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Cover image by: Austin Alonzo

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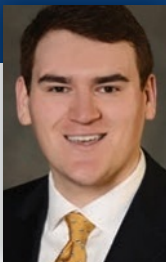
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Editor's Comment BY AUSTIN ALONZO



Why cultured meat shouldn't worry the poultry industry

In this month's issue of WATT PoultryUSA, we examine the state of the art of cultured meat and the businesses developing or investing in the technology. After speaking with knowledgeable sources and researching the subject, it's evident to me that the poultry industry shouldn't be panicking.

There's no product now

Whatever you want to call it – lab-grown, *in vitro*, cultured or clean meat – it's not here yet and it won't be arriving for some time. Even the most optimistic assessments say a publicly available product shouldn't debut sooner than 2021. Furthermore, it will be some time – maybe 10, 20 or 30 years – before a product sold at a competitive price is released. Even then, it's uncertain whether it will truly be a “meat” product or rather a mixture of cultured meat and plant-based protein that's called a meat product.

In this issue, you'll see that the technology to make meat with minimal animal involvement already exists. There is plenty of excitement around the field and investment flowing into the technology – with some coming from industry titans Tyson Foods Inc. and Cargill Inc., no less – but it's important to keep expectations grounded. For now, it's prohibitively expensive to produce and far more money and research is needed to clear that obstacle and many others.

A partnership opportunity?

There's plenty of argument for the technology that is off-putting to us in the industry, but there is a compelling contention, too. The world's population and per capita income will continue to grow, which means more people will want to eat meat. The global meat industry will be challenged to feed an estimated global population of about 10 billion by 2050. Ideology aside, cultured meat or other alternative proteins could be a viable way to help fill that appetite.

Tyson, and the alternative protein companies it is backing, certainly see cultured meat as a supplement rather than a replacement. It can't put the meat industry out of business now and most likely won't pose a real threat for a very, very long time. But, it is nevertheless a promising development that can help feed the world. ■

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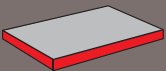
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Poultry Market Prospects BY MARK JORDAN



US broiler industry faces uncertain trade future

Protections trade rhetoric paired with constantly shifting trade alliances creates uncertainty about the size and role of trade for the broiler industry.

A decade ago, few people would have predicted Cuba and Angola – with a combined population about the size of California – would become two of the top three foreign destinations for U.S. broiler meat in 2017.

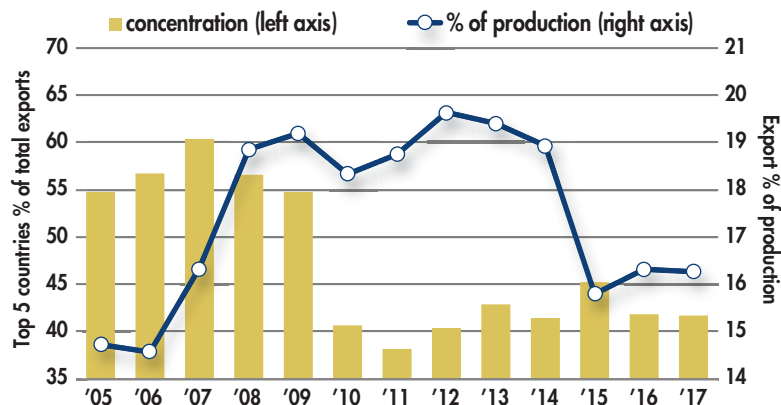
This underscores how much the trade landscape can change in a short amount of time and highlights a shift from higher levels of concentration to greater diversification among trading partners. It also raises questions around future patterns and trends.

Historical perspective

A landmark trade deal in the early 1990s resulted in a tidal wave of chicken shipped to the hungry former Soviet Union. Russia became an important export destination, with more than 25 billion pounds of chicken shipped there between 1993 and 2009.

However, Russia aggressively pursued food self-sufficiency. In 2010, it implemented trade restrictions on U.S. chicken processed with a chlorine rinse. Exports tumbled but remained fairly sizeable. For political reasons, the relationship ended in 2014, forcing the U.S. industry to look elsewhere.

Amount of US chicken exports to top five destinations and percentage of total US production exported



Source: United States Department of Agriculture, Economic Research Service & National Agricultural Statistics Service

The percentage of U.S. chicken production headed to foreign markets is slumping in recent years, averaging between 15 percent and 17 percent.

Recent trends and challenges

With Russia closed off, Mexico emerged as the top foreign destination for U.S. chicken and Cuba and Angola also rose in prominence. Ultimately, broiler exports spread out over a broader mix of countries instead of being concentrated among a few – with Russia at the center.

Between 2011 and 2014, the share of total U.S. broiler exports to the top five destinations averaged barely more than 40 percent,

down from more than 55 percent in the past. The export share of U.S. broiler production consistently approached – and even exceeded – 19 percent, peaking in 2012.

Things changed in 2015 after a crippling highly pathogenic avian influenza outbreak. Sweeping trade restrictions followed and the broiler industry struggled to get exports back into gear. The mix of export destinations remains relatively diverse, but during the past two years,



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the export share of U.S. output is languishing between 16 percent and 17 percent.

Moving forward

U.S. broiler production is increasing. This creates pressure to find a destination for much of this additional output or else drop domestic prices. But this isn't the ideal environment for that scenario, creating a conundrum for the industry.

Conditions are challenging enough for the broiler industry to grow its export program. Beef and pork are more widely available and accessible. Other chicken-exporting nations present stiffer competition, too. Protectionist measures by the White House create another layer of complication.

Despite the challenges, the U.S. remains a leading supplier of high-quality, affordable chicken. Behemoths like Russia and China may be on

the sidelines for now, but there are numerous countries throughout Latin America, Africa and the Middle East with a growing appetite for protein-based diets. Opportunities to do business there are plentiful.

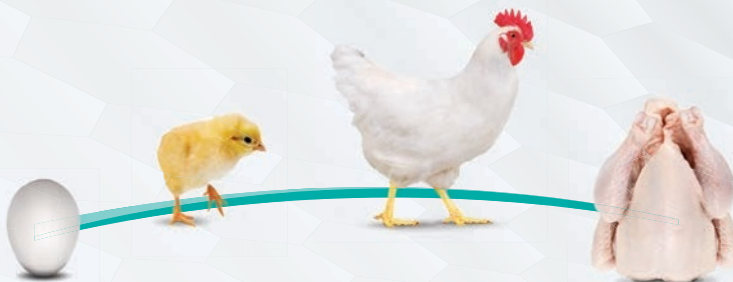
It's not clear what relationships might emerge the next few years to get chicken exports back on stronger footing, or if it will even happen. What is clear is that it will take diligence on the part of chicken companies and more accommodating gestures by our government to seize the opportunities that are available. Otherwise, the export program could be something of a trouble spot for the broiler industry these next few years. ■

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How bipartisan are Senate Chicken Caucus members?

ROY GRABER

The Senate Chicken Caucus formed in 2013 with the intent of being a bipartisan group of U.S. Senators with a common interest in the chicken industry.

According to information on the website of Sen. Chris Coons, D-Delaware, the caucus “serves as a formal group of members whose mission is to educate other senators and staff about the history, contribu-

tions, challenges and opportunities facing the U.S. chicken industry.”

Coons, who co-chairs the Senate Chicken Caucus with Sen. Johnny Isakson, R-Georgia, further stated that the caucus “provides a forum for industry leaders, officials and other stakeholders to meet with legislators and examine ways in which the federal government can better serve chicken producers.”

Sen. Lindsey Graham, R-South Carolina, ranked as most bipartisan member of the Senate Chicken Caucus. *Courtesy Sen. Lindsey Graham*



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Measuring bipartisanship

While there are twice as many Republicans on the 12-member caucus than there are Democrats, Coons, who is in the minority party, touts the committee as bipartisan. But just because it consists of members from both parties, are the members of the Senate Chicken Caucus bipartisan in their actions in Washington?

The answer to that question is actually pretty encouraging for those that encourage bipartisanship.

The Lugar Center, a nonpartisan and nonprofit group, and Georgetown University's McCourt School of Public Policy have recently released an index that ranks the bipartisanship

of each U.S. senator, although Majority Leader Mitch McConnell and Minority Leader Chuck Schumer were excluded from the rankings,

leaving 98 senators ranked.

Of those on the Senate Chicken Caucus, 8 of the 12 ranked in the upper half in terms of being bipartisan. ■

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Poultry diseases: gel or spray hatchery vaccinations?

