using only homofermentative bacteria is that they often make aerobic stability worse because the production of antifungal end products is usually suppressed. Species of propionibacteria were introduced as silage inoculants in the late 1980s in hopes of producing propionic acid and alleviating this problem but have met with limited success. Over the last 15-20 y, researchers have studied the application of killer yeasts to improve aerobic stability, bacteriophages to inhibit clostridia, and incorporation of cellulase genes into lactobacilli for improved fiber digestion in silage, but these applications have not been commercialized. Recently, identification of *L. buchneri* by Muck (1996) has led to a new paradigm to improve the aerobic stability of silages. This organism, is a heterolactic bacterium that can anaerobically convert lactic acid to acetic acid, 1,2 propanediol and ethanol and has made us reevaluate the theory of only using homolactic acid bacteria as silage inoculants. The dynamic nature of silage fermentation provides an open canvas for future research which may include identification of organisms that produce bacteriocins and antifungal compounds or that may have direct-fed microbial activity in the rumen.

Key Words: Silage, Inoculant, Fermentation

40 The end products of silage fermentation and their relationships to animal performance. Richard Muck*[1] and Limin Kung, Jr.[2], [1]*USDA, ARS, US Dairy Forage Research Center,* [2]*University of Delaware.*

Analysis of silages for fermentation products is now possible on a routine basis, but how useful are these analyses as predictors of animal performance? The commonly reported silage fermentation end products are lactic acid, the volatile fatty acids (VFA; acetic, propionic and butyric), and ethanol. All but butyric acid can be produced by least two groups of common fermentative silage microorganisms (lactic acid bacteria, enterobacteria, clostridia, yeasts). This multiplicity of sources for a given product can complicate the interpretation of a fermentation profile for a given silage. Fermentation by any of these microorganisms usually results in an increase in the energy density of the silage compared with the fresh crop because dry matter losses from fermentation generally are greater than the accompanying energy losses. However, ensiling does not improve animal performance compared with the fresh crop. The reduction in performance has been attributed principally to two factors: reduced rumen microbial fermentation and reduced intake. The VFAs in silages are a source of energy for the cow but not for rumen microorganisms. Ethanol is poorly fermented in the rumen. Thus a ration high in VFA might be expected to produce less microbial protein than one low in VFA. Studies of silage inoculants where fermentation has been shifted from VFA production to lactic acid do show trends toward improved nitrogen efficiency, but effects are small. Reduced intake has been observed in silages high in fermentation products, particularly butyric acid, acetic acid and ethanol. However, addition of these acids to good silages has not reduced intake or performance. Also inoculating silage with heterofermentative lactic acid bacteria has not reduced animal performance even when the resulting silages had acetic acid concentrations above 5% dry matter. These results suggest that the dominant microorganisms in a silage affect animal performance through mechanisms other than the major end products of fermentation. Thus, fermentation product analyses are not necessarily accurate forecasters of animal performance but can be very useful in both troubleshooting performance problems and developing practical solutions to those problems, as will be discussed.

Key Words: Silage, Fermentation, Performance

41 Improving protein utilization in silages to increase animal performance and reduce environmental burden. Ed Charmley*, *AAFC Crops and Livestock Research Centre, Nappan, NS, Canada.*

Silage normally contains between 12 and 22 % crude protein (CP). While such levels should be adequate for most productive livestock, in silages they are not. This is because of poor utilization of N in silage. Most silage-based production rations require supplemental protein to meet requirements for growth or lactation in ruminants. Silage protein is highly degradable in the rumen and as such is a poor supply of dietary protein and peptides to the small intestine. The situation is exacerbated by a scarcity of available energy in the rumen which limits microbial protein synthesis. Associated with poor utilization of silage N by ruminants are concomitant high losses of silage N to the environment. Poor utilization of silage N by ruminants is attributed to proteolytic activity by crop enzymes shortly after harvest and further microbial breakdown of protein during ensilage. The production of low molecular weight nitrogenous compounds, including ammonia, amines and amides, has a negative effect on voluntary intake of silages. This appears to relate to an ammonia burden in the blood stream as well as specific appetite suppressing characteristics of certain compounds. The poor utilization of silage N in combination with lower voluntary intake of silages can seriously limit ruminant production. Availability of protein supplements is likely to be reduced in future, making it more important than ever to maximize the use of the protein in forages and particularly silage. Methods to improve silage protein utilization exist, including improved crop drying rates, use of microbial and chemical additives and use of, or selection for, crops having characteristics that reduce protein solubility. In future, the emphasis will move away from additives and towards plant breeding and management practices. The ultimate goal will be to use ensiling technology to improve upon the protein quality characteristics of the original crop, thus tailoring the protein characteristics of the silage with the requirements of the animal.

