Recent Developments in the US Swine Industry

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During the last few years the US swine industry has seen a trend of structural changes in production systems and technologies, and these changes have occurred more rapidly than previous developments. Although the focus of this workshop is the genetic improvement of pigs, some of the above structural and "non-genetic" trends should be discussed as they can impact on how US breeders and breeding organizations must operate.

Integration

The US swine industry is undergoing large structural shifts from small/medium-sized, family oriented, relatively independent production units to production units that are larger in size and aligned with corporate and/or pork processing organizations. Additionally, a fair portion of this production is being located outside the traditional hog-producing Corn Belt region. Some of these integrated systems have the seedstock sector incorporated into the production pyramid while others do not. Re-structuring is still occurring as the industry recovers from some of the worst hog prices this century (e.g., $9.00US/cwt in 12/97). Table 1 lists some of the US organizations that have developed vertically integrated systems, and the number of sows in their sow bases in 1994 and 1999.

Table 1. Vertically integrated US pork packer-producers (adapted from Freese, 1999)

Rank 1999	Name of Operation	Sow base location	#Sows 1999	#Sows 1994
1	Smithfield Foods/ Murphy's	NC, VA, UT, MO OK, IL, AK	661,500	65,000
2	ContiGroup Co.	MO, NC, TX	162,000	20,000
3	Seaboard Corp.	KS, CO, OK	145,000	20,000
4	Cargill	NC, AR, OK	110,000	77,000
5	Farmland Indus.	KS, IA, MN,	67,000	16,000
6	Lundy Pack.	NC, SC	30,000	*
7	Hormel	CO	25,000	0
8	Clougherty Pack.	AZ, CA	23,000	17,600
9	Hatfield	PA	2,100	600

From a genetic perspective, these systems can have a number of advantages over more de-centralized seedstock/commercial production systems. Breeding objectives can be more clearly defined with pork production and processing occurring within one organization. Also, genetic lines and crosses can be identified and developed more readily for specific branded pork product lines, and having interest in both the production and processing sectors helps an organization manage risk during different

phases of pork price cycles. This is in addition to any advantages from economies of scale that can be captured with this type of system. These systems do present unique challenges to managers, and geneticists, over more traditional pork production systems, but, as information systems continue to evolve, these challenges have become much more tenable. Whether these structural shifts in production system structure continue at the current pace will depend on issues such as new regulatory statutes that may be implemented, environmental issues and the vagaries of the market place.

Reproductive Technologies

Artificial insemination has or is being widely incorporated into many US production systems, and Best Linear Unbiased Prediction (BLUP) is the method of choice for genetic evaluation of selection candidates. It's fairly well established that the uses of BLUP and AI in breeding programs have the potential of increasing the rate of accumulation of inbreeding in closed nucleus programs over other selection methods (Belonsky and Kennedy, 1988; Toro et al., 1988). Currently, most breeding programs in the US use relatively traditional methods to control inbreeding within nucleus herds. These include: restrictions on the percentage of sows mated to a single sire, number of sires retained from full and half-sib families, avoidance of mating close relatives, and/or formation of composite lines (Rathje, 2000). Given the widespread use of BLUP and AI, there will probably be greater implementation of mate selection strategies (Bunter and Long, 1991; Shepherd and Kinghorn, 1999) in future breeding programs.

PPL Therapeutics PLC announced on March 5, 2000 that five, healthy pigs were born that had been cloned using DNA from adult cells. This group's interest is in the development of pigs for xenographs for human medicine, but the development of cloning techniques for livestock species does have implications for animal agriculture. James (1988) discussed the use of clones in breeding programs and pointed out some of the difficulties that might be incurred with using this technology at the nucleus level. Depending on the cost of obtaining clones, access to the technology and the success rates of procedures, the initial implementation of this technology in the swine industry might be to use it further down the breeding pyramid than in the nucleus. Payne et al. (1999) outlined some of the main sources and influence of variation (both genetic and environmental) in pig production and performance. Given the widespread use of AI, a number of cloned boars could be put in an AI stud to provide semen for commercial production. Although not totally eliminating the variation in market pigs produced (e.g., variation due to season, stocking density, nutrition provided, and disease), this type of implementation could reduce the amount of variation in market pigs due to genetics. This type of development would also be dependent on having a genetic evaluation system in place, such as PIGBLUP, in order to ensure the right animals were being cloned.

Two groups (one in the Netherlands and one in North America) have reported they have developed a non-surgical technique for embryo transfer (ET) in swine. This technology could enhance a number of facets of a breeding program. Having an economical non-surgical procedure for ET would facilitate the distribution of germplasm through health barriers, since embryos can be washed of a number of pathogenic organisms. These transfers could be from herds of lower health status to high health herds or across country borders, where severe restrictions might currently be in place to protect the domestic herds from introduction of foreign pathogens. Additionally, this technique

could help facilitate the distribution of clones as discussed above. It would also make a number of other developing technologies, such as embryo sexing, embryo screening for DNA markers, and storage of germplasm as embryos much easier to implement in commercial production systems.

