

2020 CRP Annual Reporting

CGIAR Research Program on Livestock Agri-Food Systems (CRP LIVESTOCK)

Name of Lead Centre: International Livestock Research Institute (ILRI)

Flagship lead institutions (CGIAR Centres or lead partners):

- Flagship 1: Livestock Genetics - ILRI
- Flagship 2: Livestock Health - Swedish University for Agricultural Sciences (SLU)
- Flagship 3: Livestock Feeds and Forages - International Centre for Tropical Agriculture (CIAT)
- Flagship 4: Livestock and the Environment - ILRI
- Flagship 5: Livestock Livelihoods and Agri-Food Systems - ILRI

Other participating CGIAR Centres:

- International Centre for Agricultural Research in the Dry Areas (ICARDA)

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CGIAR is a global partnership that unites organizations engaged in research for a food-secure future. The CGIAR Research Program on Livestock provides research-based solutions to help smallholder farmers, pastoralists and agro-pastoralists transition to sustainable, resilient livelihoods and to productive enterprises that will help feed future generations. It aims to increase the productivity of livestock agri-food systems in sustainable ways, making meat, milk and eggs more available and affordable across the developing world. The Program brings together five core partners: the International Livestock Research Institute (ILRI) with a mandate on livestock; the International Center for Tropical Agriculture (CIAT), which works on forages; the International Center for Research in the Dry Areas (ICARDA), which works on small ruminants and dryland systems; the Swedish University of Agricultural Sciences (SLU) with expertise particularly in animal health and genetics and the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) which connects research into development and innovation and scaling processes.


The Program thanks all donors and organizations who globally supported its work through their contributions to the [CGIAR system](#)

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EXECUTIVE SUMMARY

Despite the disruption caused by the COVID-19 pandemic and associated travel and work restrictions, the Livestock CRP in 2020 successfully maintained momentum across its portfolio of activities. Consistent with the program's Theory of Change, increasing attention was given to preparing relevant research outputs to be taken to scale beyond the end of the CRP II portfolio in December 2021. Many planned activities were delayed, with research teams relying more heavily on local partners to implement field work, while adapting to new technologies for virtual online collaboration and meetings. On the positive side, the number of peer-reviewed journal articles published, at 227, was a substantial increase compared to previous years. Work in the priority country projects was the most adversely affected, therefore ambitions for this experiment in cross-flagship integration of research for development design and implementation were scaled back accordingly. The CRP Livestock Review conducted by CGIAR Advisory Services confirmed the quality and direction of the research undertaken by the CRP and provided management with constructive suggestions for improvement over the final year of the program.

FP1 Livestock Genetics focuses on implementation of genetic improvement programs and associated delivery systems to ensure that smallholder farmers utilize appropriate livestock breeds. Scaling of the community-based breeding model for small ruminants was strengthened in Ethiopia through a network of reproductive laboratories, while over 140,000 East African farmers used digital tools to record the performance of their dairy cattle and access artificial insemination and knowledge services.

FP2 Livestock Health identifies animal disease risks, then develops and tests methods and delivery approaches to mitigate these risks through herd health management, diagnostics and vaccine innovations. Work in the priority countries was supported through compilation of herd health guidelines and an epidemiological survey toolbox was finalized to support global efforts to eradicate *peste des petits ruminants* (PPR).

FP3 Feeds and Forages develops and scales out feed and forage technologies and decision support tools, and tests appropriate business models for their adoption. The flagship facilitated uptake of the suite of feed knowledge and assessment tools and, through partnerships with the private sector and national agricultural research systems, delivered a large number of improved forages and dual-purpose crops.

FP4 Livestock and the Environment addresses greenhouse gas emissions and adaptation to climate change. The evidence base on climate change risks and benefits associated with livestock production in Africa was strengthened, while heat stress mapping was used to develop a new climate adaptation strategy for key livestock species.

FP5 Livestock Livelihoods and Agri-Food Systems ensures that CRP technologies/strategies achieve positive impacts on the resource poor. Following requests from their governments, development of two new Livestock Master Plans was initiated in Kenya and Odisha (India). In gender, assessments were conducted for two FP interventions as part of the effort to integrate gender perspectives in the work of all CRP flagships.

