Cooperative Development Program
Strengthening Farmer Cooperative Competitiveness

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Research Scope:
IMPROVING SMALLHOLDERS' FARM RECORD-KEEPING

Countries Researched: South Africa, Peru and Ecuador
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Research Partners

Table of Contents

I. SUMMARY

Smallholder farmers produce 70 percent of the world's food. Yet, the vast majority have limited access to technology, resources and know-how. The lack of government regulation, checks and balances further limits incentives for producing high quality output that can meet international industry standards. In the livestock sector, the low productivity results have meant that dairy and beef processors have difficulties supplying enough product to the marketplace. They are searching for solutions for acquiring a more consistent, high quality, high volume of milk and beef. From a development perspective, this severely limits smallholders from improving their productivity, profitability, and their capacity to operate at a commercial level. To address the need sustainably, solutions require a strategy that address both the developmental weaknesses and the need to operate on a viable commercial basis.

Transforming Smallholders into Commercial Operators. In the livestock sector, a key aspect of transforming smallholder operations into commercial enterprises rests in collecting, maintaining and using production records. They are essential to the viable commercialization and sustainability of local cooperatives and their farmer-members. The correlation between record-keeping, productivity and profitability is clear. Smallholder cattle producers will simply not achieve a commercial scale without employing such tools.

With this premise in mind, USAID's Cooperative Development Program (CDP) supported a research activity conducted by GENEX, Valley Agricultural Software (VAS), and Urus Group in South Africa, Peru and Ecuador to study the viability, acceptability and technological appropriateness of digital record-keeping tools and farm-management guides (built into the digital record-keeping tool) to improve the efficiency, productivity and profitability of smallholder operations. GENEX, a subsidiary of URUS Group, a new global leader dedicated to serving dairy and beef cattle producers around the globe, is a U.S. cooperative implementing a USAID-funded CDP. VAS, also a subsidiary of Urus Group, is the global market leader in bovine herd management software and consulting services. VAS contributed over 50% of the resources in cost share to carry out this study. The findings and conclusions of the research articulated in this report provide a way forward for Cooperative Development Program field staff, those in the livestock industry, and governmental livestock officials to leverage the resources of the CDP by engaging the private sector to develop sustainable solutions to developmental challenges in a way that limits donor assistance. The central evaluation questions that guided the research were:

1. What challenges do smallholder farmers and cooperatives in Peru, Ecuador and South Africa face with respect to record-keeping?
2. What would relevant tools for data collection and interpretation look like?
3. Can the findings from Peru, Ecuador and South Africa serve as a framework for globally applicable record-keeping tools in emerging economies around the world?
4. What can cooperatives and processors gain from producers working with record-keeping tools?
5. How can online farm-management training platforms be applied to emerging-farmers' needs?
6. How can record-keeping and online training contribute to more environmentally friendly production methods?

<u>Findings</u>. Smallholders in emerging markets generally lack record-keeping options. The research found that the needs for farm management training topics begins with record-keeping. For a farm to effectively monitor its farm practices for increased productivity and profitability, it is essential to identify key performance indicators upon which those practices can be evaluated. The most efficient way to deliver a digital record-keeping tool is through a smartphone application that is functional offline and online (ensuring that data is pushed to the cloud when connected). The data flow between producers and cooperatives are primarily cattle numbers and production data. Between producers and processors, it is the same. But the data is limited. There is a good deal of farm data which is not documented and, thus, it is lost. The biggest roadblocks in the data-flow challenge are either not documenting the data or not having a platform to efficiently exchange the data.

Traditionally, farm herd management software products have been complicated to use, have required extensive training and customer support, and have limited penetration in emerging markets. As a result, valuable data for improving management practices (and primary food production) goes unrecorded. Though complex, digital record-keeping tools are considered *Smart Farming*, that is, Big Data applications that identify socio-economic challenges and create ways for them to be addressed. Collecting and organizing farm and animal records can play an essential role in tackling identification, production, animal health, reproduction and sanitary challenges — important determinants of the success and effectivity of their farm. In turn, there is valuable data that can be used to alleviate supply chain challenges.

<u>Conclusions and Recommendations</u>. Farmer cooperatives and associations can benefit from record-keeping by monitoring benefits of the services they bring to their members, as well as improving their selling positions with buyers. Given the appropriate tools, an exchange network (data sharing) could be established that connects farms with local industry. Training will be needed on the level of the cooperative, processor or apex organization to assure there is adequate understanding of the value of maintaining farm records. By creating herd management software in a simple and applicable smartphone application format targeted to smallholder and medium-scale producers, an affordable, viable solution can be developed. A digital record-keeping tool can essentially create an *Internet of Cows*, analogous to the *Internet of Things* (IoT). The use of Internet connectivity to input cattle information into physical devices will create a global database of simple herd management trackers. This has the potential to lead to profound changes in farm management because there will be access to specific information and decision-making capabilities that were previously not available, either technically or economically. Smallholders and emerging producers will be able to monitor productivity information rather than rely on memory and intuition to make farm-management decisions.

<u>Next Step: A Digital Record-Keeping App</u>. Global cattle owners are comprised primarily of emerging farmers who lack access to digital recording tools. This implies there is a strong opportunity for designing a business model to address the need. It is recommended that a digital record-keeping framework be created that: (a) involves an organization with a technical and dairy/ beef background, (b) accommodates multiple languages (targeting countries with many smallholder farmers), (c) provides training and technical assistance on record-keeping, and (d) establishes industry collaboration to integrate data flows. The tool should be easy to use, be affordable, be flexible, and suit multipurpose farms and dual-purpose cattle operations. Although there are several tools already

available that partially fill the needs of emerging producers, each lacks certain critical aspects, and is limited in geographic scope and applicability. As a global brand in dairy technology, VAS has the capacity to answer the need more completely with a globally applicable product.

Based on the GENEX, VAS and URUS' collaborative research, VAS has taken a first step to developing a commercial record-keeping tool suitable for emerging farmers. The smartphone app is expected to be structured initially for entry-level farmers and be free to allow smallholders access with the possibility of increased functionality using a paid software service model. This project will collaborate with VYLA, an industry partnership of leading dairy companies created to promote technology, innovation, and collaboration to connect consumers to farmers and unlock value to all value chain stakeholders.

II.   METHODOLOGY

Situational Analysis. In-house interviews were conducted among the collaborative research partners to capture the knowledge, insights, and judgments with regard to successful implementation of record-keeping and educational tools, readily available technology, literacy rates and language barriers. The interviews provided guidelines for the travel destinations, interview designs and filtering for data. Desk research followed to collect data on the dairy and beef industries in the countries involved, identifying strategic regions and partners and establishing the fundaments for the external analysis.

Field Research. An in-depth questionnaire was developed based on the input of internal staff interviews that was employed to interview smallholder producers, dairy cooperatives, processors and other value-chain stakeholders (see appendix). Two researchers on site were responsible for visiting local dairy and beef operations, collecting information and conducting interviews. The researchers were assisted by the CDP staff. In addition to smallholder beef and dairy farmers, the interviews were adjusted as needed for the farm or organization. Given that the data is all qualitative, the meetings differed slightly from the designed interviews, yet always contained the same outline (farm characteristics, record-keeping, cooperative/ association relations and training topics). Target areas in South Africa were the KwaZulu-Natal and Eastern Cape provinces. Target areas in Peru were the Lima, Cajamarca, Pasco and Arequipa provinces. The target areas in Ecuador were the Pichincha & Cotopaxi provinces.

Figure 1. Summary of Research Trips and Meeting Types

Type of Meeting	South Africa	Ecuador	Peru
Farmer	18	30	12
Processors	1	3	2
Abattoirs	3	0	1
Cooperatives	3	0	1
Associations	0	12	3
Government Agencies	1	2	1
Other Stakeholders	4	3	2

Figure 1 is an overview of the types of meeting held. A full list of the interviews can be found in the appendix.

Analysis, Conclusions and Recommendations. Based on the insights from internal and external research, there was an analysis (presented in this report together with the research findings) of the

needs for record-keeping, the possible strategic partnerships, their cross-benefits and rewards and means to achieve it. The data collected was organized, translated and polished to be presented to the range of parties of interest, including users, government authorities, relevant value chains and industry groups. In turn, experts from GENEX and its sister companies will inform the researchers on the feasibility of creating applicable record-keeping tools based on this report. Examples are: Overseas Cooperative Development Council, Peru Ministry of Agriculture, South Africa Agricultural Research Council, South Africa Department of Agriculture, Forestry and Fisheries, USDA Foreign Agricultural Service (FAS), technology firms, such as Apple, and other public and private stakeholders.

