. Stresses
 - i. Group size
 - ii. Remixing of pens
 - iii. Heat, Space, and Regrouping
 - iv. Regrouping
 - c. Costs

AST DISADVANTAGES

1. Managing starting pigs in large group size

ADVANTAGES

SORT LOSS

Packers have a grid or matrix in which optimum payment occurs. Selling market hogs outside this grid results in a discount or sort loss. The magnitude of that loss depends on the packer. Typically, the magnitude is much greater for pigs below the bottom threshold of the grid, with less magnitude for heavy weight pigs sold above the threshold. However, in most grids, it is still more advantageous to sell a percentage of the pigs above the threshold and reduce the percentage of pigs below the lower weight threshold. Auto Sort Technology (AST) gives the producer the capability of selling an extremely high percentage of the pigs in the matrix. Even though producers typically sell the heavyweight pigs before the bulk of the sales, they often estimate the weights of individual pigs in the pen incorrectly. When this occurs, not all of the heaviest pigs in the barn are sold. As a result, the next sales will still be a high percentage of the pigs above the grid.

To determine the potential value of removing all pigs at the correct slaughter weight, a mathematical model was constructed. The model used slaughter information from real farms and compared that to a theoretical system that weighed every pig prior to slaughter. Automated sorting technology (AST) allows all of the pig weights to be measured daily. Prior to loading the slaughter trailer, AST weighs and sorts all of the pigs. This means only the pigs above a set cut off are loaded. This will result in the heaviest pigs being removed from the barn. The model used margins over feed cost as the measure of profitability.

The model system also compared two different selling strategies: Aggressive sorting and limited sorting. In the aggressive sorting scenario, pigs were removed at a target weight with 50% of the pigs being removed prior to closeout. This was used to replicate a system where market weight (not barn space) is the limiting factor. The limited sorting model assumed that only 15% of the pigs were sold prior to the week of closeout. This scenario was to represent systems where space is the limiting factor. In both scenarios, the target slaughter weight was 270 pounds live.

Table 1 summarizes the results of the different scenarios. In the aggressive sorting (AS) scenario, there is almost a \$2.00/head or \$2000 per 1000 head barn advantage to AST. This advantage results from heavier pigs being sold prior to closeout (211 lb vs. 204 lb carcass).

The AS scenario has 50% of the pigs sold at the heavier weight resulting in 3500 more pounds being sold in a 1000 head barn. The sort loss will be reduced because a higher percentage of pigs being in the optimum weight range. In this model, the sort loss was reduced by \$0.69 per carcass cwt. This accounted for 73% of the improved margin over feed cost with AST compared to a conventional building. AST reduces the variation on each load allowing loads to be heavier with same number of pigs over the desired weight

range and fewer pigs below the desired weight range. This shift in sale weights results in heavier average market weights. This increased sale weight accounts for 27% of the increased margin over feed for AST compared to conventional building designs.

The LS scenario results in a \$600 per 1000 head barn advantage. It is lower than the AS scenario because fewer pigs are sold prior to closeout. The same concepts as the AS scenario apply but on fewer pigs.

Table 1 – Effect of Two levels of Pre-Closeout Sorting on Margin over Feed Cost

	AGGRESSIVE SORTING		LIMITED SORTING	
	<i>Conv.</i>	<i>AST</i>	<i>Conv.</i>	<i>AST</i>
<i>Pigs Sold the week of Close out</i>	50%	50%	85%	85%
<i>Mean Carcass WT Sold pre Close</i>	204	211	204	211
<i>Mean Carcass WT Sold at Close</i>	196	196	204	204
<i>Margin/Feed Per Pig Sold Pre Close</i>	\$ 75.16	\$ 79.14	\$ 75.16	\$ 79.14
<i>Margin/Feed Per Pig Sold at Close</i>	\$ 74.04	\$ 74.04	\$ 76.38	\$ 76.38
<i>Total Margin/Feed per Barn</i>	\$ 74,600	\$ 76,589	\$ 76,197	\$ 76,793
<i>Margin/Feed per Head</i>	\$ 74.60	\$ 76.59	\$ 76.20	\$ 76.79
<i>Value of AST per Head</i>		\$ 1.99		\$ 0.60
<i>Value of AST per 1000 head</i>		\$ 1990.00		\$ 600.00

In summary, AST provides a way to optimize pounds per square foot per year and minimize sort loss through less variation through increased accuracy of sorting.