Both products offer advantages and drawbacks for treating common poultry diseases. An expert said the choice of product depends on the scenario.

AUSTIN ALONZO

The steady removal of antibiotics from the poultry industry is elevating the importance of using vaccines to prevent common diseases. However, hatcheries must assess how best to apply vaccines to ensure proper inoculation.

Dr. Brian Jordan, an assistant professor of poultry science at the University of Georgia, spoke about the pluses and minuses of gel and spray vaccine application. He presented as part of a seminar on poultry health and nutrition on March 13 at the 2018 Midwest Poultry Federation Convention in Minneapolis.

The purpose of vaccines

In general, the value of vaccines is elevated as antibiotics and chemical ionophores are removed from the equation. Jordan said it's unlikely rules will be rolled back and instead only get tighter, which means vaccines will be critical for developing immunity to disease in longer-lived animals like breeders, layers, turkeys and even broilers.

Vaccines work by giving the animals a dose of a live pathogen which, when properly applied, helps them develop a lifelong immunity to the disease. In the hatchery, they are typically mass applied as a direct spray or a gel droplet.

The best place to apply a vaccine, he said, is in the hatchery with a direct application to the birds themselves. This way, the vaccine is applied to birds in a chick basket who then preen and groom one another, consuming



Gel or spray vaccination in the hatchery should give the chicks an even application of vaccine to properly inoculate them from diseases. *Austin Alonzo*

droplets of the spray or gel. A water-based spray is the most common and traditional application method but, in the past four or five years, interest in gels is increasing. The goal of both methods is to apply the substance so the birds receive a consistent, effective dose of the vaccine.

Spray versus gel application

Jordan's remarks centered on coccidia and coccidia vaccination. For coccidia vaccines, the live oocysts are dense and must be properly mixed. Using a water diluent for spray vaccinations requires constant mixing or aeration to prevent settling. Gels keep the oocysts in suspension but, again, they must be initially mixed properly with the vaccine to get proper suspension of the oocysts for even application. The goal of both products is to give an even application so all chicks in the basket receive the proper amount of vaccine.



Read more: Poultry sector spending more on hatchery vaccinations, www.WATTAgNet.com/articles/33372

Jordan said the spray nozzle is critical for water-based sprays. Droplet sizes vary due to the type of nozzle and the level of pressure the fluid is under. Due to the laws of fluid dynamics, the size and type of the nozzle as well as the pressure of the system need to be adjusted on a case-by-case basis to optimize the application needed for each hatchery and vaccine. Gels, on the other hand, give even, defined droplets with a consistent amount of the oocysts in the droplets.

How much vaccine is actually ingested?

Jordan studied how much of the vaccine is actually getting to the chicks in the products. He saw that with sprays, about half of the oocysts are lost between what's mixed up in the vaccine bottle and what actually gets down to the level of the chick. Small droplets are also influenced by airflow and may not reach the chicks. Gels provide larger, heavier droplets and provide almost no vaccine loss from the bottle to the chick.

The larger, heavier droplets carry a drawback, however. While recording a slow-motion video, Jordan's team noticed that the chicks shake after application of either a water-based spray or gel product. The water-based products mat down in the feathers and don't come off during the shaking. Gels do, which means at least a portion of the droplets go down to the floor of the basket where they are unlikely to be ingested by the chicks.

Which is better?

Jordan said there's no definitive answer as to one product being significantly better than another. Some vaccines will work better with gel and others will work better with spray. Both methods can be used effectively and both carry their own pros and cons. In his experience, when both products are applied under ideal conditions, no real difference is seen.

Specifically for coccidia, gel vaccination provides a slightly higher ceiling of vaccine coverage if used cor-

rectly. With sprays, the ceiling is a bit lower than gels even if application is done perfectly.

However, if there is poor application – or a mistake – then the floor, or the worst possible vaccination outcome, is significantly higher for sprays than gels.

“With spray, your consistency is going to be there a little bit more routinely,” Jordan said.

Nevertheless, the most important factor for proper application in the hatchery is the hatchery personnel itself. If the personnel are not mixing the vaccines and diluents properly, then there will never be consistent application with evenly distributed dosage.

“Some hatcheries have really great employees and have really great hatchery managers who really get buy in from their staff and they do a great job. And then some hatcheries, as hard as they try, there's a lot of personnel turnover and they have human error that occurs.

“Some hatcheries have fine-tuned operating procedures for vaccine handling and great personnel who do a great job,” he said.

“The quality control, as far as the application system, is only as good as the people that are operating it,” Jordan said. ■

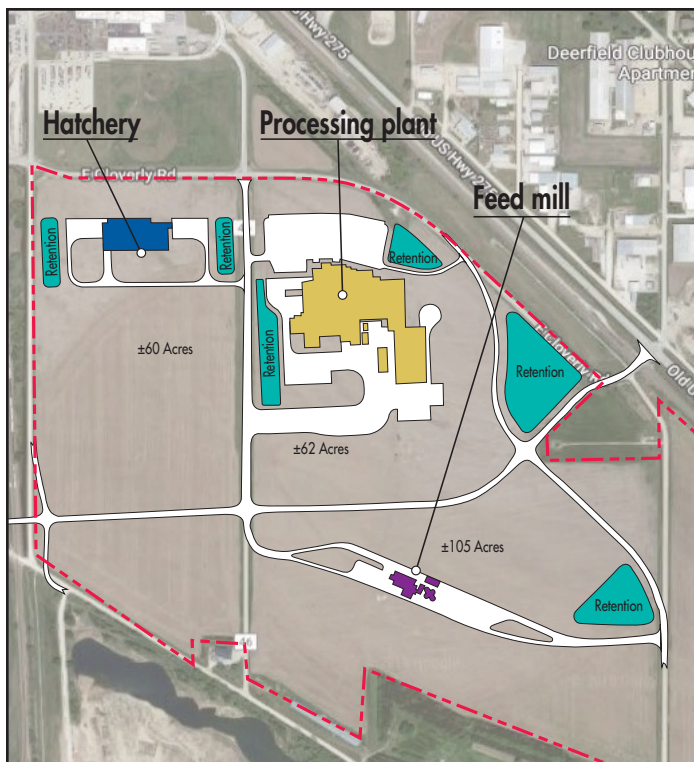


Once applied, chicks in the basket preen one another in order to consume the vaccine product. | *Austin Alonzo*

Previewing Costco's \$400 million chicken operation in Nebraska

Lincoln Premium Poultry, a company owned in part by Costco, is starting up a new complex and integrated poultry operation in Fremont, Nebraska.

AUSTIN ALONZO



Costco and Lincoln Premium Poultry's Fremont, Nebraska, poultry operation will include a processing plant, hatchery and feed mill.

In Fremont, Nebraska, far from the traditional broiler belt of the Southeast and Atlantic states, a massive new poultry complex is rising. By late 2019, the estimated \$400 million operation – complete with a feed mill, hatchery and processing plant – will be processing more than 2 million chickens a week.

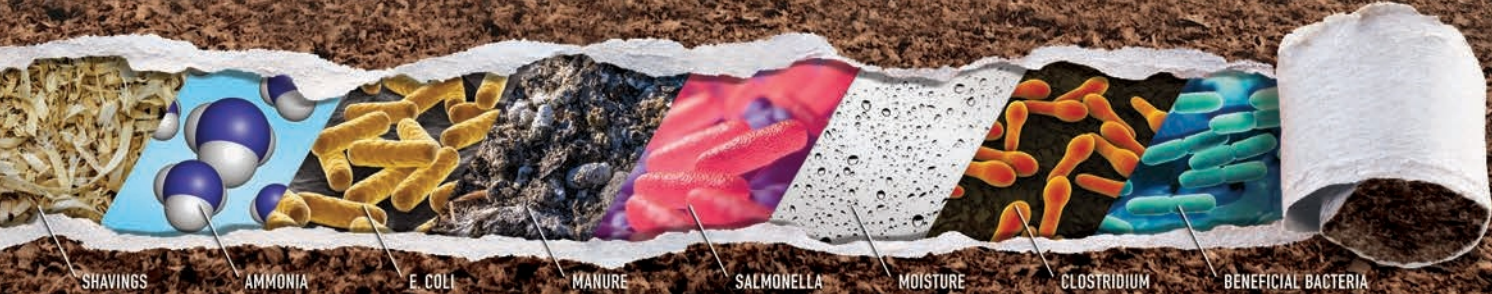
The new poultry enterprise is run by Lincoln Premium Poultry (LPP) – a company owned in part by Costco Wholesale Corp. Walt Shafer, chief operating officer for LPP, said the chickens processed at the plant will provide about 40 percent of the Issaquah, Washington, retailer's fresh chicken meat.