Health

Relative to Australia, swine producers in the US deal with more pathogenic organisms in their production systems, and health status is an important component in improving production efficiency. Schinckel et al. (1999) summarized results from three studies investigating the interactions between genetic line and health status, and concluded that these interactions were important. In the past, it has been assumed, in breeding program designs, that these interactions were relatively small. However, if they are important, it does have ramifications for both testing environments for nucleus animals and selection of seedstock to use in specific, production environments (assuming that production environments can be suitably characterized/quantified). Additionally, there is a growing trend to try and eliminate disease organisms from seedstock and production systems (e.g., Porcine Reproductive and Respiratory Syndrome/PRRS, mycoplasma, actinobacillus pleuropneumonia/APP) rather than manage the herds with those organisms present. Whether by procedures such as depopulation or medicated early weaning (MEW), a number of groups are attempting to break or have broken disease cycles of certain pathogenic organisms, such that animals have a better opportunity to express their genetic potential for economically important traits.

Finally, there is increased interest in selecting for disease resistance. In the past, approaches to this problem have usually entailed selecting for increased responsiveness in one component of the immune system to a specific pathogen. In a further development, Mallard et al. (1998) selected for high and low immune responsiveness in Yorkshire pigs using an index that reflected different components of the immune system. They did achieve a selection response, but the line with high immune responsiveness also had more severe arthritis than the other lines in the experiment. As work in the molecular area continues, it is hoped that information will come to light that gives us a better understanding of the genetic control of the immune system, and how that information could be used in a breeding program.

Feed Additives

Ractopamine HCl (RAC) is a beta-adrenergic agonist. One company in the US has recently received approval (12/99), from the Food and Drug Administration (FDA), to provide this compound to producers as a feed additive in swine diets, and it has no withdrawal times (can be fed up to the time of slaughter). Table 2 summarizes some of the effects this feed additive has on production and carcass traits.

Table 2. Effects of ractopamine on growth and carcass traits in finishing pigs (least square means adapted from Schroeder et al., 2000a and Schroeder et al., 2000b).

	RAC level, ppm				
	0	5	10	15	20
Trait					
ADG, (kg)	0.82	0.89	0.87	0.86	0.89
ADFI, (kg)	2.86	2.84	2.76	2.67	2.73
FCR	3.51	3.22	3.18	3.13	3.08
Final wt., (kg)	109.5	108.6	109.1	108.8	108.9
Dressing %	72.3	73.1	74.2	73.9	74.3
10^{th} rib BF, cm	2.91	2.89	2.67	2.85	2.66
LEA, cm2	33.45	35.19	37.18	35.46	36.81
Carcass lean, %#	52.33	52.81	55.60	55.23	55.37

- carcass lean as a percent of the hot carcass

RAC appears to favourably affect average daily gain, feed conversion ratio and the amount of lean in carcasses. A number of organizations are currently doing growth and carcass trials to ascertain whether this feed additive could be used in their production systems and effects on pork quality. It is currently unclear whether significant genotype x environmental interactions exist for this feed additive (different genetic lines respond differently). It is also unclear what consumer reaction might be to pork being raised with the use of this compound. However, if large segments of the industry adopt the practice of feeding RAC, it could affect how we define breeding objectives in current breeding programs.

NPPC Maternal Line Genetic Evaluation Program

The National Pork Producers Council (NPPC) has completed its Maternal Line Genetic Evaluation program, and results will be presented in a symposium on March 19-20, 2000. This was a large trial involving 6 different maternal lines. Six hundred 10-14 day old gilts from each line entered the project, were developed, bred and carried through four parities of production on two 1600-sow farms. The lines in the trial were: American Diamond Genetics, Danbred USA, DeKalb DK44, DeKalb MPX200, NSR Yorkshire-Landrace and Newsham Hybrids (USA). Results from this trial will provide information on gilt development effects on subsequent reproduction, sow reproductive efficiency differences, sow longevity and progeny market pig performance.

"New" Dam Lines

Currently, the majority of US seedstock producers are using BLUP evaluation procedures, coupled with dam indexes, in selection schemes to improve the reproductive performance of their maternal lines. However, some groups are also using immigration to develop new maternal lines. One line that is being incorporated into breeding schemes is the Nebraska Index Line (Johnson, 1998). This line underwent selection for ovulation rate and embryo survival for 14 generations followed by 4 generations of selection for ovulation rate and litter size. The line was recently released

to the US industry, and the maternal line MPX200 (see above section) was derived from the Nebraska Index Line. Results from the NPPC Maternal Line trial will provide a good characterization of how this line compares to other maternal lines currently available to the industry.

Some breeding organizations have or are considering development of dam lines using the Chinese Meishan breed. This breed has exceptional reproductive performance, relative to western breeds (Rothschild and Bidanel, 1998), and Chen et al. (2000a; 2000b) have shown that selection for lean growth rate in a Meishan composite line would be successful with little effects on litter traits. Although, currently, these dam lines are not being used widely in commercial production, they may be utilized to a greater extent in future production systems.

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