Part A: NARRATIVE SECTION

1. Key Results

1.1 Highlight Global Progress and Achievements

Towards the first target, 100 million more farm households adopting improved varieties, breeds, trees, and/or improved management practices, the CRP Livestock can report one contribution. CIAT's existing *Urochloa* hybrids were scaled on approximately 100,000 additional hectares in 2020, reaching a total of at least 1,100,000 hectares in 30 countries. At the time of reporting, 2020 data had not yet been shared by the private sector partner but will be available by mid-2021. By the end of 2019, the countries which had made the most progress in terms of area planted were:

- Latin America – Argentina, Brazil, Colombia, Mexico, Venezuela;
- Asia – China, Laos, Malaysia, Thailand, Vietnam;
- Africa – Democratic Republic of Congo, Ethiopia, Kenya, South Africa, Uganda.

No other adoption studies or impact assessments were planned or carried out by the CRP Livestock in 2020, thus there is limited evidence of any contributions towards the other CGIAR Strategic Results Framework targets.

1.2 CRP Progress towards Outputs and Outcomes (spheres of control and influence)

1.2.1 Overall CRP progress

Even with disruptions caused by the COVID-19 pandemic in 2020, the Livestock CRP successfully maintained momentum across its portfolio of activities as the program prepares to finish in 2021. Consistent with the program's Theory of Change, preparations to take relevant results to scale were given more attention, whether by leveraging opportunities through bilateral funded projects, by conducting scaling assessments, or by preparing to consolidate and package results for wider uptake. The pandemic's associated travel and work restrictions delayed many field and laboratory activities, requiring research teams to adjust their research designs and schedules and to rely more heavily on local partners to implement field work. The most adversely affected was the CRP's cross-flagship experiment in translating research results into design and piloting livestock development interventions in its four priority countries, which was already under a tight schedule given its stalled start and shortened horizon. Ambitions have therefore been scaled back accordingly. Otherwise, flagship programs were able to complete 35 (55%) of 64 planned milestones, generate 66 new Innovations and 9 new Policies, and produce 227 publications – a significant increase from previous years. External assessments by the Independent Steering Committee and the CRP Livestock Review conducted by CGIAR Advisory Services confirmed the quality and direction of the research undertaken by the program and endorsed efforts and progress made in cultivating an impact-oriented research culture based on Theory of Change.

Emerging efforts to consolidate results to date were particularly evident in FP1 Livestock Genetics, with the integration of components of the flagship's genetics improvement models for dairy cattle and small ruminants to bring the work to scale. Over 140,000 farmers in East Africa are reported using digital tools

for recording dairy performance of dairy cows and accessing knowledge services, supporting selection with genomic tools of appropriately adapted animals for breeding and establishing viable local artificial insemination services. For small ruminants in Ethiopia, expanded use of the community-based breeding model is now strengthened through a network of reproductive laboratories. Herd health guides compiled by FP2 Livestock Health for our priority country production systems demonstrates the better balance achieved between individual disease versus integrated health management, including notably more efficient antimicrobial use. A survey toolbox was also finalized to support the global effort to eradicate PPR. Next steps were achieved in the development of vaccines for two key livestock diseases, African swine fever (ASF) and East Coast fever (ECF). To improve livestock nutrition, FP3 Feeds and Forages achieved further development and uptake of the suite of tools designed to make feed knowledge widely accessible and applied, while delivering a range of improved forages and dual-purpose crops, several to be distributed through private sector arrangements. FP4 Livestock and the Environment, working with FP2, developed a new climate adaptation strategy by mapping heat stress for targeting tolerant breeds, and strengthened the evidence base on climate change risks and benefits associated with livestock in Africa. FP5 Livestock Livelihoods and Agri-Food Systems continued scaling out evidence-based Livestock Master Plans to guide national investments by responding to requests from two new countries. Gender assessments completed for two FP2 Livestock Health innovations were indicative of the progress made over the course of the CRP to enable better integration of gender perspectives into our research.