PAYLEAN[®]

Paylean[®] (ractopamine hydrochloride – Elanco Animal Health) is a repartitioning agent for feeding to swine. Paylean increases average daily feed intake, increases average daily gain, and lowers feed conversion ration when fed to pigs prior to market.

The optimal return from feeding Paylean occurs when an individual pig consumes two to four weeks of Paylean, depending on dose and marketing strategies. In a typical system, Paylean frequently is not fed to the fastest growing pigs. Thus, the Paylean value is lost on 15-20% of the pigs. Paylean is included in the diet for the pigs after the first 15-20% are sold. Sales resume two weeks after Paylean inclusion. Four weeks after Paylean inclusion the barn is closed out. This results in Paylean being included for an average of 21 days in the diet.

Typically, producers do not use a stepped-up Paylean inclusion (4.5g/ton followed by 9.0g/ton) because of the inability to feed 9 g per ton for a controlled period. AST allows the pigs to be grouped on a weekly or biweekly basis by weight and then fed the appropriate dose of Paylean, which could include a step up program.

To understand the potential economic impacts of an optimal Paylean feeding strategy for each pig, a new mathematical model was constructed. This model compared conventional buildings and feeding strategies to buildings with AST. Two static Paylean feeding levels of 4.5 and 9 grams per ton (10 and 20 ppm) were evaluated in both AST and conventional buildings.

PAYLEAN STRATEGIES

The model used three weeks feeding of Paylean as the optimum return based upon the data provided by Elanco Animal Health and Kansas State University. The barn type (conventional vs. AST) determined the percentage and for how long those pigs were fed Paylean.

In the conventional barn, Paylean administration was modeled to follow conventional feeding strategies. After the first cut of pigs removed for slaughter, Paylean was fed for three weeks until the barn was closed out. This resulted in 85% of pigs receiving Paylean for three weeks.

In the AST barns, it was assumed that all pigs received Paylean for three weeks, as pigs would be segregated prior to marketing and placed on different diets relative to their weight. With the AST barns, two sorting strategies were identified. An aggressive sorting strategy (AST-A) assumed that 50% of the pigs would be removed prior to the last week of closeout. This strategy was used to model a system that had excess building capacity and attempted to target a specific market weight at the top end of the matrix. The second AST situation, which was a limited sorting situation (AST-L), was used to model a system where space was limited, and 85% of the pigs were removed the last week prior to closeout.

MEASUREMENTS

The measure of return chosen was margin over feed cost. As in all scenarios, slaughter weight was standardized at 270 lb. Feed cost was calculated at \$2.20 per bushel corn and \$165 per ton soybean meal. Paylean diets were adjusted to 1.1% lysine.

Table 2 – Effect of Paylean on Margin over Feed Cost with Various Barn Designs and Marketing Strategies

	LEVEL OF PAYLEAN PER TON					
	4.5 g/T			9 g/T		
	Conv.	AST - A	AST -L	Conv.	AST - A	AST -L
<i>Pigs Sold at Close-out</i>	85%	50%	85%	85%	50%	85%
<i>Closeout - Margin over Feed</i>	\$ 74.78	\$ 74.78	\$ 74.78	\$ 76.08	\$ 76.08	\$ 76.08
<i>Pigs Sold Pre-Closeout</i>	15%	50%	15%	15%	50%	15%
<i>Pre-closeout - Margin/Feed</i>	\$ 75.32	\$ 75.43	\$ 75.43	\$ 75.32	\$ 76.11	\$ 76.11
<i>Average Margin Per Pig</i>	\$ 74.86	\$ 75.10	\$ 74.88	\$ 75.97	\$ 76.10	\$ 76.09
<i>Margin/Feed per 1000 Head</i>	\$74,860	\$75,102	\$74,877	\$75,968	\$76,097	\$76,087

*No value was given for extra space after first cut.

RESULTS

Table 2 summarizes the results of the Paylean mathematical model. Nine grams per ton of Paylean yielded greater margin over feed cost than 4.5 g per ton in all three scenarios (conventional, AST-L or AST-A). At either inclusion rate of Paylean, there were not any significant differences in profitability between the three scenarios.

PEN UTILIZATION IMPROVEMENT

When filling a typical 1000-head barn with 40 pens and single pen capacity of 25 head, the barn design is to provide 7.2 sq ft per head. However, producers normally leave 10% of pens unfilled to accommodate pigs that have to be removed during the growing period. The 10% reduction restricts space to 6.5 sq ft per head in the pens that are utilized. The free pen space is thus underutilized, until the barn manager sorts fallback, recovery pigs, or normal pigs into those pens. Since there is a direct correlation between space and average daily gain, a reduction in space will lower average daily gain. In a typical barn, leaving 10% of pens open reduces average daily gain by 0.025 lb per day, resulting in a reduced exit weight of 3 lb per head over the 120-day feeding period. The AST system eliminates this restriction.