III. FINDINGS

A. Global Trends

Several trends identified during the desk research phase are significant for understanding the importance of digital record-keeping tools. These include:

(a) Emerging/ Smallholder Farmer Food Production. As providers of nearly 70 percent of the world's food supply, smallholders and family farmers need an adequate and just framework that enables them to keep animal records, optimize production and allow for easier connection to the global food industry. The responsibility is large, but for smallholder farmers, access to resources, markets and agricultural know-how often falls short (FAO, 2016).

(b) Food Production. In order to sustain a growing population, global food production has to increase by 50 percent despite the challenges of climate change and limited land and water resources (Rothschild 2016). Innovative solutions to optimize global food production are needed. One solution rests with the smartphone which has revolutionized the ability to gather and exchange data. It can be applied to advance the *Internet of Cows,* contributing data that could potentially alleviate concerns in the global dairy and beef supply chains. Farmers' access to explicit information provides them with new decision-making capabilities which can improve farm management in ways that are currently not technically or economically possible.

Figure 3, on the next page, shows that the average milk yield per animal in the continents with large numbers (Africa, Asia and South America) of cattle is low when compared to other continents. Figure 4 confirms that the global trends for beef production (with the exception of certain parts in South America, for example, Brazil, & Chile), have similar challenges. The efficiencies of production are low, quality standards are limited and result in many problems for commercial processors to keep up with industrial demand and standards.

Figure 3. Global Average Dairy Yield per Cattle (2014)

No data	0 kg		1,800 kg		3,600 kg	
		900 kg		2,700 kg		>4,500 kg
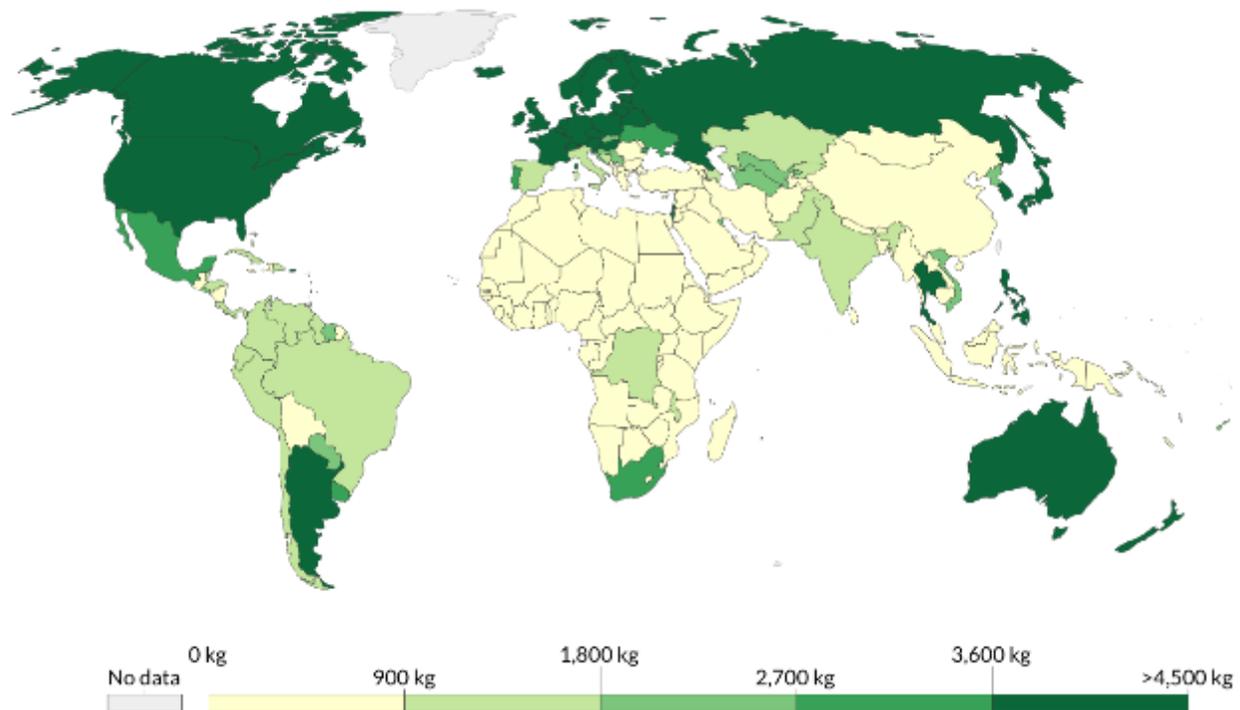
Figure 4. Global Average Beef Yield per Cattle (2014)

No data	0 kg		120 kg		240 kg	
		60 kg		180 kg		>300 kg
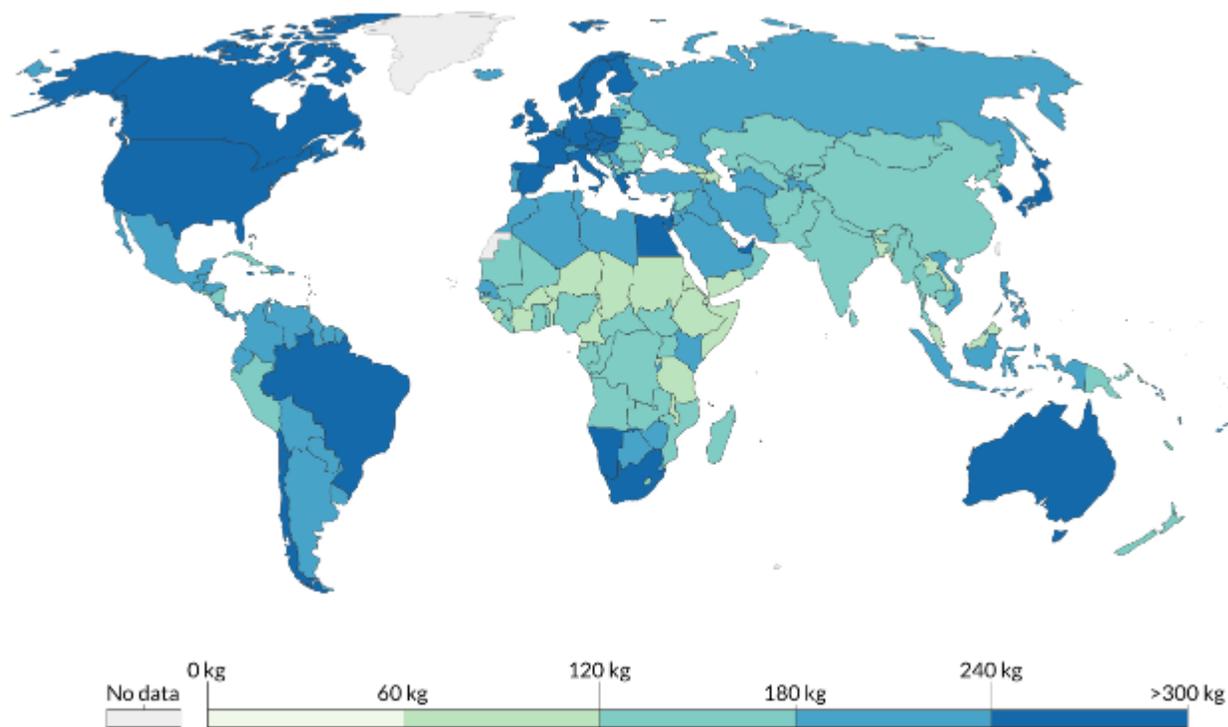
Source: Food and Agriculture Organization of the United Nations (FAO) (2014).

(c) Food Security. Cattle populations globally have been affected by disease epidemics and the human population has been affected by zoonotic diseases as a result. Outbreaks in the 1990s, such as bovine spongiform encephalopathy (BSE or mad cow disease) and foot-and-mouth disease (FMD) have driven many countries to adapt systems of national traceability (FAO 2016). Zoonotic diseases can be transmitted from animals to humans through the air (aerosol), by direct and indirect contact (fomite transmission), by ingestion and by insect transmission (Pelzer & Currin 2009). These diseases include anthrax, brucellosis, cryptosporidiosis, dermatophilosis, Escherichia coli, giardiasis, leptospirosis, listeriosis, pseudocowpox, Q fever, rabies, ringworm, salmonellosis, tuberculosis, and vesicular stomatitis (Pelzer & Currin 2009).