Key Words: Silage, Protein utilization, Animal performance

42 Reflections and concluding remarks. J.W. Thomas*, *Michigan State University.*

Titles of abstracts and symposia about forages in 2002 are somewhat similar to those of the l950s and l960s. This similarity disappears when one examines the complexity and significance of the contents, the results and the discussions of current presentations. Silage microbiology has progressed from attempting to identify the bacteria to using strains of desirable bacteria as innoculants to improve silage quality and decrease losses. Chemical changes during ensiling are being directed to make a more nutritious product and to improve animal performance instead of merely identifying and characterizing these chemicals. When optimum end products are identified, modified organisms could be used as innoculants. Procedures that can be economically viable in large animal facilities have been developed in place of those used in smaller units. For instance, we evaluate silage in bunker silos rather than small cement stave silos and large hay bales not 40 lb. bales. We evaluate forages for large groups of cows using total mixed raions not a forage for individual cows. All this has been accomplished by the innnovative and cooperative efforts in the research by academic staff, graduate students and industry personnel. My investigations involved over 23 faculty and 59 students in the areas of forage harvesting, storing and feeding practices.

Key Words: Silage innoculants, Silage chemistry, Forages

Physiology
Improving Reproductive Efficiency with Hormone Treatments

43 Optimization of timed insemination programs and integration with bST to increase pregnancy rates in lactating dairy cows. W. W. Thatcher*[1], L. Badinga[1], S. M. Pancarci[1], F. Moreira[1], R. Pershing[1], A. Guzeloglu[1], T. R. Bilby[1], S. Kamimura[1], and J. Santos[2], [1]*University of Florida, Gainesville, FL, USA,* [2]*University of California, Davis, CA, USA.*

Ovsynch permitted timed insemination with normal fertility. Pregnancy rate of cyclic cows was increased ∼20% with a pre-synchronization program of two $PGF_{2\alpha}$ injections 14 days apart and initiation of the Ovsynch program 12 days after the 2nd $PGF_{2\alpha}$. This enhancement in fertility is associated with placement of cows in early diestrus (i.e., d5-10) at initiation of Ovsynch to avoid early metestrus and late diestrus. Following pre-synchronization with $PGF_{2\alpha}$, ECP has provided alternative systems for timed insemination (Heat Synch: GnRH[d0]-$PGF_{2\alpha}$ [d7]-ECP[d8;1mg]; Double ECP: ECP[d0; 2mg]-$PGF_{2\alpha}$ [d10]-ECP[d11;1mg]) with pregnancy rates comparable to Ovsynch. Strategies to enhance embryonic development and survival include injection of bST (Posilac, 500 mg) at the time of insemination within a Pre-synchronization/Ovsynch program that increased pregnancy rates

∼17%. In vitro studies indicated that both bST and IGF-I reduced frequency of unfertilized oocytes and stimulated embryonic development to the blastocyst stage. Lactating dairy cows received +/- bST (500 mg, Posilac) at 16 h after the 2nd GnRH of Ovsynch and were sacrificed at either d 3 or d 7 post-ovulation to examine oviductal and uterine genes of the IGF system. In bST-treated cows, levels of IGF-II mRNA were higher (+ 250%) in oviducts but lower in uteri (- 60%; $P<0.05$) than control cows. Regardless of site or stage, IGFBP-3 mRNA levels were higher (+ 125%) in bST-treated cows. At D7 of the estrous cycle, GHR mRNA was decreased (- 30%) in bST-treated cows. Oviductal IGF-I luminal contents did not change; whereas, uterine IGF-I luminal contents increased ($P < 0.01$) between d 3 and 7, and were higher in bST-treated cows. In multiparous non-lactating dairy cows, bST treatment reduced pregnancy rates (19% < 60%) at d 17 based on presence of a conceptus. BST fertility responses are likely to involve both direct as well as complex and tissue specific regulation of IGFs and IGFBPs within both the embryo and reproductive tract and may be sensitive to lactational status.

Key Words: bovine somatotropin, timed insemination, embryo

44 Use of CIDR-B for regulating reproduction. Reuben J. Mapletoft*[1] and John P. Kastelic[2], [1]*University of Saskatchewan, Saskatoon, SK Canada,* [2]*AAFC, Research Centre, Lethbridge, AB Canada.*

Our knowledge of the physiology of the bovine estrous cycle has expanded greatly in recent years, primarily because of the use of ultrasonography to observe ovarian changes and follicular wave dynamics. With this new knowledge has come new methods of manipulating and controlling ovarian function. The use of CIDR-B devices for the synchronization of estrus in cattle is now well accepted throughout the world; in fact, Canada and the USA are two of the last countries to have CIDR-B devices available for use in bovine practice. The use of CIDR-B devices along with other hormone products, such as GnRH and pLH, has permitted fixed-time AI with high pregnancy rates in the beef herd. Recent research, such as that with the use of estradiol along with CIDR-B devices, offers new and exciting ways that we may be able to manipulate the bovine estrous cycle. Experiments described in this report demonstrate several different methods of eliminating estrus detection permitting fixed-time AI in heifers and lactating beef cows with highly acceptable pregnancy rates. Recent data suggest that steroid hormones readily available on the veterinary pharmaceutical market such as estradiol cypionate (ECP) and injectable progesterone can be successfully used to synchronize follicular wave emergence and ovulation in a CIDR-B-based fixed-time AI program. Various other approaches will be discussed including the synchronization of recipients used in embryo transfer and the resynchronization of animals not conceiving to the fixed-time insemination.