There is also "free space" available in a large capacity pen system compared to a traditional pen capacity system. "Free space" is the amount of open space available for pigs for activities such as dunging, drinking, eating, and movement. "Free space" increases as pen capacity increases because there are fewer gates and blind corners around feeders in pens. Researchers at Prairie Swine Center at University of Illinois have shown only minor improvements in average daily gains as "free space" increases.

Table 3 – Value for Improved Pen Utilization

<i>Inventory (Head)</i>	1000
<i>Improvement in Average Daily Gain (lb)</i>	0.025
<i>Slaughter Value (270 lb)</i>	\$0.45/lb
<i>Value per Head (120 Days)</i>	\$1.36
<i>Net Value per Head (Minus Feed)</i>	\$0.91
<i>Total Net Value per 1000 Head</i>	\$910
<i>Total Net Value per 1000 Head (Annualized)</i>	\$2366

TRIM LOSS

Slaughter plants report trim loss of 0.9% per head. A percentage of this trim loss occurs when pigs are sorted, mixed, loaded, and unloaded for slaughter. AST pigs are conditioned to movement, and thus trim loss will be reduced. Table 4 assumes a reduction of 50% in trim loss.

Table 4 – Value in Reduction of Trim Loss

<i>Inventory (Head)</i>	1000
<i>Reduction in Trim Loss (lb)</i>	0.45%
<i>Value of Trim Loss per lb (66% Value)</i>	\$0.30
<i>Value of Trim Loss per Head</i>	\$0.27
<i>Value of Trim Loss per 1000 Head</i>	\$270
<i>Value of Trim Loss per 1000 Head (Annualized)</i>	\$702

FEED SAVINGS

AST provides the capability of allowing 100% of the market group off feed for an identified period. This has the advantage of eliminating feed cost for that period. A 270-lb slaughter pig is expected to consume 5.35 lb per day. Assuming diet cost at \$0.065 per lb (includes Paylean, proper protein for Paylean, grind mix, and delivery) and assuming pigs are restricted on feed for 75% of this daily consumption, the savings per pig is \$0.26.

Table 5 – Feed Savings

<i>Inventory (Head)</i>	1000
<i>Feed Savings (lb - 75% of feed)</i>	4
<i>Value of Feed Savings per Head</i>	\$0.26
<i>Value of Feed Savings per 1000 Head</i>	\$260
<i>Value of Feed Savings per 1000 Head (Annualized)</i>	\$676

DEADS AND DOWNERS

Deads and downers typically average 0.5% with 0.375% attributed to deads in transport and 0.125% attributed to deads and downers at the slaughter plant. AST has the pigs conditioned to moving, so pigs are easier to load and unload. Assuming this system would decrease deads and downers by 50%, the value increased in 1000 head barn would be as follows in Table 6.

Table 6 – Savings from Deads and Downers

<i>Inventory (Head)</i>	1000
<i>Reduction of Deads/Downers</i>	0.50%
<i>Value per Head with Reduction</i>	\$0.61
<i>Value per 1000 Head</i>	\$607.50
<i>Value per 1000 Head (Annualized)</i>	\$1579.50

*Discount on downers varies by plant.

SORTING LABOR

Producers indicate a cost of \$0.25-0.40 per head in marking and sorting pigs for slaughter. AST eliminates the majority of this labor because pigs are sorted

automatically. Assuming AST captures most of the cost of marking and sorting, the value is illustrated in Table 7.

Table 7 – Savings from Sorting and Marking Labor

<i>Inventory (Head)</i>	1000
<i>Cost Savings of Sorting per Head</i>	\$0.25
<i>Cost Savings per 1000 Head</i>	\$250
<i>Cost Savings per 1000 Head (Annualized)</i>	\$650

LOADING LABOR

In a typical scenario, it requires four people approximately one hour to load a slaughter truck. AST allows pigs to be accustomed to walking distances through restricted areas, which greatly facilitates loading and unloading. Table 8 assumes AST will reduce loading labor by 50%.