To illustrate the significance of the problem for smallholder producers, the incidence of brucellosis spikes are high in rural populations and among small communities of cattle owners where the industrial standards of milk processing and food preparation are not applied (Dadar, Shahali & Whatmore 2019). The increased use of antibiotics and hormones also pose another threat for the consumer. Today, identification and traceability of live domestic animals and of products of animal origin is a legal requirement in order to export internationally (OIE 2019). A smartphone application has the potential to create a recognized certification. Animal traceability has significant importance for animal health and public health. Yet, countries such as South Africa, Peru and Ecuador lack an adequate system of standardized identification; the private sector can play a role in setting industrywide standards.

Challenges. The Food and Agriculture Organization of the UN (FAO) established several factors that should be considered before adopting any type of animal identification or information recording systems in low-input production environments (FAO, 2016):

- Low External Input. Smallholder farmers oftentimes depend on low-input production systems, e.g., subsistence pasture systems. Animal production is low cost and dependent on local genetic resources. Lack of financial resources limits possibilities for the implementation of modern technologies.

- Limited Access to Resources. Smallholder producers in developing countries often lack access to land, feed, water, finance and services, making it difficult for them to rise beyond subsistence production, grow, be profitable and commercialize.

- Inadequate Infrastructure. Essential facilities for record-keeping such as information communication systems, marketing systems, transportation systems, equipment and laboratory services are frequently missing.

- Low Knowledge and Literacy Rates. Developing countries are faced with constraints, such as illiterate herdsmen and limited knowledge on farm management. Record-keeping requires the user to enter information and to make decision based on herd summaries.

- Multiple Uses of Livestock. Livestock often serves a variety of purposes. A single animal might be used for milk, meat and draught. This could impact the type of information that is relevant to the

producer, as well as how the information will be utilized. This is especially important for recording progress and goals on genetic improvement.

The challenges listed above paint an accurate picture of emerging markets. For a digital record-keeping solution to be viable, it will need to be easy to use (including pictures), affordable (low external input and resources), flexible (take into account lacking infrastructure and open to integrations with value chain actors), and suit multipurpose farms (a solution for both dairy and beef).

B. South Africa, Peru and Ecuador

Industry Challenges. Figure 5, on the next page, illustrates the general population, cattle number, dairy and beef production figures in the study countries. FAO recommends per capita dairy consumption of 135 kg, but the data for South Africa, Peru and Ecuador indicates that the supply falls short. Moreover, Peru has a major challenge in its beef industry with low production and per capita consumption half of the global average. Peru and Ecuador have higher per capita milk consumption than supply; as a result, they are dependent on imports. These and the challenges listed below are similar in emerging countries across the globe and highlight the need for improvement in production methods and industry standardization.

- South Africa, Peru and Ecuador all have challenges with the export of beef because of the threat of cattle-specific diseases. Incidents have limited their ability to export to higher currency markets.

- South Africa, Peru and Ecuador have limited infrastructure for animal identification, regulation and traceability.

- There is little record-keeping activity, and in the cases where there is, data is documented in notebooks for farm management purposes. The valuable data is rarely used to analyze production trends.

Applicability of Digital Record-Keeping. Digital record-keeping can begin to address the problem of animal traceability by creating individual animal history files. Industry collaborations could create a network of exchangeable cow files when an animal is transferred through different stages of the value chain. Collecting and organizing farm and animal records has the potential to tackle identification, production, animal health, reproduction and sanitary challenges. These, in turn, can help farmers make their farms more productive, thereby increasing levels of primary food production. A viable digital record-keeping solution must be easy to use (including pictures), affordable (low external input and resources), flexible (taking into account limited infrastructure and open to integrations with value chain actors) and suit multipurpose farms (a solution for both dairy and beef). While several cellphone apps are currently available to aid dairy and beef producers in herd management, none of them address all areas of need, create transferrable files, or have the geographic scope needed by the industry.

Figure 5. Industry Overviews (FAO, 2016)

	South Africa	Peru	Ecuador
Population (2014)	54,540,000	30,970,000	16,140,000
Nr of Cattle (2014)	13,920,000	5,580,000	4,580,000
Nr of Dairy Cattle (2017)	615,0000	874,000	1,592,000
Dairy			
Annual Milk Production (2014)	3,340,000 tons	1,870,000 tons	2,120,000 tons
Annual Milk Yield per Animal (2014)	3513 kilograms	1559 kilograms	1606 kilograms
Annual Milk Consumption per Capita (2013), *Global Average is 100kg per capita*	55.75 kilograms	62.15 kilograms	139.6 kilograms
Annual Milk Supply per Capita before Imports and Exports (Total Production/Population) (2014)	62.24 kilograms	60.38 kilograms	131.35 kilograms
Beef			
Annual Beef Production (2014)	1,000,000 tons	196,232 tons	268,740 tons
Annual Meat Yield per Cattle (2014)	297.1 kilograms	142.7 kilograms	205.7 kilograms
Annual Beef Consumption per Capita (2013), *Global Average is 9.32kg on average*	18.03 kilograms	4.69 kilograms	16.61 kilograms
Annual Beef Supply per Capita before Imports and Exports (Total Production/Population) (2014)	18.33 kilograms	6.34 kilograms	17.76 kilograms
Animals Slaughtered for Meat (2014)	3,368,571	1,376,391	1,306,619

South Africa (beef)

Record-keeping amongst smallholder farmers is virtually non-existing. Record management software is available, but it is too high-end for a smallholder audience. Most of the smallholder cooperatives in South Africa, really need basic tools. Especially around the growing cities, there are some efforts to commercialize farms. Yet, it is very difficult because there are no fences or protection. Stock theft is a common issue so they're trying to come up with a new system, such as tattooing the cow's ears.

—Lieb Venter
CDP Chief of Party, South Africa

The *Red Meat Producer Organization* (RPO) in South Africa is the largest beef association in the country. The supply chain is generally vertically integrated, with most feedlots owning their own abattoirs (with some linked to small, medium and micro-enterprises). Some farmers also sell directly to the consumers or wholesalers. The South African beef industry lacks a uniform national animal identification system. Two of the biggest challenges in the industry are food safety (FMD, antibiotics,

hormones and other harmful agents ending up in the food) and stock theft, since there is no traceability system. This, in turn, results in poor industry incentives. Inefficient farms usually fail under such condition, but the government heavily supports emerging farmers in an effort to help them survive. There is a duality in the challenge of helping the farmers and creating an efficient market. The lack of farm data on which the country and industry can reflect means there is little to no key performance indicators (KPIs) to underpin policies and other incentives.

The photograph above is of Sanele Mbele's beef farm in Dundee, South Africa. His farm served as one of the research sites to identify the challenges for record-keeping for emerging farmers. The Owotathe Cooperative currently has 16 members and is a part of the CDP program. The records Sanele maintains are the date of birth, the dam, vaccination records and the dehorning protocol. The records are kept in a physical notebook. All his records are used for farm management purposes and do not transfer into later stages in the value chain. When the cows reach auction, given the lack of appropriate tools, records do not transfer. As a result, valuable information that can provide feedback to both the farmer and the industry is lost.

Peru (dairy and beef)

Everybody in Peru has access to a cellphone. Working with cellphones can be an effective tool. Cellphones and apps are everywhere you go – even among many smallholder farmers. A 3G connection is available in most of Peru. A 4G connection is maybe in 70 percent of Peru but this will transition to everywhere within the next few years. Record-keeping for smallholder farmers should include the basics for production, reproduction, genetics and maybe some nutrition. What would really help the producers would be a tool with an overview of the markets where they can put in connections to resources. This would be something the cooperative could do.

—Joe Mantilla
CDP Chief of Party, Peru

Peru's dairy industry faces two significant challenges: (a) low milk prices, and (b) very low production levels (low milk yields per animal). The major concern in Peru is to increase production. Smallholder dairy farmers in Peru rarely keep animal records and conventional breeding is more popular than AI as opposed to the larger dairies. Record-keeping tools could help with increased efficiencies in production and a better understanding of cattle genetics, encouraging the use of AI. Peru also faces challenges with the quality of dairy products. Most commercial milk is sold in the form of condensed milk or milk powder. In the informal sector, consumption and processing of raw milk is common practice. There is a mostly quantity- (rather than a quality-) based pricing system since it is often too expensive for industrial players to compete with prices in the informal sector. As a result, there is no incentive for smallholder farmers to produce higher quality milk. This practice happens with both the formal and informal sectors in Peru. Since the challenge in industry is so big and largely a result of institutional and infrastructural challenges, the industry has not evolved into a progressive one. The lack of farm records has created a situation where the national production data is questionable, and the effect on policies is difficult to quantify.