The business relationship with Costco

Shafer said LPP's role is to, essentially, operate and manage the asset and the business on Costco's behalf. Costco is LPP's customer, he said, and the majority of the products will go to Costco depots and warehouses.

"Lincoln Premium Poultry is a company created for Costco in collaboration with Costco," Jessica Kolterman, a spokeswoman for LPP, said. "Our com-

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ppany reflects the values of Costco, and we are excited to partner with them in developing a fantastic product for Costco's members."

However, the operation will not supply all of Costco's chicken and it will still have other suppliers, Shafer said. This plant will process birds at 6 pounds, 4 ounces live weight to provide the specific size, weight and price Costco wants.

When asked if the project is a prototype for future facilities supplying Costco, Shafer replied: "Who knows."

"My goal is to make this successful," he said. "If we're successful, which I know we will be, I think it will throw the subject up for debate in the future."

Why Nebraska?

Shafer said the site works because of its location in the country as well as the ready supply of grains and potential growers.

Fremont's central location in the continent and its ability to supply depots around the country works for Costco. In the beginning, Shafer said most of the product will supply locations in the western U.S. Also beneficial for logistics, and unlike operations in the South and on the Atlantic coast, corn and soybeans for the estimated 500 chicken houses needed to supply the plant will come directly from the state.

BY THE NUMBERS

\$400mil The estimated total cost of the new poultry complex in Fremont, Nebraska.

Although the state lacks a tradition of growing poultry, Doug Oertwich, a farmer from near Pilger, Nebraska, who will be running a breeder operation for LPP, said the prospect of raising birds is appealing to the state's crop farmers.

Raising chickens creates an opportunity for farmers



Walt Shafer, chief operations officer of Lincoln Premium Poultry, and Doug Oertwich, a farmer from near Pilger, Nebraska, who will grow birds for the new poultry operation. *Austin Alonzo*

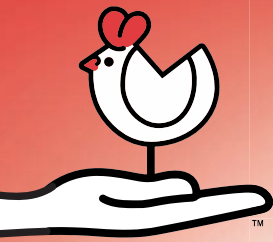
to bring in more, diversified income and generate paying work for family who would otherwise leave the farm. Doug Oertwich said his own son, Nicholas Oertwich, is coming back home to raise birds with him. Crop farmers also relish the prospect of creating their own, organic fertilizer and spreading it on their crops.

Training the farmers

While Nebraska is known for a tradition of crop farming and cattle ranching, its farmers are unfamiliar with raising chickens. LPP was tasked with recruiting farmers from the surrounding region and training them in husbandry.

Oertwich served on an advisory board formed to recruit potential growers and help LPP and Costco understand the nuances of working in the state. After years of work, LPP recruited 125 farmers to put up chicken houses and grow birds on contract.

To train the new farmers, LPP is working with Auburn University to offer grower seminars on key concepts like house ventilation and animal husbandry. In the near future, a model chicken house will be built near the processing plant in Fremont. Shafer said it will host classes on growing in a working classroom featuring the exact same equipment growers will use.



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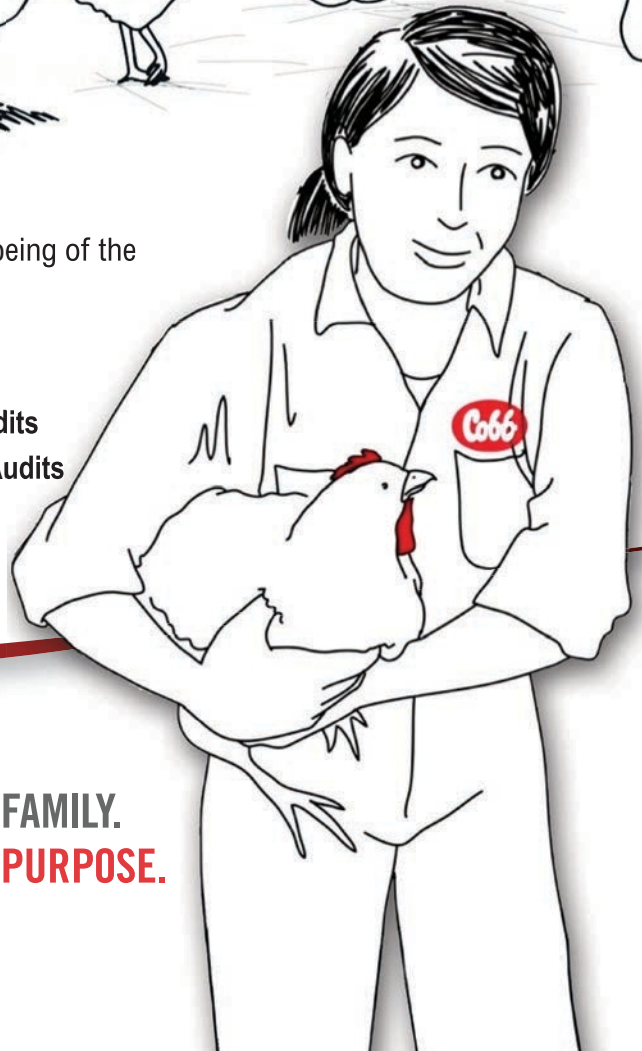


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Lincoln Premium Poultry's feed mill will source locally grown corn and soybean meal to feed the birds grown in one of 500 nearby broiler houses. *Austin Alonzo*

The integrator relationship

As in a traditional vertically integrated poultry company, LPP will supply the feed and the animals as well as the building requirements for the poultry houses. The growers, working on a 15-year contract, are responsible for building the houses, raising the animals and supplying labor. In total, the growers will be investing about \$300 million to finance construction of new houses.

LPP contracted with QC Supply, based in Schuyler, Nebraska, to serve as the general contractor for broiler house construction. QC is coordinating construction in collaboration with the growers. All houses will be identical and feature a state-of-the-art design and the latest growing equipment. The grower's compensation contract is inspired by a guaranteed base-pay concept. This way, the contract can reward above-average performance without punishing below-average performance, Shafer said.

Shafer said he's already hired a complex manager, live production manager, breeder manager and veterinarian. LPP is expecting to benefit from working with new equipment and housing and employing growers newly trained in modern techniques and management.

Raising birds better than the rest

Shafer said all birds will be raised antibiotic free and Costco will require regular third-party audits on biosecurity practices

and animal welfare. He said it's uncertain if the company will sign onto any type of animal welfare standards. However, the company requires LPP "to be better than the rest" and birds will be raised at a stocking density lower than the industry average, he said.

The houses will be solid side wall and utilize tunnel ventilation with cool cells, and birds will be raised on cottonwood bedding. Breeder growers will clean out their litter once a year. Broiler growers will compost their litter in the house using a windrowing technique after each flock.

Oertwich said even though it is not required by the state, LPP and its growers will follow a nutrient management plan – based on plans used in the Chesapeake Bay watershed – to assess and mitigate the environmental impact of spreading manure on their fields.

Catching and transportation

LPP will use an automated catching machine – a CMC Industries Apollo model – which stores birds in drawer modules. The system doesn't require any physical handling of the birds, which reduces the risk of injury to the birds and the workers, Schafer said.

Transport trailers will feature curtain side walls. They use a solid, ventilated top with tarps or curtains covering the sides and back of the trailer. This prevents dust and feathers from exiting the trailer during transport and pro-

tects the birds from exposure.

At the plant, the birds will be kept indoors in an automatic lairage system capable of holding up to 12 tractor

trailer loads of birds, or about 72,000 animals. This facility will calm the birds and warm if they are cold or cool if they are hot. After the truck

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\$400 MILLION CHICKEN OPERATION

is unloaded, it will be washed and completely sanitized. Used modules will be washed and sanitized, too.

The individual drawers and modules will be removed and placed directly into a controlled atmosphere stunning (CAS) system manufactured by Marel. After stunning, birds will be removed from the drawers and hung directly on a processing line. There will be no dumping, Shafer said, to the benefit of the animal and the live hangers.

BY THE NUMBERS

\$300 mil The amount invested by the 125 contract growers who will build 500 broiler houses to supply the plant.



Read more: Lincoln Premium Poultry securing contract growers, www.WATTAgNet.com/articles/33212

The processing facility

In total, LPP's Fremont complex will contain a 400,000-square-foot processing plant, a 95,000-square-foot hatchery and a feed mill capable of holding five days' worth of finished feed, or 15,000 metric tons. The feed mill should be operational by the end of 2018 and feeding should start in early 2019. The hatchery should be complete in spring 2019 so birds can be placed by June 2019.