Table 8 – Savings from Loading labor

<i>Inventory (Head)</i>	1000
<i>Loading Time (hours - 50% Reduction)</i>	0.5
<i>Staff People per Loading</i>	4
<i>Labor Cost per Hour</i>	\$10
<i>Reduction in Labor per Load</i>	\$20
<i>Reduction in Loading Cost per Head</i>	\$0.11
<i>Loading Cost Reduction (5.5 Loads) per 1000 Head</i>	\$110
<i>Loading Cost Reduction (5.5 Loads) per 1000 Head (Annualized)</i>	\$286

CLEANING & DISINFECTION

Producers empty, clean, and disinfect barns between each group of pigs. Pigs in large groups establish dunging patterns based on seasonal environments. These dunging patterns are confined to a much smaller surface area in large groups compared to traditional groups. A significant amount of time is spent cleaning slats and removing diet fat that has covered the flooring. Naturally, reducing the dunging zone reduces the facility cleaning time. Cleaning and disinfecting is either completed by employed or contracted labor. A typical cleaning/disinfecting cost is \$400 per 1000-head barn. A considerable amount of this is the time to clean pen gates. AST utilizes large pen capacity, and thus, reduces the labor required in cleaning and disinfecting. The minimal number of pens may allow use of a robotic cleaner. Table 9 assumes a 50% reduction in cleaning with improved efficiency compared to the traditional methods.

Table 9 – Savings from Labor Reduction in Cleaning/Disinfection

<i>Inventory (Head)</i>	1000
<i>Annual Cleaning Times (Nursery-Finisher)</i>	2.6
<i>Cost per Cleaning</i>	\$400
<i>Expected Reduction in Cleaning/Disinfection Cost with Big Pens</i>	50%
<i>Savings per Head</i>	\$0.20
<i>Savings per 1000 Head Barn</i>	\$200
<i>Savings per 1000 Head Barn (Annualized)</i>	\$520

SLAUGHTER TRAILER WASTE REDUCTION

Having the pigs off feed for an identified period prior to slaughter not only reduces feed cost but also reduces the cleaning required in transport trailers. Typically, producers spend \$75 for cleaning, pressure washing, and disinfecting a trailer. Table 10 assumes that a 50% reduction in cost of cleaning and disinfecting a trailer would occur with 100% of the pigs off feed at designated number of hours pre-transport.

Table 10 – Savings from Slaughter Trailer Waste

<i>Inventory (Head)</i>	1000
<i>Number of Slaughter Loads per 1000 Head Barn</i>	5.56
<i>Cost Reduction in Cleaning (50%) per Trailer</i>	\$37.50
<i>Cleaning and Disinfecting Cost Savings per Head</i>	\$0.20
<i>Cleaning and Disinfecting Cost Savings per 1000 Head Barn</i>	\$208.50
<i>Cleaning and Disinfecting Cost Savings per 1000 Head Barn (Annualized)</i>	\$542.10

PLANT WASTE

Slaughtering pigs that have been held off feed a designated number of hours reduces the amount of feed that has to be discarded in the plant waste system. Estimates that are 10% of plant waste are composed of feed and removal water. Table 11 illustrates the plant cost savings on a per head basis from feed withdrawal.

Table 11 – Savings from Feed Withdrawal for Plant

<i>Inventory (Head)</i>	1000
<i>Amount of Feed Waste Eliminated (lb)</i>	5
<i>Plant Value of Feed Waste Reduction (Gallons)</i>	1.2
<i>Expected Reduction in Plant Waste</i>	10%
<i>Value per Head</i>	\$0.05
<i>Value per 1000 Head</i>	\$60
<i>Value per 1000 Head (Annualized)</i>	\$156

MISCELLANEOUS

DATA CAPTURE

The AST system can be designed to capture weights over a designated period, such as one week. Coupling the weights with the feed disappearing over that period would result in calculation of average daily feed intake. The current AST system captures the number of individual weights. Since the individual pig is not identified, further research is needed to understand if all pigs over a given period of one week go through the scales the same number of times. Otherwise, the weight calculated could be skewed. Capturing average daily gain and average daily feed intake allows producers to benchmark their diet to the calculated diet. No value has been assigned at this point.

STRESSES

Group Size

There has been inconsistency in studies on effect of group size on performance. Most recently, it has been determined that if all other factors are equal, group size up to at least 80 animals is viable.