Peru is also among one of the lowest beef consuming countries in South America and is not able to meet domestic demand due to underproduction and a lack of a modern system. Domestic per capita beef consumption, at 4.69 kg before imports, is significantly below the global average of 9.32 kg. Additionally, because of Peru's outdated beef production system, most of the cattle is old and the meat is of poor quality. 80 percent of the cattle are in the highlands and jungle under semi-intensive or extensive production systems; the remaining 20 percent are in the coast under intensive production systems. Just like the Peruvian dairy sector, the beef sector is heavily influenced by the different geographies in the country.

Ecuador (dairy)

> *Amongst the rural population, Ecuador has a low national awareness of food safety regulation and standards. This is supplemented by infrastructural problems relating to plants, facilities & technology. Given a lack of financial resources to meet national standards and regulation, there is little incentive for smallholders to meet commercial standards. Record-keeping may be a relatively easy step in the right direction.*
>
> —Leonardo Larco
> GENEX distributor, Peru

Ecuador's dairy industry is more successful than Peru when comparing cattle numbers to total milk production (figure 5). In March 2013, the Ministry of Agriculture in Ecuador introduced an official pricing scheme as an obligatory milk payment system (Sandoval 2016). The scheme is based on minimum fat and protein content supplemented by three other features such as reductase, total bacterial counts and colony forming units. Additionally, bonuses are awarded for hygienic quality (free of brucellosis, tuberculosis and vaccinated against FMD (Sandoval 2016). The Ministry of Agriculture is also responsible for enforcing this pricing system. However, like Peru, there are still many areas in Ecuador where milk price is based on volume rather than solids. These are mainly areas of predominately smallholder farmers in informal sectors (Sandoval 2016). Record-keeping conditions are similar to Peru, where smallholder farmers have a limited understanding of the value of record-keeping and generally collect little to no animal records.

IV.   ANALYSIS

A.   Guiding Research Questions and Hypotheses

The research design articulated six questions that served as the foundation for the survey tool.

1. What Challenges Do Smallholder Farmers and Cooperatives in Peru, Ecuador and South Africa Face with Respect to Record-Keeping?

    Hypothesis. Peru, Ecuador and South Africa have similar challenges facing the collection of basic farm data. On the farm level, smallholders often have poor or no record-keeping systems in place. This contributes to inefficient management decisions, low production and poor quality. On the cooperative level, this results in financial challenges and limited options to engage in the value-chain on behalf of their members. For the processors, this leads to both production and quality challenges.

    Confirmed. Challenges with record-keeping in emerging markets begin with (a) a poor understanding of the value of information and why it is worth the time to record numbers, and (b) a lack of appropriate record-keeping tools. Before adopting any type of animal identification or information recording systems in low input production environments, the following must be considered: low external inputs, limited access to resources, inadequate infrastructure, low knowledge and literacy rates and multiple uses of livestock.

2. What Would Relevant Tools for Data Collection and Interpretation Look Like?

    Hypothesis. Versions of Valley Agricultural Software's DairyComp and BeefComp software programs could be designed for emerging producers, with application to many countries. Common record-keeping needs for dairy and beef operations start with basic information such as cow identification, calving information, reproduction data, health information, etc. On-paper record-keeping systems are outdated and require unnecessary administration and archives, back-logging and are prone to human errors. Alternatively, given limited access to technology, the smartphone has the potential to collect data and communicate it to the cloud. Smartphones, 3G and 4G connections are becoming a part of daily life in emerging economies. Using the cloud for data communication could improve the benefits for producer, cooperative and processor collaboration.

    Confirmed. A general framework has been established (see page 14). Relevant record-keeping tools should start with recording identification data, production data, animal health data, reproduction data and include action items to ensure management and sanitary protocol compliance. With the introduction of the VAS Platform (cloud-based dairy-management software), there is a possibility to tweak the existing program to design an applicable solution. The needs and characteristics have been identified. The continuation of this project is a next step.

3. Can the Findings from Peru, Ecuador and South Africa Serve as a Framework for Globally Applicable Record-Keeping Tools in Emerging Economies Around the World?

Hypothesis. The most basic challenges with managing cattle are shared across emerging economies. Modernizing smallholder farmer operations through record-keeping and online training programs could result in strengthening the linkages between farmers, cooperatives and processors and assisting the development of local communities by transcending subsistence production.

Confirmed. Whereas the specific national challenges are unique, the research found that record-keeping related challenges are similar across the visited countries. The barriers in scalability are finding a company with a tech and dairy/beef background, language, training and boots on the ground.

4. What Can Cooperatives and Processors Gain from Producers Working with Record-Keeping Tools?

Hypothesis. Producers with access to record-keeping tools will have better productivity/ quality than the producers who do not work with them. As a result, producers using record-keeping tools could strengthen the market position for cooperatives. For processors, a dataflow system relating to milk and beef production allows for growth opportunities and a continuous system of quality assurance throughout the processing chain. Record-keeping resources could be used as non-financial production incentives to increase the profitability of stakeholders in the value chain. In turn, increased access to farm-data can contribute to product traceability.

Confirmed. The aggregation of data can provide valuable input for animal traceability, making financial projections, production analyses, improving/ monitoring sanitary protocols, benchmarking and provide key performance indicators. The ultimate goal is to help the entire supply chain become more efficient while monitoring quality. Many of the processors, cooperatives and farmers interviewed stated that if the right tool were available, they would be willing to pay for it.

5. How Can Online Farm-Management Training Platforms be Applied to Emerging-Farmers' Needs?

Hypothesis. *dairylearning.com* is an e-learning provider within the URUS family. Their aim is to expand their e-learning curriculum and gain a wider impact on the industry. *dairylearning.com* courses could be linked to the above programs' generated farm-reports to bring the most-needed education topics to the farmers. Online courses will have a wider audience and a greater scope for topics.

Confirmation Pending. The needs for training are clear. Record-keeping is essential to the viable commercialization and sustainability of local cooperative partners and their member farmers. There is a direct correlation between record-keeping, productivity and profitability advances. Training on record-keeping is therefore a must. However, the applicability of e-

learning through the cellphone is more challenging. The current in-house *dairylearning.com* platform requires a computer and a strong internet connection to be fully utilized. Therefore, under the current conditions of the training platform it is challenging to target the true emerging farmers that have no/limited access to technology outside of a smartphone.

6. How Can Record-Keeping and Online Training Contribute to More Sustainable Production Methods?

Hypothesis. A lack of record-keeping contributes to several challenges down the value chain of dairy and beef industries. Farm data generated as a result of record-keeping has important by-products such as traceability, disease control and genetic progress, all of which strengthen the value chain. Training will help the smallholder farmers understand the importance of those by-products which can be implemented to build resilience against unforeseen circumstances. On a wider scale, the aggregation of animal record-keeping data can have a positive socio-economic impact that has the ability to influence markets, regulation and policies; all steps towards improving sustainability in the dairy and beef industries.

Confirmed. Availability and access to farm data are essential to alleviating supply chain concerns: increased primary production efficiencies, traceability, projection analysis, improved genetics, and improved animal health. As smallholder farmers improve their ability to make better management decisions, waste of resources will decrease.

B. Farmer Needs and Benefits

Record-keeping data that can be collected within the simple parameters illustrated in Figure 6 on the next page are crucial for daily farm management and monitoring production efficiencies. Likewise, this data (when aggregated) can be capitalized by linking it with the industry. During the research trips to South Africa, Ecuador and Peru, many challenges with record-keeping became apparent. Emerging farmers tend to keep limited or no farm/ animal records. The farmers who do generally record information by hand in notebooks (similar to the U.S. several decades ago). In most cases, the notebooks are used for general management practices, but rarely to analyze data trends on the farm.

On the bright side, the vast majority of emerging farmers visited have access to smartphones, Wi-Fi and 3G/ 4G data. For the areas that have limited coverage, farmers should be able to temporarily store their data on their phones until it can be uploaded to the cloud. The majority of visited farms/ organizations are optimistic about using a cellphone application which can help in organizing farm records. In many cases, farmers know that record-keeping is important; yet, they find it hard to outline precisely the benefits that it can bring them outside of helping with general management practices.