Birds are expected to start running through the plant in September 2019. After about 45 weeks, the plant should be processing more than 2 million birds a week. It's expected to employ about 1,000.

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BY THE NUMBERS

2 mil

The number of chickens expected to be processed weekly once the plant reaches full capacity.

an air-chilling system after plucking and evisceration. Shafer said about 80 percent of the equipment in the plant will be made by Marel.

Labor and automation

Labor, Shafer said, will be the most critical issue at the plant. As a hedge against challenging labor markets, LPP is employing high-speed, automated machinery in every step of the process. Robotics will also be used to package products.

“The list goes on and on, everything from automatic label application to palletization to even the deboning,” Shafer said.

Shafer said automation will help reduce the need for workers – he cited automated deboning as requiring 100 fewer workers than manual, as an example – but it will require more workers with higher educational and mechanical expertise.

The labor market is tight in the region, so LPP is partnering with recruiters to find unemployed and underemployed workers in western Omaha and the area surrounding Fremont. The conversation on attracting, employing and housing poultry plant workers is ongoing, he said. ■

BY THE NUMBERS

\$1.2 bil

The estimated economic impact in Nebraska from the installation of the new poultry operation.

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9 keys for a **successful coccidia vaccination program**

Managing coccidia using a live vaccine requires a different mindset, as well as more intense husbandry, than using a chemical-based program.

AUSTIN ALONZO

Coccidia is a nuisance that's pervasive in broiler houses and difficult to control in antibiotic-free operations. Vaccination is a key tool against the disease, but its effectiveness depends on proper administration and management.

On March 13, Dr. Audrey McElroy, a professor and

extension specialist focusing on intestinal health at Texas A&M University, spoke about the most important factors involved in vaccinating chicks against coccidiosis and managing cycling into adulthood. McElroy spoke as part of an event on broiler production at the 2018 Midwest Poultry Federation Convention in Minneapolis.



Proper coccidia vaccine cycling requires farmers to scrutinize their husbandry and management of chicks and pullets. *Austin Alonzo*

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SUCCESSFUL COCCIDIA VACCINATION PROGRAM

How coccidia vaccination works

Coccidia vaccination typically occurs by spraying a vaccine made with live oocysts of the coccidia pathogen onto chicks in the hatchery. Ideally, it's a controlled dose administered in equal amounts to all the chicks. Once the chicks are placed in the house for four to seven days, they will shed the oocysts into the environment. The birds will then uptake oocysts from the litter, will be re-infected and shed again in larger numbers. Hopefully, by the third round of ingestion, the animals will gain complete immunity.

McElroy said this process takes the life of the flock. So, in short-lived flocks, total immunity isn't developing. Nevertheless, the bird is protected from more pathogenic coccidia in the environment by beginning an immune response to the vaccine.

Problems occur when vaccine application is inconsistent, or when some birds get a dose and others don't. The unvaccinated birds don't have the immunity, suffer more detrimental disease consequences and develop clinical coccidia or possibly necrotic enteritis.

With that in mind, McElroy offered these nine keys for a successful vaccine program starting in the hatchery and going all the way to the finishing barn.

1 Store and mix vaccine properly

Vaccines contain live oocysts and can't be frozen. McElroy said if there are any ice crystals formed, oocysts are destroyed and the vaccine is ineffective.

Along with storage, diluted vaccines must be properly mixed. Sporulated oocysts are dense and will settle to the bottom of the container. If not properly mixed, vaccine be unevenly applied.

2 Ensure spray nozzles are applying evenly

In an automated spraying system, the nozzles are critical. If they are not functioning properly, then birds aren't getting the vaccine. McElroy said a simple technique to check the sprayer nozzle's applica-



Once chicks are sprayed with a vaccine, they need the right environmental conditions to encourage preening before transportation to the farm. The chicks consume the vaccine during this critical time.

Austin Alonzo

tion is to send a box through the sprayer with a piece of paper in it while recording the action in slow motion. Watch the video and see how the spray is applied. Application must be uniform, or as close as possible, to ensure vaccine cycling.

3 Allow the chicks to preen after spraying

Chicks consume the vaccine while preening one another after the application. They must be given at least 15 minutes prior to preen and placed in an area with lighting conditions that will stimulate activity. The vaccines are dyed to encourage preening.

4 Establish the right conditions on the farm before arrival

Birds must be placed in comfortable conditions that are neither too hot nor too cold. Both will stress the chicks and discourage them from feeding.



Birds need access to feces so they can cycle the vaccine. Use a stocking density allowing for a good spread of the oocysts in the environment and then uptake.

If density is too high, particularly in the brood chamber, there will likely be excess moisture in the litter which encourages sporulation. If the birds are confined, they can be overwhelmed with oocysts. A single oocysts can replicate tens of thousands of times if given the right conditions. If density is too low, there won't be enough shedding, or sporulation, and the birds will not uptake uniformly.

5 Give the birds enough time in the brood chamber

Chicks must be in the brooding chamber long enough to shed oocysts and then uptake them again. The initial peak of oocyst output occurs at about four to eight days. However, the birds shouldn't be allowed to cycle twice because the chamber will then be densely packed with oocysts that will overcome intestinal integrity.

6 Feed the chicks

The chicks need access to feed immediately upon arrival. If feed access is delayed, they'll suffer from delayed gut development and vaccine cycling as well as an altered gut microbe population. The first week of life is critical for intestinal development and it's all based on feed access.

Birds need access to supplemental feed for at least nine days to encourage feed uptake. If the birds are used to seeing feed in the feed pans, they'll eat whatever collects in the pans. So, the supplemental pans must be filled with feed, not litter or feces.

When transitioning from starter to grower feed, avoid switching during peak coccidia cycling. Changing the

type of feed, particle size or composition will cause intestinal stress. Additional stress placed on a gut already compromised by the vaccine can cause health problems.

7 Litter management

Litter moisture must be monitored. Wetter litter indicates a higher presence of oocysts and greater cycling, which can be detrimental to intestinal health, as well as an environment encouraging *Clostridium* growth. McElroy encouraged managing litter rather than cleaning it out entirely because of the beneficial microbiota living in the substrate.

8 Monitor for intestinal changes

Watch for indicators of intestinal health like droppings in the litter. When droppings are loose, fluffy or coated with mucus, that indicates there's an intestinal shift – possibly due to too much coccidia cycling. If growers pay attention to the environment, they can learn a lot about the gut health.

9 Pay attention to the details inside the house

Finally, farmers need to observe other factors in the house to ensure proper vaccine cycling and health. Water lines need to be clean and uniform to prevent microbial changes. House temperatures must be set to avoid either heat or cold stress, as both can affect the microbial population of the gut.

"It's every piece to the puzzle in terms of basic management and every piece is important," McElroy said. "Day-to-day management is hopefully how we can have a more successful vaccine program." ■



Read more: The future of poultry health: New and old challenge, www.WATTAgNet.com/articles/29615



Dr. Paul Modzszak (left) is a leading researcher in the field of culturing poultry tissue. *Courtesy New Harvest*

Growing edible meat products without an animal: It sounds like something out of science fiction. But, it's becoming reality as scientists, startups and venture capitalists pour resources into the emerging technology.

While even the most optimistic assessment places the product years away from the grocery store, the novelty of the technology is attracting press around the world as well as the attention of the animal agriculture business. Already beset by a changing market for their products and the transition to new animal husbandry methods, this technology seems like another challenge for the poultry industry. But, is it?

The state of the art

Right now, the technology exists to yield an edible meat product – called lab-grown meat, *in vitro* meat, cultured meat or clean meat. However, the process is still far from creating a competitive product.

Dr. Paul Mozdziak, a leading mind in the field of cell culturing, who's focused on poultry application of the technology, explained the process. A sample of muscle tissue is collected from an animal, either dead or alive, and

Cultured meat: lab to table becoming more of a reality

Researchers and startups are developing ways to grow meat with minimal involvement from an animal. How soon might a product be headed to market?

AUSTIN ALONZO

is ground up. The tissue is then treated with enzymes that digest away myofibril and contractile proteins and release muscle derived cells. Those cells are placed in a cell culture dish with a defined cell media or undefined cell media, which has an animal serum component, so they reconstitute as muscle tissue, or what's being called cultured meat.