Table 12 – Post Weaning Performance from 4-10 Weeks of Age

	GROUP SIZE						
	10	20	30	40	60	SEM	P
<i>Feed intake (g/d)</i>	770	746	788	774	808	38.9	NS
<i>DLWG (g/d)</i>	543	540	524	544	540	13.7	NS
<i>FCR</i>	1.42	1.43	1.50	1.51	1.52	0.039	NS

(Lamb 2001)

Remixing of Pigs

AST utilizes big pen capacity. Trials have shown that with 30 or more pigs in a group, socialization is different from less than 30 per group. If you remove or add pigs into the population, when there is greater than 30 pigs per pen, the stress is less than small pen groups. Remixing in the traditional system frequently increases death loss and reduces average daily gain.

Heat, Space, and Regrouping

A study (Hyun et al. 1998) showed that the effects of different stressors (high temperature, restricted space allowance, and regrouping) on average daily gain, feed intake, and feed conversion, when presented together, are additive.

Regrouping

A study (Schmolke and Gonyou 1999) determined that mating or regrouping of pigs within two weeks of marketing led to decreases in weight gain in the range of 7%.

Costs

Producers installing AST systems in new facilities are finding they pay for themselves because they use barn space more efficiently than traditional barns. AST buildings can be designed with or without long alleyways which means more useable pig space. For example, in a typical 40' x 200' barn about 600 sq. ft. is usually allotted to alleyways. By eliminating all but a short alley near the barn door and a small operator station adjacent to the AST scale, 550 sq. ft. in useable pig space is gained.

Producers may elect to add more pig spaces to the building to increase revenue, depending on the permit status for the site. Another option is to shorten the length of the building by 14 feet which lowers construction costs.

The cost of retro fitting a conventional 40-pen, 25-head per pen facility with AST would be approximately \$10-20 per pig space.

Summary

AST offers the capability to manage all of these stresses that lower average daily gain, feed intake, and feed conversion.

DISADVANTAGES

PEN CAPACITY

AST combines automatic weighing and sorting of pigs. Some of the advantages and disadvantages have been identified in this draft document. Large group size capacity will be the biggest challenge in wean-to-finish facilities. This is not a factor in a feeder pig to finishing flow. In a feeder pig to finishing flow, the pigs have already been successfully started during the nursery phase. Housing in large groups triggers similar fighting as occurs during transport. The short-term reduction in average daily gain in the adaptation from nursery to finisher is expected to be similar to what occurs in transport when pigs do not maintain pen integrity. Most systems do not maintain pen integrity from the nursery to the finisher, and thus, would be the same adaptation that occurs during the resocialization. Three years ago, there was a stronger movement to large group size, but research from University of Illinois and Prairie State Swine Center has failed to identify the anticipated value of large groups. This anticipated value is termed "free space", which increases the number of pigs in a barn while slightly reducing space per pig. Trials from both of these groups indicated that there was no disadvantage to large pen capacities. In my estimation, the percentage of producers using large group pens would be less than 1%.

In wean-to-finish, management has to provide more discipline to properly start pigs. Producers can start successfully a large number of pigs per pen in wean-to-finish. For producers that are concerned about starting large group capacities, a system of interchangeable gates can be used to alter pen size with traditional capacities for 8-10 days post weaning. These gates can then be rearranged to configure the large pen capacity allowing producers to capture advantages of wean-to-finish and AST. Large group capacity is more favorable to large sow units or systems commingling pigs to multiple sow units. This is illustrated in the following example: assuming a 2500 head sow unit producing 1000 pigs per week, the sow unit will typically wean a minimum of twice per week and generate 500 pigs per wean day. The groups are split into barrows and gilts making each size 250 head. Each group is split into light, medium, and heavy groups, which makes each group for feeding 83 head. If these groups are left intact by sex, the average weight of the group would be 10 lb similar to what the producer would generally feed for the lightweight group to facilitate their growth. This mean that the producer will be feeding the pre-starter diet to 100% of the population rather than 30% or less of the population. The net result is to increase cost of gain during the first eight weeks post weaning by \$0.01-0.015. Assuming this gain is 45 lb, the increased cost per pig may be \$0.45 per head.

Producers may have an easier time identifying fallback or treatment pigs but a more difficult time in catching pigs. Increased attention needs to be given to be certain there is an adequate feed mat, feeder, zone heating, and water when starting these pigs. A marking system for the pigs that must be removed or treated would be extremely helpful. A system with a crowd gate to restrict the space when catching pigs may also be helpful. One of the challenges in removing fallback and sick pigs in wean-to-finish barns is that if they are crowded, you may see an increase in leg injuries due to catching the leg when they are excited. There are advantages to large group pens. With the reduction in gates, it is much easier for the producer to get in every pen several times per day to observe feed, identify, and treat. Good management practices will go a long way in improving adaptation of this technology to wean to finish barns.

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