Figure 6. Framework for a Digital Record-Keeping Tool

Identification	Production	Animal Health	Reproduction	Action Items
GPS Location Farm (-GPS coordinates farm)	Weight at birth -Average weight at birth	Vaccination Program: - Lot Number - Types - Date delivery	Insemination records -Average conception rate	Vaccinations / health treatments due
Type of farm: - (confinement/ grazing) - Area of farm - Altitude	Weaning weights *(kg and lbs)* -Average weaning weights Age at weaning - Average age at weaning	Treatments: - Lot Number - Types - Dosage - Date delivery - Withdrawal	Conventional breeding records - Days with the bull	Castration
Date of birth	Weights at sale *(kg and lbs)* - Average weight at sale Age at sale -Average age at sale	Disease events - Type - History	Reproductive status per animal	Planned insemination dates Planned conventional breeding dates
Sire Information	Milk Production total herd - Average milk production per cow	Morbidity rates: - Lungs - Lameness - Ticks - Digestive	Expected due date for calving	Alerts animals close to calving
Dam information	Number of lactations		Calving interval	Cull / sell
Breed	Lactation curves of individual cow - Lactation curves of herd		Automatic assignment pedigree information for newborn calves	Dipping (Tick treatments)
Animal ID	Beef grade of animal			Calendar with manual entry
Gender	Weights at sale - Average weight at sale			Ability to transfer cow files on app
Date of death Date of Sale	Efficiency per hectare			Benchmarking
Picture of Animal	Animals per lactation group - Animals per pen/pasture			Graphical / Visual representation of valuable farm management data
Purpose of farm: - Dairy, beef or dual purpose	Basic milk quality indicators - SCC - Components - Bacteria Plate Count - Etc.			

The five principle categories listed at the top Figure 6 are key factors that provide critical information for management decisions:

1. Identification. The ability to keep records on animals depends directly on animal identification. Common methods of animal identification are branding, tattooing, ear-tagging, ear-notching and electronic identification. The most important aspect of identification is that it should make the animal easily recognizable. Studies have shown that smallholder farmers that rely on memory to identify/ track animals are often proven wrong. A recent case study where 70 smallholder farms were analyzed of which 90 percent did not keep any records has indicated a substantial mismatch between farmer statements and clinical findings (Celander 2017). Animal identification and record-keeping can reduce that mismatch. Besides, documenting birth date and pedigree information also allows to monitor progress in production, determine good genetics that can improve the marketing of dairy and beef animals.

2. Production. In order to be able to reflect the success of a farm, the farmers should know the profitability of the quantity and quality of the output. Studies show that farms keeping individual animal records have better average milk yield per cow, higher milk fat percentages and lower bacterial and bulk tank SCC scores then those that do not (Rhone & Elzo 2008). Record-keeping provides smallholder farmers with the tools to measure such changes and evaluate the policies implemented by farm management. Furthermore, overviews of herd lactation curves can assist farmers in understanding the effects of seasonality and climate disruptions. A smartphone application with easy data-entry features can organize information in interpretable and structured format.

3. Animal Health. Keeping cattle disease records is an important factor in assessing the health of the individual cow and the health of the total herd population. Disease outbreaks can be devastating to any operation. Knowing the source of where the animal is purchased and monitoring the treatment regimen should help reduce loss to diseases (Powell & Troxel 2010). Understanding those implications leads to better management practices for reoccurring events. Examples of such records are vaccination, dipping/ spraying, treatment, de-worming and postmortem (Powell & Troxel 2010). Besides, the use of certain medication such as hormones, de-wormers and antibiotics will require a certain withdrawal time before the animal products can be consumed again. Specifically, for international exports the safety and traceability aspect are important.

4. Reproduction. Efficient livestock recording systems offer opportunities that are crucial to genetic improvement efforts. The globalization of the cattle artificial insemination and embryo transfer industries provide opportunities for smallholder farms to excel their herds. The Swedish International Agricultural Network Initiative indicates, that there is no better way to conserve an animal breed than by keeping it competitive (SIANI 2017). The report summarizes that crossbreeding with high-producing breeds has been proven difficult to manage in practice when there is limited infrastructure to document genetic progress. Rather, continued selection with crossbred cattle populations that form synthetic breeds tend to perform better; the primary reason being that it allows for the conservation of genes essential for environmental adaptation along with desired genes (e.g. production traits,

disease immunity etc.). Note, the report emphasizes that this is how historically most breeds have been developed. As a result, the globalization of artificial insemination and embryo transfer practices require efficient systems for risk analysis that monitor relevant breeds for important characteristics and their genetic makeup. By doing so, cattle breeds can be selected for particular environments, genetic progress plans can be designed, and the effectivity of such practices can be monitored. Early record-keeping studies have suggested that the basic reproductive information should at least include calving date, dates of insemination, confirmation of pregnancy and information on culled animals (Flamant, 1998).

5. <u>Action Items / Benchmarking</u>. Action items are important since they can act as a tool to ensure protocol compliance. This will contribute to monitoring planned vaccinations/ treatment dates, medicine/ hormone withdrawal periods and send warnings that help with daily management practices. This is information of great value to both the consumer and the industry since protocol compliance will result in a safe consumer product and higher wide scale production by preventing the dumping of contaminated milk/ beef. Finally, including benchmarking can provide farmers with the opportunity to compare themselves regionally, nationally and internationally to reflect on their relative performance.

V.   CONCLUSIONS AND RECOMMENDATIONS

In combination with the collected farm-gate prices for milk or the price of beef animals, the key production data articulated in the previous section will give smallholder farmers an overview of what decisions they can or cannot afford to make. It can also help evaluate what decisions have been beneficial in the past and which have not. Overall, record-keeping serves as an overall farm monitoring tool that can be a decisive factor in on-farm decision-making, including financial decisions. A good history of transactions through record-keeping can also provide increased access to credit by providing a clear picture of the performance of the farm. Likewise, the same advantage extends to cooperative and industry level decisions.

As smallholder farmers increasingly depend on the income they receive from dairy and beef production, they need to transition from subsistence-level production to commercial operations. Without adequate skills, technology, knowledge and access to affordable inputs and markets, this will be difficult to achieve. Although the barriers emerging farmers face in making this transition differs from location to location, poor farm management has proven to be an endemic weakness in most emerging countries. For local producers, the effects are reflected in low production levels and poor product quality. The result is often unprofitable and failing farms. Insufficient quantity and quality of products provide challenges for the industry to meet market demands. This, in many cases, affect the prices offered to smallholders. It is where a digital record-keeping tool can make a difference.

A.   The Record-Keeping Framework

<u>Identification</u>. Step one in record-keeping is identification. Using an application with exchangeable cow files will allow animals to be traced back to their source farms. In cases of disease outbreaks or other complications, it can assist the industry to mitigate the damage through processor and
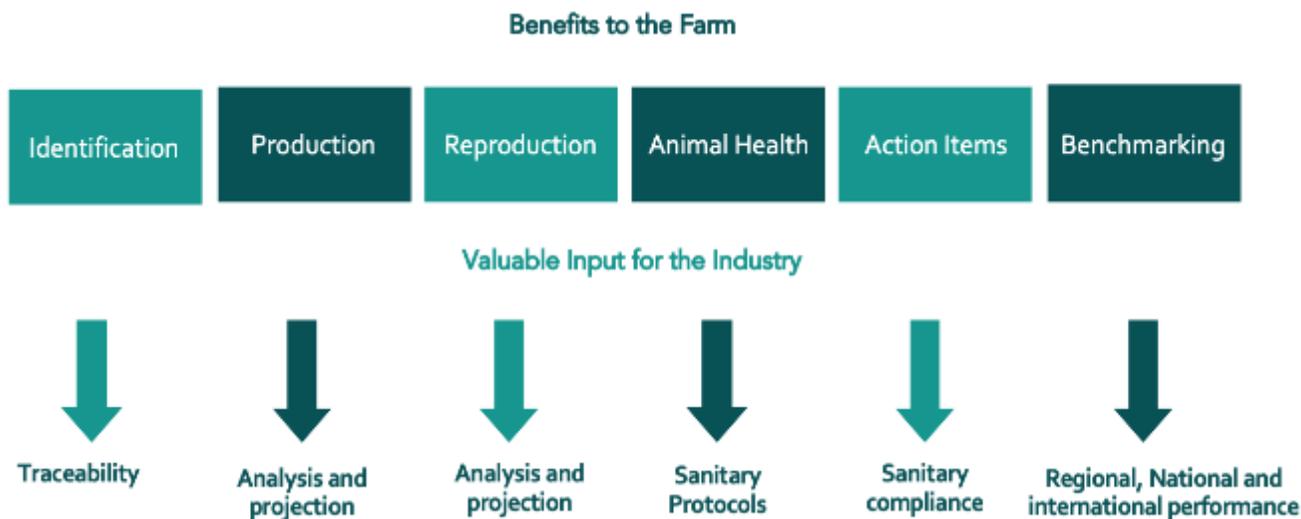
retailer collaborations. An identification application can also serve as a certification for marketing of animal products.