Mozdziak, a professor in the Prestage Department of Poultry Science at North Carolina State University, said this is not a novel process. What is new is the level of excitement surrounding the process.

"There's a lot of people out there with ideas and getting money, and there's not been a lot produced to practice right now," Mozdziak said. "The question is, 'What's the first product going to be? What's the first product going to look like? Where is the space going to be in the next two to three years?' and it could be a very exciting time."

Hurdles to market

The largest technical hurdle may be that the current process can't yield a product exactly like what's in the meat case. Meat is made up of more than just muscle cells. They include connective tissues, blood and fat, too.



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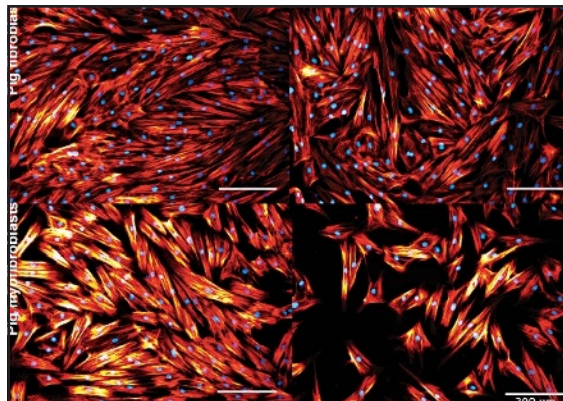
CULTURED MEAT

An ongoing challenge in growing tissue is developing thickness. The tissues are not vascularized, Mozdziak said, so the serum used to grow the cells cannot get to the center of a dense chunk of tissue. Without vascularization, growing large pieces of meat is exceedingly difficult. Making a more complicated cut of meat requires vascularization as well as the ability to synthesize the other elements of what makes meat.

The second major hurdle is the cost of the process. In March 2017, an article in The Wall Street Journal on start-up Memphis Meats said its technology creates a pound of chicken meat for “less than \$9,000.” Mozdziak said key contributors to the high price tag are the necessary infrastructure: cellular serum and media, laboratory facilities, and a bioreactor where tissue can be grown.

If someone develops a process and is able to scale it, this will help with costs. Even then, the price of cellular media will still contribute to a higher cost than conventional meat products.

“It’s going to be a long time, in my humble opinion with my 25 years of cell culture experience, before it’s anywhere near what the cost of classically raised meat is,” Mozdziak said.



This microscopy shows cultured pork fibroblasts – the connective tissue that produces collagen. Research on fibroblasts could be useful in culturing connective tissue in complex cuts of meat in the future. *Jess Krieger, New Harvest Research Fellow*

science and technology for the Good Food Institute (GFI), said a product may be available in a high-end restaurant within three to five years, could be commercially available in five years and price competitive within the next 10 to 15 years. Welch said the GFI is an accelerator for, and promoter of, plant-based foods and the cultured meat sector.

Welch’s confidence stems from the proof offered by startup companies, like Memphis Meats, that it is already possible to create the product on a small scale. There’s no “huge red flag” showing the technology does not exist, he said, and the science community, with expertise in stem cell work and culturing human tissue, is moving into the meat sector, too. The other key ingredient, Welch said, is more money lining up behind the product.

Erin Kim, communications director for cellular agriculture research group New Harvest, was more skeptical and – citing organizational policy – declined to make predictions. However, she said the research surrounding the product is limited, as is the funding to support it, and that shows in the current lack of any kind of product. New Harvest, a nonprofit group involved in advancing cellular agriculture research, is providing funding for Mozdziak’s research.

“We’ve seen a lot of talk, a lot of predictions about the market availability,” Kim said. “But it’s 2018 now and there still is no cultured product whether it is chicken, or beef or something else. I think that says a lot.” ■



Study: US consumers leery of lab-grown meat: www.WATTAgNet.com/articles/30440

How far away is a competitive product?

Opinions differ on how soon a product may debut, but there is agreement that the product won’t be publicly available for several years.

Mozdziak said a demonstration product could be available in three to five years. But, something that will be price competitive and widely available could be as far as 20 to 30 years away. An important factor worth considering is whether the product will be a mix of muscle tissue and plant-based proteins that’s sold as cultured meat, or something more complex.

Citing others in the sector, Dr. David Welch, director of



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The emerging business of cultured meat

Like any promising technology, cultured meat is attracting a lot of buzz and investment money, but who is involved?

AUSTIN ALONZO

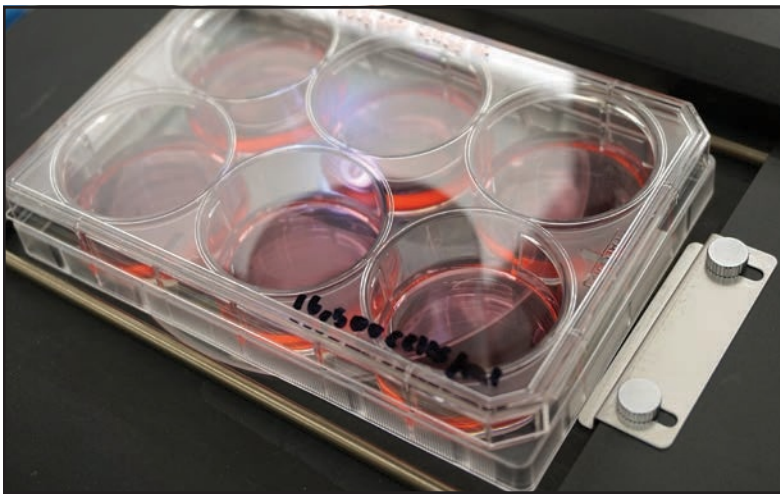
While a product may not be on the market just yet, investments are streaming into the nascent technology of creating meat products using cell cultures.

The product, known as lab-grown meat, *in vitro* meat, cultured meat or clean meat, is a few years away from the market but there's already a cadre of startups and investors working on putting a product on a plate and eventually a grocer's shelf.

The financial question

Some of the technology behind cultured meat products already exists, but a number of hurdles lie between the state of the art today and going to market. The most significant may be the financial obstacle.

A leading researcher in the field, Dr. Paul Mozdziak, a professor in the Prestage Department of Poultry Science at North Carolina State University, said significant investments are needed to set up the infrastructure and to purchase the inputs needed to actually grow the cells. The hope is, he said, the process will continue to be refined and these costs will be reduced due to economies of scale.



A course at North Carolina State University taught by Dr. Paul Mozdziak provides students the opportunity to culture chicken muscle cells like these. *Terrence O'Keefe*

The other part of the research equation is funding. Two leading agencies are involved in raising funding for, and awareness of, the technology: New Harvest and the Good Food Institute (GFI).

New Harvest is a New York-based group focused on funding academic research surrounding what it calls cellular agriculture. Erin Kim, the nonprofit group's communications director, said it is funding six scientists working on areas like meat, egg products and leather. Mozdziak received research funding from New Harvest.

The GFI is a Washington-based technology accelerator focused on advancing the plant-based and cultured meat sectors. Dr. David Welch, its director of science and technology, said the nonprofit employs four scientists who do foundational work in the industry, helps researchers and startups find funding and provides some research funding.



Can poultry survive the rise of alternative proteins?: www.WATTAgNet.com/articles/33855



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CULTURED MEAT

Why invest in cultured meat?

Kim and Welch said the groups are donor supported. Kim said investors come from a variety of backgrounds and have differing motivations. A large contingent are vegan or animal welfare advocates who want to advance the technology as an alternative to conventional animal agriculture. Another significant portion are techno-optimists and futurists who see it as a way for humanity to develop more food with less resources. Others are venture capitalists who see it as a potentially profitable technology.

Welch said his group is optimistic about the future of cultured meat and sees the technology making great strides within the next 10 to 15 years. However, the missing ingredient is more funding and more scientists with expertise in the field.

He said investors are interested in the product because the global population is rapidly growing, and they think the food system isn't sustainable and cannot feed a global population of 10 billion. Furthermore, they believe the product will be healthier because it eliminates the risk of foodborne illness and the need for antibiotic use in animal agriculture.

The companies making cultured meat

Welch said there's about 15 companies actively working on cultured meat products. Some are well established, while others are what he called stealth startups. In the U.S., there's Memphis Meats and San Francisco-based Just Inc., formerly known as Hampton Creek. It recently announced its intention to market a cultured meat product by the end of 2018. Outside the U.S., he mentioned MosaMeat, based in Maastricht, The Netherlands; SuperMeat, based in Tel Aviv, Israel; and Integriculture, based in Tokyo.