Adjustments to the CRP research agenda included initiating work, as noted, to enable geographical targeting for heat tolerant livestock breeds – an emerging climate related adaptation challenge in East Africa. This complements earlier work to identify genetic markers for heat tolerance. Another line of research to develop transgenic trypanoresistant cattle was suspended—despite promising results from preparatory experiments—after repeated failure to establish viable pregnancies with the ApoL1-modified blastocysts, representing a good example of science testing a hypothesis and raising new questions to be answered first. The other major adjustment to the CRP agenda has been the reduced scope to test our overarching hypothesis that we can accelerate livestock research into impact through a multidisciplinary approach to designing and piloting integrated livestock interventions in the four priority countries (Ethiopia, Tanzania, Uganda, Vietnam). Delays imposed by the pandemic have limited testing and the evidence that can be generated in the remaining time. Nonetheless, the multidisciplinary effort in the four priority countries significantly amplified the interaction across flagships in 2020. By working together to combine flagship innovations as an integrated strategy for a specific context, research teams are understanding better the interdependencies between the flagships. The Royal Tropical Institute (Netherlands) began documenting lessons from the experience during 2020.

Outputs achieved this year provide evidence that the expertise from FP5 Livelihoods on gender, business models and scaling readiness assessments is being applied more systematically across the flagships. Other outputs reflecting collaborations include the joint development of the Rapid Household Multi-Indicator Survey (RHoMIS) tool by FP4 and FP5, the environmental benefits of forages by FP3 and FP4, and the new work on heat stress mapping by FP2 and FP4.

At the CRP level, the key role of livestock in climate change mitigation and adaptation continued to motivate a range of collaborative and complementary activities between CCAFS and multiple Livestock CRP flagships. FP4 strengthened the collaboration with PIM focused on addressing governance and tenure in pastoralist systems. FP3 maintained its joint work with the Genebank Platform to improve use of its forage collection. A new promising collaboration with FISH is expanding the Livestock Master Plan model to include aquaculture and fisheries.

Finally, we want to pay tribute to our colleague, Michael Blummel, cluster leader for FP3 and an inspiring role model for CGIAR researchers, who died in 2020 after a short illness.

1.2.2a Progress by flagships

FP1 - Livestock Genetics: Five of 12 milestones were completed, and two policies and 17 innovations reported. Towards data [outcome 1], a mobile application for capturing dairy-cattle performance and providing feedback is in use by 140,000 East African livestock keepers (milestone 1.1.7). Towards genetic improvement strategies [2], a genomic tool for determining the breed composition of dairy-cattle was developed (1.2.4) and the selection index for the Tanzanian dairy-cattle breeding program updated (1.2.6). To deliver improved genetics [3] in emerging dairy systems, a viable and sustainable business model based on fixed-time artificial insemination technology through a mix of public-private actors was developed and tested in Kenya (1.3.4), and nine reproductive laboratories established to support dissemination of improved small ruminant genetics from breeding programs in Ethiopia and Tanzania (1.3.3). On policies, two were investments by national partners in flagship innovations, and one (joint with FP4) was on policy influence. Of the seventeen innovations reported, two are ready for next user uptake. A course correction was made with work on the production of transgenic cattle suspended due to failure in establishing pregnancies with ApoL1-modified blastocysts, despite earlier success with ApoL1-modified blastocysts in mice and blastocysts derived from unmodified cells of the same cell line in cattle.

FP2 - Livestock Health: Six of 17 milestones were completed, and 14 innovations reported. Achievements to support disease prioritization [2.1] included launch of a PPR survey toolbox supporting global eradication efforts (2.1.2) and mapping of livestock related ticks in North Africa (2.1.9). FP2 engaged in the Global Burden of Animal Disease project, with responsibility for the Ethiopian component. Herd health work [2.2] produced a guide on herd health management for dairy, pigs and small ruminants being applied in Uganda and Ethiopia (2.2.3). The “community conversations” innovation was shown to be effective in strengthening herd health practices. Research on antimicrobial resistance [2.3] translated to the roll out of three kinds of training in medically rational use of antimicrobials in priority countries (2.3.4). Vaccine highlights [2.4] were construction of 10 modified candidate attenuated ASF viruses using CRISPR/cas9 technology and describing two novel nanoparticle technologies for improving an ECF vaccine. Validation and further testing of these achievements will be done by partners as soon as the pandemic allows. To improve delivery of animal health services and products [2.5], market analyses reported in Kenya and Mali are providing information for policy makers on the role of private sector.