Production and Reproduction. Milk processors and meat packing plants in emerging markets struggle to source enough raw material. As the demand for global food production increases, the industry will need to have an increasingly more accurate picture of production. Production data will be essential for improving levels of production. In turn, reproduction data can assist in providing an overview of expected cattle numbers and future produce as well as genetic improvement.

Animal Health and Action Items. Farmers with poor management practices and industries that have limited compliance with international standards face challenges with the safety of products. As each smallholder only provides small quantities, the industry currently can only achieve a random sampling for quality. Data on animal health can help reduce the contamination of produce and serve as a KPI for sanitary protocols. Data on action items can serve as KPIs on the compliance of sanitary protocols and can play a role in improving the quality and safety of animal products.

Benchmarking. One of the most important features for the industry is benchmarking. Aggregated data can assist the industry in reflecting on regional, national and international performance. It will clarify challenges and relevant KPIs to determine long-term global strategies. This could serve as incentives for the industry to improve collaboration with smallholder farmers.

Figure 7. Where the Farmer Benefits Align with Industry Needs

Benefits to the Farm

| Identification | Production | Reproduction | Animal Health | Action Items | Benchmarking |

Valuable Input for the Industry

| Traceability | Analysis and projection | Analysis and projection | Sanitary Protocols | Sanitary compliance | Regional, National and international performance |

B.   Industry Benefits

A digital record-keeping tool can have a widespread positive socio-economic impact by encouraging smallholder commercialization, higher global food production and food security. During the research, almost every stakeholder involved in the value chain indicated a serious need for this information. Many organizations and companies are trying to create their own record-keeping systems, but simply do not have the resources, knowledge or dedicated interest to provide a solution beyond their own production systems.

At the cooperative level, there is an opportunity to support record-keeping by providing the resources and training through partnerships with trade associations, donors/ implementing organizations and vendors. Cooperatives need capable management and governance and the ability to adapt to prevailing business conditions. Cooperatives often fail without a market-driven approach that allows them to compete; however, whether and how they can gain a competitive advantage is through professional management, operational and financial efficiency, high quality products, and competitive pricing (OCDC, 2007). Encouraging smallholder farmers with record-keeping tools is an important first step to achieve the conditions necessary for transparency, professional management, efficiency and all the benefits associated.

C. Scalability

Smallholder farmers and producer cooperatives across the globe – not just those in South Africa, Peru and Ecuador – face the same challenges of record-keeping. Although smartphone ownership and 3G/4G connectivity limits how many smallholders will be reached through an app, it has been observed that where there exist business-minded farmers with access to viable markets, connectivity and resources for owning a smartphone are usually not issues. This was found to be true in all three study countries and is expected to be similar in most emerging countries. The primary requirements recommended for the development of a globally applicable, digital record-keeping tool are:

- Organizational Engagement. To create a software solution for dairy/ beef farmers, the creator has to be familiar in the worlds of both software and livestock farming. Any organization creating a digital dairy and beef record-keeping platform should have a background in software/ mobile application development. Also, the company should have a background in livestock farming to appropriately address the farm management needs with a relevant software solution.

- Multiple Languages. Language is important for an application since markets with smallholder farmers in most cases speak little to no English. Localization of the tool is key for applicability. Examples of impactful languages for smallholder farmers are Spanish (throughout South America and Spain), French (Africa, Canada and France) Portuguese (Brazil and Portugal), Hindi (India), Russian (Russia, Belarus, Kyrgyzstan and Kazakhstan with a potential transfer to the former Soviet Countries), Bengali (Bangladesh) and Urdu (Pakistan).

- Technical Assistance. Training is essential since dairy and beef record-keeping platform is hard to quantify if the farmer does not understand the types of key performance indicators (KPIs) that are available or their value to the farming operation. Whereas the function of a digital record-keeping application should be to provide valuable management information in an intuitive output, farmers will not always have the knowledge necessary to use the data to its full potential. As noted earlier, however, the applicability of e-learning through a cellphone application may not be a viable solution given limited access to technology and a strong internet connection in emerging countries. A limited number of farmers can be provided training by GENEX directly through the Cooperative Development Program, but a larger international strategy is needed to realize the full value of the tool. Instead, it is recommended that agriculture ministries, apex organizations, processors,

producer cooperatives and associations be approached directly with information on the value of record keeping and applicability of the tool, who will then disseminate the information to the individual farmers.

- Collaboration. Building and creating a digital dairy and beef record-keeping platform will not have the impact hoped for without gaining industry-wide recognition. Part of the value of using the proposed platform is to aggregate data; this requires a large number of farmers inputting data. It is recommended that industry collaborations be established to integrate data flows. A project would require strong relationships with actors in the industry, e.g., processors, cooperatives and NGOs. Also, strategic collaboration with the industry is necessary for achieving traceability of dairy and beef products, and the lead organization must be willing and able to deploy resources to establish its presence.

D.   Next Steps

GENEX and VAS have the potential to fulfill the requirements identified in this report, a genetics company and a technology company respectively, with dairy and beef expertise. The current development of a VAS Platform offers the willingness to invest in restructuring the core principles of its software to meet the needs of smallholder farmers. This application will be in a smartphone application format. VAS will explore a pricing model suitable for emerging farmers/ markets while remaining profitable. Producer organizations or processors may choose to purchase the tool and provide it as a service to the individual producers to improve production and output. Based on their existing industry presence, both companies can leverage relationships with cooperatives, processors, agriculture ministries and NGOs. This tool has the potential to standardize the documentation of key farm performance indicators for farms and cooperatives participating in GENEX' Cooperative Development Program in Peru and South Africa. The potential, however, is far greater.

VAS management has scheduled a beta version of the record-keeping app to be developed by fall of 2019, which will then be tested for usability by emerging farmers, including participants in GENEX' Cooperative Development Program. Cooperatives and producer organizations will be encouraged to promote the tool to their members in order to improve the quality and quantity of products, thereby expanding the cooperatives' market positions.

Another opportunity is to collaborate with VYLA, an industry partnership led by VAS, Land O'Lakes, Antelliq, Lely and Nestlé. As leaders in the dairy industry, these companies have collectively founded the VYLA alliance with a mission to unlock the value of farm-to-fork through a transparent dairy supply chain. Consolidating data from partner companies across the value chain in one platform will enable transparent and efficient communication with the community, assuring quality and ethical practices. A record-keeping app for smallholders is an early step to bringing emerging countries into a more transparent system with industry metrics, benchmarking and impact reporting regarding sustainability and animal welfare.

VI.   COLLABORATING PARTNERS

GENEX is a U.S. cooperative with 13,000 member-owners and is a subsidiary of Urus Group. Based in Wisconsin, GENEX and URUS are global companies with a presence in more than 70 countries, selling 20 million units of semen annually along with many other products and services. Since the 1990s, GENEX has applied cooperative know-how, expertise, and technology to addressing livestock development challenges in emerging economies around the world with support from USAID and the USDA.

Urus Group is a new global leader dedicated to serving dairy and beef cattle producers around the globe. As a holding company with cooperative and private ownership, URUS connects well-established agricultural organizations — AgSource, Alta Genetics, GENEX, Jetstream Genetics, PEAK/GENESIS, SCCL and VAS. Each of these organizations has its own unique identity, products and services. These companies provide cutting-edge genetics to accelerate genetic progress, customized reproductive service to maximize conceptions, dairy management information to take producers to the frontline of smart dairy farming, and an array of products and services to help the cow achieve her genetic potential. Put simply, these companies focus on the cow and her caretaker.