Perhaps the most recognized of these companies is Memphis Meats, founded in 2015 and based in Berkeley, California. According to Steve Myrick, the



Memphis Meats co-founders Dr. Uma Valenti (center) and Dr. Nick Genovese (right), founded the startup with a view that alternative, cultured proteins can help feed the world. *Memphis Meats*

company's vice president of operations, it was founded by Dr. Uma Valenti and Dr. Nick Genovese, who share the CEO role, with a view that meat production practices are not going to feed the world. Instead, an alternative, cultured product will be necessary.

The company produced several product demos – a beef meatball as well as chicken and duck products – and attracted wide investor interest. As of August 2017, it had raised \$22 million.

Myrick did not share a target date for marketing a product. The company is focused on reducing the cost of production and increasing its production scale with the money raised from its investors. He said there's already an intense demand for the product.

“Our target consumer is the mainstream meat eater,” Myrick said. “We think many consumers who don't eat conventionally produced meat today will consider Memphis Meats, but we are firmly focused on people who already love meat.”

Meat industry players investing in cultured meat

Myrick mentioned investments from venture capital groups Draper Fisher Jurvetson, based in



Cultured meat products, like this demonstration chicken product made by Memphis Meats, likely won't be publicly available for several years. *Memphis Meats*

Menlo Park, California, and Atómico, based in London, as well as agribusiness companies Tyson Foods Inc. and Cargill Inc.

Cargill declined to comment for this article. Caroline Ahn, a spokeswoman for Tyson, referred to a January 2018 statement by its CEO and President Tom Hayes. It explained the reasoning behind the company's investment in Memphis Meats and other ventures.

"This isn't an 'either or' scenario; it's a 'yes and' scenario," Hayes said in the statement. "A protein strategy inclusive of alternative forms is intuitive for Tyson Foods. It's another step toward giving today's consumers what they want and feeding tomorrow's consumers sustainably for years to come."

In May 2018, Tyson invested \$2.2 million in Jerusalem-based Future Meat Technologies. The startup says it is producing cultured meat at \$800 per kilogram and has a roadmap to producing at a price of \$5 to \$10 per kilogram by 2020.

A challenge or an opportunity?

Looking to Cargill and Tyson's investments, Welch said animal agriculture can either see the technology as a threat or an opportunity. The challenge of feeding as many as 10 billion people in the coming decades will require changes to the global food system.

"There are opportunities for some more forward-thinking companies in the poultry space to see those opportunities and pivot whether that's through investment or through working with some of these clean meat

companies as they continue to grow," Welch said. "If the current system isn't going to work, then the companies that are going to succeed in the food space in the future are the ones that adapt and change their processes and invest in new technologies."

Mozdziak said the industry shouldn't worry about cultured meat and instead should embrace the technology. It's unlikely cultured meat will put anyone out of business anytime soon, but there is real concern about whether the world will have enough meat by 2050. A supplemental protein product can help fill that need.

However, Kim said the industry is pre-competitive. The research surrounding the technology is still in its infancy. Much more research and funding is needed to move cultured meat forward and progress will ultimately be slow.

"To watch the developments would be very wise, but I don't think there's much to actually worry about. I think getting these products to compete in a meaningful way, that is going to be a huge challenge," Kim said. "It's going to be a very long while before there's a pure cultured meat product out on the market – one that's not 90 percent or more filler and one that tastes as good."

For now, those in and around the cultured meat field don't see themselves as a threat to conventional agriculture but rather another option for a hungry world.

"We are not trying to threaten anyone's business. We are trying to feed a growing world in a sustainable way. We've found that's a goal that everyone shares, including conventional meat and poultry producers," Myrick said. "We will need multiple production methods to feed the globe, and we believe clean meat is one of those production methods."

"No one knows exactly what the future of food will look like. That's why we're exploring new approaches. Some will resonate with consumers more than others, but we believe every attempt will move us forward." ■

New German hatchery focuses on complete transparency

A new broiler hatchery in Germany is working to bring the outside in and reap the benefits of being transparent.

MARK CLEMENTS



The new Optibrut hatchery in Germany tries to maximize the use of transparency and natural light. *Mark Clements*

A new hatchery with an emphasis on transparency in the outskirts of Nordhorn, northwest Germany, came into operation late last year.

The Optibrut facility, close the border with the Netherlands, is working with transparency literally and figuratively.

By making the maximum use of natural light, it is bringing the benefits associated with daylight inside the building for workers and chicks, but the development has also been described as a “YouTube” hatchery, opening up the work that is carried out

there to all who want to see.

The facility is the initiative of Hans Groot Koerkamp and Klas Knol, Dutch nationals with a history in chick and other agricultural production.

A year in construction, Koerkamp and Knol worked with design-and-build partner Bright Buildings, specialists in architecture that make the maximum use of natural light. Building, machines and installations are said to be “optimally matched,” yet despite the future-looking design, costs were

kept low through use of standard components.

Harnessing light

Maximizing use of natural light is thought to bring several benefits, with daylight said to make employees and chicks feel fitter, more energetic and alert. Where staff are concerned, this is said to raise productivity while lowering absenteeism and, where energy costs are concerned, bills are lower.

The transparent nature of the building is not restricted to the outer walls. Inside, there are glass-walled corridors, which means the public, should they want, can see up-close how operations are carried out.

The Optibrut hatchery may claim to be the first completely transparent



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www.WATTAgNet.com/articles/23898

hatchery in Europe with all direct benefits that such an approach brings, but it is hoped the benefits will spread beyond its glass walls.

In addition to an optimal working and hatching environment for staff and chicks, there were other drivers behind the design and, according to Koerkamp, the hatchery is also different from others as it has been designed from the farmers' viewpoint.

"We thought, 'How can we combine the hatchery with farmers' experiences?' and with transparency, we can help to tell their story," he said.

Among the most modern

The hatchery has started production with 850,000 chicks per week but has the capacity to produce 1.6 million. It will supply the German market, which is also from where all inputs are sourced, but being close to the border with the Netherlands, it can also easily ship chicks there if the need arises. The hatchery produces Ross 308 chicks.

The hatchery has the capacity to receive 80,000 eggs per hour, with the receiving area being fully automated, as is the candling and transfer room, which can handle 90,000 chicks per hour.

It uses the HatchCare system, which gives chicks unlimited access to feed, water and light as soon as they hatch, preventing dehydration and stimulating intestine growth. Not only does the system provide a high-quality chick, but with good welfare credentials, it aligns with the approach of being transparent.

There is a linear sexing line with room for eight people to work, and with two chutes per sexer, which are ergonomic and switchable. The



The hatchery sources fertile eggs from Germany and chicks are sent to German farms. But, because it is close to the Netherlands, it could also supply Dutch producers. *Mark Clements*



Internal glass corridors allow visitors to see how the hatchery works. *Mark Clements*

facility has what has been described as the most chick-friendly counter in the world, with an accuracy of better than 1 in 2 chicks, and a capacity of 72,000 chicks per hour.

"Our chicks are a little more expensive to buy, but they do not need such

high temperatures when they arrive on farm, growth has already started, and they don't need antibiotics, so the farmer quickly gets that money back," Koerkamp said.

Chicks are dispatched to customers in trays which also contain feed. The hatchery has its own tray color, blue, and will only accept its own trays back from farmers to help prevent contamination. ■

Editor's note: HatchTech technology used in this facility is being employed at Bell & Evans (Farmers Pride Inc.) welfare-centered hatchery which opened in August 2017



5 people-related challenges for turkey breeder managers

Most challenges are related to people, and meeting those challenges is a matter of 'executing the basics'

ROY GRABER

Gerald Duncan, agriculture operations adviser for Cargill Turkey Products, believes that five of the biggest challenges facing turkey breeder and hatchery managers all have a common denominator: people.

While speaking at the 2018 Midwest Poultry Federation Convention in Minneapolis on March 13, Duncan told managers in attendance addressing these challenges is a matter of "executing the basics."

"If you focus on these things every day when you walk through the door, you'll be doing your job," said Duncan.

1 Staffing

Duncan, when speaking to hatchery and breeder managers, says the No. 1 complaint is never how many eggs the turkeys are laying, or the current disease threat. It is staffing.

The turkey industry, and the workplace as a whole, has changed a lot over the past 30 years, Duncan said.

Turnover rates are high, and so are employee expectations. Gone are the days when a worker was asked to do something and they did it without question. Now employees want to know why they are expected to finish a certain task.

Duncan referred to "help wanted" signs that touted signing bonuses, but those bonus offers have done little good to attract good employees.