Key Words: Bovine, Reproduction, CIDR-B

45 A review of methods to synchronize estrus in postpartum beef cows and replacement beef heifers. D.J. Patterson*, F.N. Kojima, and M.F. Smith, *University of Missouri.*

This review will consider methods currently available to control estrous cycles of postpartum beef cows and replacement beef heifers. Development of methods to control the estrous cycle of the cow has occurred in five distinct phases. The physiological basis for estrus synchronization followed the discovery that progesterone inhibited preovulatory follicular maturation and ovulation. Regulation of estrous cycles was believed to be associated with control of the corpus luteum, whose life span and secretory activity are regulated by trophic and lytic mechanisms. Phase I included efforts to prolong the luteal phase of the estrous cycle or to establish an artificial luteal phase by administering exogenous progesterone. Later, progestational agents were combined with estrogens or gonadotropins in Phase II; whereas Phase III involved prostaglandin $F_{2\alpha}$ (PG) and its analogs as luteolytic agents. Treatments that combined progestational agents with PG characterized Phase IV. Precise monitoring of ovarian follicles and corpora lutea over time by transrectal ultrasonography expanded our understanding of the bovine estrous cycle and particularly the change that occurs during a follicular wave. We now know (Phase V) that precise control of estrous cycles requires the manipulation of both follicular waves and luteal lifespan. This review will include specific discussion of progestins, PG, and gonadotropin-releasing hormone (GnRH) and the various combinations of these hormones or their analogs being used to more precisely control the interval and timing of estrus following treatment. The review will also address the potential benefits of these treatments in eliciting response among peripubertal heifers and anestrous cows, and point to the flexibility in matching specific protocols with the particular beef management system involved. The review will conclude with a discussion of recent advances in the development of economical methods of artificially inseminating beef cows and heifers at a fixed time with high fertility, which would potentially result in a dramatic increase in the adoption of AI in beef herds.

Key Words: Estrus Synchronization, Beef Cattle, Artificial Insemination

Swine Species
Value-Added Pork Products for 21st Century Consumers

46 Economic analysis of production factors important in developing value-added pork products. R. L. Plain*[1], [1]*University of Missouri - Columbia.*

Value-added agriculture has become a topic of great interest among farmers. Many hog producers are excited about the potential to add value to their hogs through non-traditional marketing arrangements. There are three general approaches to value-added pork: through niche markets, through commodity markets and through vertical integration. Adding value to pork by marketing through a niche is based on selling the product to consumers at a premium over what is charged for commodity pork. Consumers are willing to pay this premium if they perceive there is greater value in the niche market product. The source of this enhanced value is frequently associated with one of three areas - environmental (the pork is better for the environment or the animal, e.g. pasture produced pork), health (the pork is better for the consumer, e.g. organic pork), or social (the pork is better for the community, e.g. family or locally produced pork). Adding value to pork when marketing through a commodity market is based on producing an animal that has greater value to the packer. This added value may arise from some trait of the hog (e.g. leaner, less PSE) or of the transaction (e.g. volume sales or scheduled delivery) between the producer and the packer. The third approach to value added pork involves forward integration of the hog producer in the pork chain. Many hog producers are investigating the potential to slaughter, process and distribute the pork from their hogs. This interest arises from the belief that they can market their pork at a higher price through a niche or that they can capture some of the profits being earned by the firms in the middle of the pork chain. Whether marketing value-added pork through a niche, a commodity market or more directly to consumers, the added value must be greater than the additional cost in order to be profitable.

Key Words: Pork production, Value-added, Economic analysis

47 Breeding and genetics in the evolving swine industry. J.A.B. Emsley*, *PIC, Franklin KY, USA.*

Over the last forty years, the 20th century consumer has benefited directly in lowered cost of pork because of improved productivity and efficiency of the swine production industry. Technology developments, including powerful statistical methods and faster computers, have permitted an increasingly comprehensive approach to genetic improvement at the macroscopic level. Results include 33% less feed to the same weight and 33% more lean. Tools that probe the sub-microscopic level of the swine genome now offer the added precision and fine-tuning needed to navigate customized genetic pathways that yield, at lower cost, food of the kind and quality that consumers will demand and pay for in the next forty years, into the 21st century. Knowledge of gene action and gene-gene interaction offers promise of direct means of improvement in disease resistance, animal well-being, meat quality and human health. Food marketers will ensure that, from these technical gains, a variety of pork products will result. Industry demands for tailored