Valley Agricultural Software (VAS) is the global market leader in bovine management software (DairyComp/ BeefComp) and consulting services. It also provides beef management software. VAS is an innovative technology company providing on-premise and Cloud solutions, business intelligence, analytics and integration to efficiently manage dairy operations. Globally, more than 7.5 Million cows are registered through DairyComp. VAS provides application support and consultation based on real-world knowledge and on-farm experience. The VAS team knows the dairy business, and knows that it's always changing, working with customers to transform dairy operations and efficiency. The VAS development team watches trends solicit input from customers and couples it with their experience and imagination to keep VAS a leader in farm technology. Having started in the U.S., today VAS has customers in 41 countries.

APPENDIX

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Meetings Overview CDP Research Trips

	1. South Africa		
Location	**Meeting**	**Persona**	**Main Contact**
East London, Eastern Cape	The Eastern Cape Rural Development Agency (ECRDA)	Government & Beef Farmer	Metaimba Maphuma
East London, Eastern Cape	Meeting Berlin Beef	Feedlot & Abattoir	Vusi Buthelezi
East London, Eastern Cape	Elliott Brothers	Abattoir	Glen Page
Sutterheim, Eastern Cape	Eastern Cape Rural Development and Agricultural Reform Center	Government	Mfunda Macanda & Fundisile Bese
Whittlesea, Eastern Cape	Zulukhama Development Trust	Collection of villagers & Farmer personas)	Canzibe Rawana
Elliot, Eastern Cape	Chairman and members Ikhepu Secondary Cooperative	Cooperative & Beef Farmers	Gcina Madasa
Elliot, Eastern Cape	Andrews Abattoir	Abattoir	Nicholas Andrews
Malojeni	Triple C Feedlot and Abattoir	Feedlot & Abattoir	Andy Hentzen
Umzinyathi DC, Kwazulu-Natal	Chairman Owotathe Cooperative	Cooperative & Beef Farmer	Sanele Mbhele
Dundee, Kwazulu-Natal	Orange Grove Dairy	General Manager Dairy Processor	Guy Deveroux
Wasbank, Kwazulu-Natal	Up George Bonsamaras	Beef Farmer	Derek Ralfe
Dundee, Kwazulu-Natal	Auctioneer BKB	Auctioneer	Stoffel Mouton
Dundee, Kwazulu-Natal	Member Owotathe Cooperative (farmer)	Cooperative & Beef Farmer	Mrs. Masukhu
Dundee, Kwazulu-Natal	LIMA Rural Development Agency	NGO	John Flannigan
Dundee, Kwazulu-Natal	AfriTan	Tanning Factory	Craig van Heerden

The table above provides an overview of the location, meeting, persona and main contacts of the visits made in South Africa between the 03/18/2019 – 03/29/2019

Ecuador			
Location	**Meeting**	**Persona**	**Main Contact**
Latacunga, Cotopaxi	Hacienda Las Monjas	Dairy Farmer	-
Latacunga, Cotopaxi	Centro de Acopio AGROPAZ (Pastocalle); Centro de Acopio SIERRA NEVADA (Cumbijin, Salcedo) – 11 local dairy associations and farmers	Dairy Farmers / Dual purpose farmers	-
Meija, Pichincha	Hacienda San Esteban	Dairy Farmer	-
Meija, Pichincha	Dairy Farm	Dairy farmer and ex-president Holstein association)	Jorge Arturo Lopez
Quito, Pichincha	USDA	Government	Andres Barahona
Quito, Pichincha	AGSO/El Ordeño	Dairy Processor	Esteban Del Hierro
Meija, Pichincha	Centro Agrícola Cantonal Mejía	Dairy Farmers	Santiago Tinajero
Meija, Pichincha	Hacienda Santa Lucrecia	Dairy Farmers	Maria Eugenia, Ing. Wilson and Ing. Luis Duran
Meija, Pichincha	Holstein Association	President and Dairy Farmer	San Rafael
Pedro Vicennte Maldonado, pichincha	Roundtable – 11 dairymen - (Hacienda La Betania)	Dairy Farmers	Roberto Rosero
Quito, Pichincha	Ministerio de Agricultura y Ganadería	Government	Eddie Pesántez Benitez
Quito, Pichincha	Pasteurizado de Quito	Dairy Processor	Galo M. Izurieta
Quito, Pichincha	Nestle	Dairy Processor	Frank Blacio
Quito, Pichincha	ToniCorp	Dairy Processor	José Lucas Loor, Enrique Navarrete & Juan Carlos Cedeño

The table above provides an overview of the location, meeting, persona and main contacts of the visits made in South Africa between the 04/08/2019 – 04/12/2019

Peru			
Location	**Meeting**	**Persona**	**Main Contact Person**
Lurin, Lima	La Querencia	Dairy Farmers	Clifford Watson
Oxapampa, Pacho	Agencia Agraria Oxapampa municipality cattle association	Chairman Assocation	Oscar Ruffner
Oxapampa, Pacho	Beef Farmer	Beef Farmer	Hugo Schaus
Oxapampa, Pacho	Rancho Ruffner	Dual Purpose Farmer	Gerald Ruffner
Oxapampa, Pacho	Maffrox	Abattoir	Edward Becerra
Oxapampa, Pacho	FLORALP	General Manager Dairy Processor	Jaime Marin Frey
Pozuzo, Pacho	Asociación de Ganaderos y Agricultores de Pozuzo (ADIGAP)	Chairman Association and Beef Farmer	Roberto Schaus
Cajamarca, Cajamarca	Alamo Dairy Farm	Dairy Farmer	Louis Linarez
Cajamarca, Cajamarca	El Cortigo Dairy Farm	Dairy Farmer	Alfredo Valera
La Granja, Cajamarca	Co-operative Atahualpa Jerusalem & Porcon Dairy Farm La Granja Porcón	Dairy Farmer & Chairman Association	-
Cajamarca, Cajamarca	Fongal	Chairman Association	Alfredo Valera
Cajamarca, Cajamarca	Gloria Cajamarca	Chief Gloria Cajamarca – Dairy Processor	Percy Ramos
Santa Rita, Arequipa	Meeting Fundo America	Dairy Farmer	Carlos Lozada Garcia
Arequipa, Arequipa	Establo Agroindustria Ganadera	Dairy Farmer	Adolfo Morán Vásquez
Arequipa, Arequipa	Sistema Nacional Procacidad de Lechera Arequipa	Secretary – Government / Dairy Farmer	-
Lima, Lima	EuroMilk	Distributor Dairy Products	Andres Bances

The table above provides an overview of the location, meeting, persona and main contacts of the visits made in South Africa between the 04/22/2019 – 05/03/2019

Illustrative Interview Questionnaire: Identifying Local Dairy & Beef Producer Needs

Name / Role:	Location:
Dairy:	Date:

General

1. How many bred to beef, lactating milking cows, young stock and total cows do you have in your farm?

2. What are the main characteristics of your farm (surface, livestock, crops, family work)?

3. Please provide an overview of your farm management structure. (administration, production & people)?

4. How are financial decisions made on your operation?

5. What are the biggest improvements you would like to make on your operation?

6. What are the biggest challenges you foresee achieving those?

7. What challenges do you face regarding raising livestock and growing quality feed?

8. What type of breeds do you have in your herd? Do you have a system of genetic improvement at farm level? YES or NO. If YES, describe?

For Dairies:

9. Do you sell milk commercially to a dairy plant/cooperative or sell locally? How do you get paid?

10. Which hygienical practices do you follow in your parlor before and during the milking process?

11. What does milk quality mean to you? And which criteria does it have to meet to be sold?

For Beef:

12. Do you sell beef commercially to a processing plant/cooperative or sell locally? How do you get paid?

13. Which criteria do your cows have to meet in order to get sold to a processor?

14. How do you transport beef cows to the processor?

Co-op Oriented

15. What role does the cooperative play in your day to day way of doing business, list any services you currently receive from your co-op?

16. Do you share any data with your co-op, if so, please list which data you share?

17. What is the biggest challenge in communication with the cooperative?

18. In what way does participating in the co-op benefit you?

19. Do you participate as a member in your cooperative member/delegate meeting?

20. Are there any services you would like your cooperative to provide that are currently not available? If YES, please list.

Education

21. Have you ever had any sort of formal education or training regarding dairy/beef management? (i.e. feeding reproduction, genetics, etc.)?

22. Do you receive any help/consulting from companies/organizations that can help you address management problems you may have? If YES, can you list the general area and who provides assistance.