Duncan said staffing challenges will continue to be an issue in coming years, so it is best to try to understand the issues as well as possible.

2 Safety

Workers want to know they are safe on the job and that their employers take safety seriously.

"Is safety the first word out of your mouth in the hiring process? It should be," said Duncan.

Duncan told convention attendees that workers



6 antibiotic-free supplements that can harm water lines:
www.WATTAgNet.com/articles/33785

want to have input in the safety program. That input should be taken into consideration, and managers should follow through with solid ideas.

3 Biosecurity

“A biosecurity plan is only as good as the execution by its people,” Duncan said.

Turkey facilities need to have a solid program developed that can be easily communicated. Managers should take the time to help people understand the expectations of the program.

Good biosecurity tools and materials need to be provided as well, he said.

4 Animal welfare

A strong animal welfare program is particularly important, and equally important is that all employees fully understand and embrace it.

Duncan gave a metaphor saying today’s poultts have been developed by leading geneticists and as a result

are sophisticated, high-performance machines. In a way, these poultts are like a Ferrari. But most people wouldn’t park their Ferraris in a hay barn.

Turkey hatchery and breeding facilities must have a zero-tolerance mindset when it comes to situations where the animals are not receiving the best conditions and treatment possible.

Continuous focus on animal welfare is also imperative. Duncan’s advice is to train, retrain, trust and verify.

5 Food safety

All workers must be fully versed on food safety programs and their importance. There cannot be any weak links, and no shortcuts can be allowed.

“There are no trophies for second place with *Salmonella*,” said Duncan. ■



Gerald Duncan, agriculture operations adviser, Cargill Turkey Products. *Roy Graber*

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The global animal feed premix market is projected to reach revenues of more than US\$27 billion by 2022.

Livestock premixes evolve to meet consumer demands

From ingredient availability to AGP elimination, market trends and challenges are influencing the animal feed premix industry.

JACKIE ROEMBKE

Premixes ensure feed manufacturers safe and consistent inclusions of trace minerals, medications, vitamins, additives and supplements.

In the years ahead, the global premix industry is poised for growth. According to market research firm Mordor Intelligence, the global animal feed premix market is set to reach an estimated value of US\$27.53 billion by 2022.

Beyond the requirements of animal health and productivity, market forces are influencing premix formulations and manufacturing.

“The premix industry will no longer be relevant with simple blending facilities and basic formulation support services,” says Adriano Marcon, group director, Cargill Animal Nutrition. “On the manufacturing side, in order to ensure the highest level of nutrient accuracy, blending precision and absence of cross contamination, line and facility segregation is required in addition to new production technologies like RFID, barcoding and micro-dosing automation. On the service side, as customers evolve and build their own nutrition capabilities, service innovation is required to add distinctive value.”

Consumers' sway on premix production

Consumers are demanding to know more about

food production and safety, an interest that has trickled down to affect the role of the premix manufacturer.

“The market is increasingly being driven by consumer choices and preferences,” says Tom Taylor, managing director for Cargill’s U.S. premix and nutrition Provimi business. “In the United States, customer requirements for how we manufacture premix are evolving.”

In addition to the elimination of antibiotics for growth promotion (AGPs), consumers seek more “natural, wholesome and sustainable” options for their own diets, which will continue to influence how food animals are fed.

As consumers embrace no-antibiotics-ever meats and products, the need for alternative solutions is further amplified for livestock producers when they are faced with environmental pressures, such as weather fluctuations, density and health stressors, Taylor said.

To maintain animal performance in post-AGP production, premix manufacturers have had to adjust their formulations and come to market with products featuring alternative feed additive solutions.

Adoption of specialty feed additives

When AGPs were banned in Europe more than a decade ago, the market for medicated premix dropped by more than 50 percent, said Harm de Wildt, CEO of Trouw Nutrition. During this time, Trouw Nutrition shifted its focus to the research and development of functional feed additives as an AGP replacement.

“The reduction of AGPs brings new processing techniques and new technical questions,” said François Fernandez, director of Neovia’s Wisium. “But the main influence of the AGP ban and its challenges is that it pushed us to optimize and adapt our ways to create solutions for the market.”

In the wake of AGP elimination in the United States, for example, nutritionists are seeing more demand to include feed additives, such as probiotics, prebiotics and phytonics, in premix formulations to improve immunity, maintain performance and enhance gut health.

Debunking trace mineral myths in animal nutrition: www.WATTAgNet.com/articles/32241

“The importance of premixing technologies will become even more relevant in the future as a large number of new ingredients come to market,” de Wildt said. “The premix company has been and will remain a gatekeeper — selecting effective ingredients from non-effective ingredients — and will need to assure quality even when new ingredients are used.”

The efficacy of these feed additive combinations is informing the long-term strategic plans and investments being made by premix manufacturers. For example, Macron points to Cargill’s investment in phytogetic feed additive supplier, Delacon, and its purchase of natural animal health product manufacturer, Diamond V.

Chuck Loefer, vice president of ADM Animal Nutrition, agrees: “The increased need for alternative additives is one of the reasons ADM is investing in new specialty feed additive developments in bioactives.”

While its medicated blend volumes have decreased, ADM Animal Nutrition experienced an increase in complex premixes containing the company’s feed additives, such as its whole-cell yeast product and vegetable-based DHA omega-3 source.

However, the addition of new additives can complicate feed production.

“It is important that we work closely with customers on their premix formulations to ensure the premix is of the highest quality,” Loefer said. “These formulations start to include more non-traditional ingredients with various physical and chemical properties, which may make it challenging to produce a uniform and stable premix that mixes properly during the feed milling process.”

Other factors shaping today’s premixes

Beyond consumer pressure and reductions in medi-

ANIMAL FEED PREMIXES NOW include more alternative additives in the wake of AGP elimination.

LIVESTOCK PREMIXES EVOLVE

cated mixtures, the premix industry is faced with several challenges and overarching trends that are changing the way they do business and formulate their products.

1. Emphasis on safety and traceability: Feed safety is the top priority for premix manufacturers. Ensuring their customers receive the exact, quality formulations is paramount in premix production. To do so, suppliers utilize barcode systems, RFID technology and dosing automation to ensure ingredient traceability.

“Now, more than ever, we’re seeing that it’s critical to invest in technology that provides customers the highest level of assurance in the traceability of ingredients, additives and other animal nutrition products,” Taylor said.

2. Ingredient availability struggles: Beyond the current vitamins E and A shortages, supply chain issues and ingredient availability are a challenge for premix manufacturers.

“The premix industry has two drivers: the supply chain, i.e., ingredient availability; and the nutritional knowledge and capability to formulate quality premixes to meet the



Cargill Animal Nutrition's new medication-free facility in Lewisburg, Ohio, will open in spring 2019.

needs of an animal throughout its life cycle,” de Wildt said.

When premix ingredient supplies are volatile, manufacturers may reformulate as a temporary solution or rely on support from long-term suppliers.

“With the recent vitamin crisis, we see the importance of securing our sourcing and increasing preventive actions to reduce sourcing risks,” Fernandez said.

3. Consolidation narrows competition: Consolidation is an ongoing trend in the animal feed industry.

Premix manufacturers will be challenged by the grow-



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ing segment of professional farming and further consolidation at the integrator level, de Wildt said.

4. Influx of automation: Aside from shortages of qualified labor, the need for precision measurements without risk of human error or injury is spurring a surge in automation among premix manufacturers. Investments range from state-of-the-art micro-ingredient systems to robotic packaging lines.

5. Leveraging technology: Large premix manufacturers are expanding and investing in specialized services, such as in-line NIRs, animal production data management, farm expansion planning and environmental services, Marcon said.

“We are changing the nutrition focus from least-cost formulation to animal profitability optimization through the new animal production economic models,” he said. “The digital nutrition and analytics revolution will both complement and enhance our animal production solutions.”

PREMIX SUPPLIERS ARE INVESTING in dedicated unmedicated production lines and facilities to prevent contamination.

Opportunities for premix manufacturers

Asia-Pacific promises the most growth potential for the premix industry. By 2022, it will hold more than 33 percent of the premix market, Mordor Intelligence reports. The Middle East and Africa are also flagged as accelerated growth markets.

De Wildt said this development will be fueled by increased animal protein consumption happening mainly in developing economies. Sources suggest the investment in modernized production systems and further feed industry consolidation will also contribute to this growth.

In mature markets, like North America and Europe, sustainable feed solutions, intensification and complex feed formulations will drive premix sales. ■



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Feeding broilers a **Mediterranean diet**

The benefits of a Mediterranean diet are well-known to humans, but what about applying such a novel idea in broiler feeding practices?

IOANNIS MAVROMICHALIS



The benefits of a healthy Mediterranean diet are many and well-known worldwide. In fact, Mayo Clinic currently recommends on their website that “the Mediterranean diet incorporates the basics of healthy eating — plus a splash of flavorful olive oil and perhaps a glass of red wine — among other components characterizing the traditional cooking style of countries bordering the Mediterranean Sea.”

Healthy eating is not exactly

what we have in mind when it comes to feeding broilers, as such a notion is related with longevity in humans. But healthy is healthy no matter how we define it, and now that antibiotics are no longer fashionable in the broiler industry, we need to broaden our horizons if we want to remain financially healthy as broiler producers.

In broilers, a healthy diet is one that supports good gut health. This means a microbiota balance that excludes pathogens while fa-

voring beneficial bacteria. Indeed, the majority of scientific research in the last decade or so has focused entirely on this aspect. At the same time, growth potential for modern broiler genetics continues unabated, and this without a doubt increases the oxidation stress caused by increasing metabolic demands. Much ink and digital power have been exerted over the issue of metabolic oxidation stress, but the industry remains unmoved. Perhaps oxidation stress



Healthy eating, like a diet rich in antioxidants enjoyed in many Mediterranean countries, is a concept that can be applied to modern animal feeding. *Seoterra | Dreamstime.com*

suffers the same fate as immunity; if you cannot easily measure something, then it is easier to ignore it. Indeed, it is currently difficult to measure the negative effects of oxidative stress, and, as such, the level of performance loss remains unclear. That we are not



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MEDITERRANEAN DIET

able to quantify such significant aspect of nutritional distress does not mean birds of high genetic potential do not suffer from it. To the contrary, the negative effects are well documented in scientific literature, even though there is still work to be done to transfer such knowledge down to commercial level.

Back to the concept of a Mediterranean diet for broilers: We can isolate for the purposes

of this discussion the specific mention to olive oil and red wine. First, it is important to realize that olive trees and vines live a long and prosperous life, the same if not longer than some varieties of tea trees. What characterizes such long-living plants is their abundant production of antioxidant compounds — among a myriad of other beneficial compounds, of course. Modern human medicinal

practices praise the beneficial effects of moderate consumption of all of the above products, stressing the importance of receiving adequate antioxidant compounds especially under stressful conditions. In broilers, such conditions include super-rapid growth, over-crowding, sub-clinical disease pressure, uncomfortable bedding conditions, parasitic infections and, of course, heat stress.



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Oleuropein is a phenolic bitter compound found in green olives and olive leaves.

Tannjuska | Dreamstime.com

Olive tree

The olive tree produces oleuropein, which is a phenolic bitter compound found in green olives and olive leaves. It is the same bitter compound that makes eating unprocessed olives an unpleasant experience. Oleuropein, however, is currently believed to possess medicinal properties as an antioxidant and stimulator of the immune system. Other important bio-active compounds are oleuropein and hydroxytyrosol, luteolin, rutin, caffeic acid, catechin and apigenin, and elenolic acid. In fact, oleuropein, together with 10-hydroxyoleuropein, ligstroside and 10-hydroxyligstroside, are tyrosol esters of elenolic acid. The phenolic composition of olive leaf extract varies according to plant variety, harvesting season and method, leaf maturity, storage conditions and extraction method.

It merits mentioning that leaf

extracts are preferred over olive extracts because of the higher concentration (over ten times higher) of phenols in leaves. Feeding olive press waste has other beneficial effects, namely in terms of functional fibers and residual olive oil. Today, the use

of leaf extracts has been commercialized in the form of additives, whereas the feeding of press waste remains a local farm-specific practice.

Grapes

That grapes contain signifi-

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MEDITERRANEAN DIET

cant quantities of phenols with antioxidant properties needs little advertising. It is now common knowledge that drinking a glass of red wine brings about much in terms of improved cardio-vascular health, among other beneficial effects. In fact, grape antioxidant properties have been trusted upon during times when vitamin E (a strong natural antioxidant) becomes prohibitively expensive to replace it (at least partially). Research is still on-going on how best to characterize, isolate and take advantage of the many bio-active compounds in grapes. Anthocyanins, those pigments in red wine, have received scant attention from the scientific community because they cannot influence the color of animal products.



Grapes contain significant quantities of phenols with antioxidant properties.

Ralf Hettler | iStockPhoto.com

WE NEED TO BROADEN our horizons if we want to remain financially healthy as broiler producers.

But, as antioxidants, all these phenolic (red wine) and flavonoid (white wine) compounds have captured the interest of human medicine and research continues to identify their best use.

Oxidative stress

Stressful conditions, including the process of metabolizing nutrients at a super-high rate, invariably leads to production of undesirable compounds, among which and perhaps the most dangerous are those called free-radicals. These chemical compounds "steal" electrons from nearby molecules, harming cells through long-term irreparable damage. It has been shown that cellular membranes and DNA are particularly vulnerable to free-radical damage, and this can lead to severe neurological damage and genetic malfunction. It is believed that aging is due (at least partly) to the natural decline in controlling free-radical damage.

Living organisms contain a great number of defense mechanisms against free-radicals, among which are molecules such as superoxide dismutase, glutathione peroxidase and Q10. What these molecules do is simply donate electrons to scavenging free-radicals, rendering them virtually harmless. Here it

should be noted that there are countless molecules that can donate electrons, but such dedicated metabolic "antioxidants" as the ones mentioned above are specific for certain processes working with greater efficacy and specificity — and they spare all other molecules required for other purposes. The need for a great number of dedicated antioxidants is due to the fact that antioxidants are not interchangeable; this applies to those provided through feed ingredients.

Perhaps it is high time to define antioxidants as a new nutrient in feed formulation practice.

Nature has ensured that animals receive daily a good amount of extra antioxidants through their feed. Such antioxidants include familiar names, such as vitamin C, vitamin E and selenium. There are more not so well-known, such as phenols and flavones, of which there are thousands in the plant kingdom. Naturally, free-ranging animals would consume countless quantities of such natural antioxidants, but confined animals in farms receive virtually none — thus the need to pay more attention to antioxidants. Perhaps it is high time to define antioxidants as a new nutrient in feed formulation practices, but this is rather too advanced thinking for current times.

Feeding a Mediterranean diet to broilers (0-35 days of age)*

	Negative	Positive	Mediterranean	Significance
Weight gain (g/day)	65.6	67.8	68.1	0.10
Feed intake (g/day)	100.3	100.9	101.6	None
Feed/gain	1.529 ^b	1.489 ^a	1.493 ^a	0.05

a, b: Means within a row with different superscript are significantly different.

*Data courtesy of Nor-Group (Denmark)

Results of a recent trial in Southeast Asia are encouraging, as birds appeared to respond to antibiotics (positive control) or antioxidant support (Mediterranean).

Practical experiences

The allure of Mediterranean diets remains strong, worldwide, and it is now important to consider if any elements of this practice can be applied into animal nutrition. Broilers, being a quick test animal, are always first to be used when new concepts come up. Indeed, in a recent trial in Southeast Asia, under commercial conditions, a mix of olive leaf and grape extracts was tested in broilers. The birds were given a diet without any antibiotics (negative control), with antibiotics (positive control)



How animal feed oxidation affects livestock productivity: www.WATTAgNet.com/articles/30712

and finally what we should call a Mediterranean diet (one with the extracts mentioned above but without any antibiotics).

Results are encouraging (see the table) as birds appeared to respond to antibiotics or antioxidant support. A higher growth potential (albeit marginal) manifested itself more clearly into signifi-

cantly improved feed conversion ratio. Naturally, such preliminary results require further verification and clarification. But, nevertheless, they point to the interesting notion that antioxidant nutrition (a “Mediterranean diet” is perhaps better from a marketing point of view) requires our attention. ■

Ioannis Mavromichalis, Ph.D., is an animal nutrition industry consultant. To contact Mavromichalis, email imavromichalis@icloud.com.

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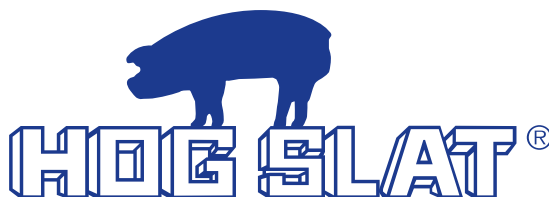
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