23. Which areas of herd management does your dairy/ beef operation struggle with the most?

24. Is there any dairy/beef topic that you would like to learn about more?

25. For what areas does your dairy/beef operations have standard operating procedures?

26. Have you ever been trained to interpret and make decisions using dairy/beef records?

27. What perspectives do you have in the future of your farm? Do you have plans to increase the number of cows and / and / or diversify your livestock?

Record-Keeping

28. How do you keep track of your cows? (paper/electronic)

29. how do you ID your cows? Ear tags, brands, ear notching, etc.

30. Do you have a software herd management system to keep your records? Offline/online

31. **(if records available)** How long have you been keeping the records of your dairy/ beef operations and how easily are they available?

32. What indicators are most important to your dairy/beef operation?

33. Which indicators would you like to start tracking in the future?

34. **(if no records available)** why is your dairy/ beef operation not keeping records? Are you aware of the benefits?

35. Do you have internet access on either a computer or a cellphone?

36. Do you consider record-keeping an important practice? And do you think record-keeping is something that your farm needs, and you or your staff is willing to adapt to?

37. Would you be interested in having a simple app to track cow records and report data to the co-ops

Illustrative Interview Questionnaire: Identifying the Commercial Dairy & Beef Processor Needs

Name / Role:	Location:
Dairy:	Date:

General

1. How many farms do you collect milk / beef from?

2. With how many cooperatives do you work?

3. What is the volume of milk/ amount of beef you collect on a daily and annual basis?

4. What type of products do you make? And in which areas do you mostly sell your products

5. Which limitations do you face regarding to increasing your productions capacity?

6. What is the priority is production, quantity or quality? Do you receive incentives from the government or an NGO?

7. What are your marketing strategies? Do you export dairy/beef products?

8. What are the challenges for COUNTRY X's dairy/beef industry?

9. What is the competitive landscape for milk/beef processors like?

Farmer Relationships

10. How do you maintain relationships with the farmers? And what type of challenges are involved?

11. How are your customers paid for the milk / beef that they produce? And is this under a verbal or a written contract?

12. What happens if the farmer fails to meet the set criteria?

13. Do you offer any market / non-market incentives to milk/beef producers (credit, access to training, tools, connections to feed sources, etc.)?

Product Quality

14. How important is it to ensure high milk/ beef quality?

15. At what stages in the processing chain do you reflect on milk/beef quality? How do you reflect on them?

16. Do the producers receive a premium for components or low somatic cell count scores? What type of incentives do beef producers receive?

17. What criteria do milk/beef producers have to fulfill in order to qualify for selling their product to you?

18. What happens if the farmer fails to meet the set criteria?

19. What are the most common problems with milk/beef quality?

20. Do you label your products with information relating to the milk/beef quality? Would customers be willing to pay extra for a higher milk/beef quality?

Data Flow

21. How important is the traceability of your products?

22. Is there any form of data flow between the producer and the farmer? Which data do you currently receive?

23. How is the data/information collected from producers utilized?

24. What data is most important to your dairy processing facility to have access to? Is it important for you to have better access to data?

25. Which roadblocks are there with the dataflow from producer to processor?

26. If you had to describe a dataflow system that would suit all your needs, what would it look like?

27. Why is it important to have access to farm data from processor's point of view?

28. Do you think better access to data can affect your profitability?

Education

29. How do you currently train your partners to meet production and quality expectations?

30. Is the training sufficient, or are there areas where you find there is room for improvement?

31. Do you have an online training page, training modules or instruction manuals through which partners learn what is expected from them?

32. Would you consider online training modules for record-keeping as a non-financial incentive to help the farmers? What type of topics are important from a processor's point of view?

33. What is the biggest factor in limiting local farmer and cooperative productivity?

Illustrative Interview Questionnaire: Identifying Local Dairy & Beef Cooperatives Needs

Name / Role:	Location:
Dairy:	Date:

General

1. How many farms do you work with?

2. What is the volume of milk / quantity of beef you collect on a daily and annual basis?

3. Do you have your own processing facility or relations with local/commercial milk/beef processors?

4. What type of challenges does your cooperative face in doing business? Are they country specific?

5. Please provide an overview of your farm management structure. (administration, production & people)?

6. How are financial decisions made in your cooperative?

7. What are the biggest improvements you would like to make in your cooperative?

Farmer Relationships

8. What role does the co-op play for local producers, do you offer any market / non-market incentives to milk producers (credit, access to training, tools, connections to feed sources, etc.)?

9. Do you have existing partnerships with marketplaces that provide benefits for your members? How do they get access to the benefits?

10. What is the biggest challenge in communication between the farmer and the cooperative?

11. In what way does participating in the co-op benefit the farmers?

12. Are there any services you would like to provide as a cooperative that are currently not available? If YES, please list. Why are you not able to provide them?

13. How do you maintain relationships with the farmers? And what types of challenges are involved?

14. How are your customers paid for the milk that they produce? And is this under a verbal or a written contract?

15. What happens if the farmer fails to meet the set criteria? Do you evaluate member performance?

Data Flow

16. Do the farms share any data with the cooperative, if so, what type of data? Is there any benchmarking to compare performance?

17. Do you share any data with processing facilities?

18. How do you share the data between different parties?

19. If you had to describe a dataflow system that would suit all your needs, what would it look like?

Record-Keeping

20. Do your members keep records on their livestock? (paper/electronic)

21. Does the cooperative monitor milk quality?

22. Do they have a software herd management system to keep your records? Offline/online

23. **(if records available)** How long have your members been keeping the records of your dairy/ beef operations and how easily are they available?

24. What indicators are most important to your dairy/beef operation?

25. Which indicators would you like to start tracking in the future?

26. **(if no records available)** why are your dairy/ beef operations not keeping records? Are you aware of the benefits?

27. Do most operations have internet access on either a computer or a cellphone?

28. Do you consider record-keeping an important practice? And do you think record-keeping is something that farms needs and are willing to adapt to?

29. Would you be interested in having producers use a simple app to track cow records and report data to the co-ops?

30. What type of data is important for the cooperative and processors?

Education

31. How do you currently train your partners to meet production and quality expectations?

32. Is the training sufficient, or are there areas where you find there is room for improvement?

33. Do you have an online training page, training modules or instruction manuals through which partners learn what is expected from them?

34. Would you consider online training modules as a non-financial incentive to help the farmers? What type of topics are important from a cooperative's point of view?

35. What is the biggest factor in limiting local farmer and cooperative productivity?

36. Do you see feasible ways in which the milk productivity could effectively be increased?

Illustrative Interview Questionnaire: Value Chains

General

1. What is the role of your organization in the national agriculture industry?

2. What type of difficulties do farmers in Country X experience?

3. What are the biggest challenges in lifting smallholder farmers above the subsistence level of production?

4. What is the role of your organization in the dairy and beef industries?

5. Are there clear national trends which stakeholders have to adapt to?

6. What is the priority of focus? E.g. Production, quality, sustainability, developing local communities, economic development, export relationships etc.

7. What type of research do you conduct?

8. How do you interpret, use and act on the information that you collect through the research?

9. What type of projects are you working on now and in the next five years?

10. Do you work directly with farmers, cooperatives or processors?

11. Do you work on those challenges in collaboration with a governmental institution, NGO, or private organization?

Data

12. Does your organization collect data from local farmers, cooperatives or processors?

13. Why do you collect the data and how is it utilized? Do you report this data to any other organizations?

14. How important is the need for transparency? And is this for the consumer, the organization or the government?

15. Has the introduction of farm-data changed the industry significantly? Or are methods still sub-optimal for the most part?

Record-Keeping

16. Do you collect or use cow information? If so, how does it help the organization?

17. Could record-keeping be used to increase the transparency of the production chain and improve the position of the local dairy/beef industry in a global context?

18. Has your organization ever been involved in any record-keeping projects?

19. What was the outcome?

Education

20. Has your organization ever been involved in any education/farmer training projects?

21. What were the participants' biggest needs? And how did you act on them?

22. Which issues for general farm practices are still prevalent due to a lack in education?

23. Has your organization ever provided online training programs?

24. What influences do you see from commercial companies active in the area?

25. Do they provide any sort of training?

Genetics

26. How widely is artificial insemination implemented in the industry

27. Is the implementation of AI dependent on certain regions of the country?

28. How has the use of bovine genetics changed the industry?

29. Why do you collect the data and how is it utilized? Do you report this data to any other organizations?

30. How important is the need for transparency? And is this for the consumer, the organization or the government?

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