FP3 - Feeds and Forages: Twelve of 15 milestones were completed, and one policy and 23 innovations reported. To strengthen feed/forage prioritization capacity [3.1], the Feed Assessment Tool (FEAST) and Gendered(G)-FEAST) were applied (Vietnam/Kenya/Tanzania/[Uganda](#)), the new Tropical Forages tool launched, the Animal Feed Analysis Web Application (AFAWA) tool promoted, near-infrared spectroscopy (NIRS) equations/facilities developed, and the Sub-Saharan Africa feeds database updated. To promote use of improved forages [3.3], *Urochloa* hybrids were commercialized, and promising grass/barley hybrids shared with partners. A new forage variety (Colombia) and Napier grass varieties (Ethiopia) were released. Towards uptake of dual-purpose cultivars [3.4], maize hybrids were disseminated (India), two new barley varieties released (Turkey) and barley genotypes shared (Morocco/Lebanon). To better use feed/forage resources [3.5], a feed company applied flagship research for commercial Total Mixed Rations (small ruminants), and steam/chemical deconstruction of straws/stovers piloted (India). Regarding rangeland/pasture management [3.6], best-bet agronomic practices for cactus pear were developed/promoted (Asia/Africa). To improve uptake of feed/forage resources [3.8], forage cost-benefit

analyses were conducted (Colombia), forage business models described (Kenya/India/Malawi/Ethiopia/Middle East/northern Africa), and Quality Declared Seed guidelines drafted (Ethiopia). Extension approaches were tested (Kenya/[Tanzania](#)) and training materials developed (Haiti/Uganda/India/Kenya/Tanzania/Colombia). A Colombian Sustainable Cattle Policy with contribution from the CRP is under revision by the government.

FP4 - Livestock and the Environment: Five of seven milestones were completed, and two policies and 3 innovations reported. The flagship supported quantification of environmental footprints (milestone 4.2.2) to help decision makers consider environmental issues by continuing its work with the RHoMIS tool. This work will contribute to several manuscripts identifying pathways for sustainable livestock intensification. Steady progress was made on rolling out the Comprehensive Livestock Environmental Assessment for Improved Nutrition, a Secured Environment and Sustainable Development (CLEANED) and targeting tools with partners (4.2.1) The heat stress mapping algorithm was refined and made accessible, and in Uganda the results have fed into a [policy brief](#) (4.2.4). For Milestone 4.3, additional sustainable rangeland management practices ([grazing management](#) and [direct seeding](#)) were documented in partnership with the International Union for Conservation of Nature. To disseminate rangeland management tools (4.5), improved [governance tools](#) are available for uptake in Kenya, and being finalized in Tanzania/Ethiopia. To influence global agendas (4.6), a [study](#) was published on the feasibility of Index Based Livestock Insurance in Ethiopia, and a [paper](#) was published on the need for research on livestock and environment in lower and middle income countries.

FP5 - Livestock Livelihoods and Agri-Food Systems: The flagship completed seven of the 13 milestones planned for 2020, reporting a total of 9 innovations (one in stage 3) and five policies (one in level 2 with an associated OICR, on using nutrition education materials in the Rwandan community health workers curriculum). To guide policy [5.1] with new modelling tools [5.2], improving modelling approaches (5.1.6) and demonstrating their application (5.1.7) was achieved in the design of Livestock Master Plans initiated in Odisha and The Gambia. Based on work under two bilateral projects, progress was made on improving livestock system modelling tools but not completed (5.2.3). In the gender and social equity cluster, two gender responsive livestock health innovations were assessed, one in Ethiopia with community conversations and the other one in Kenya on vaccine delivery (5.3.5). The other milestones were extended to 2021. Development actors and government agencies in Kenya adopting tailored options for nutritional impact through livestock development (5.5.4) was met through adoption of social and behaviour change counselling cards on animal source foods consumption. On value chain related activities, improved small ruminant livestock value chain business approaches were completed for Ethiopia (5.7.4), while good progress was made on the other two milestones.

1.2.2b Relevance to COVID-19 by flagship

FP1 - Livestock Genetics: In Ethiopia, Scientists from ILRI and CIAT, in collaboration with various institutions and experts from national partners, have been supporting the Ethiopian government in its effort to contain the spread of COVID-19 in Ethiopia through [optimizing and validating pooled testing to increase efficiency](#). It was found that including four samples in one pool is optimal for fast screening that does not compromise test sensitivity. It was used in the first months where the caseload was relatively low for mass testing. It increased testing efficiency by almost 300 percent, with turnaround times reduced to 12 hours from 36 hours. Other areas of support included: [identifying hotspot areas for priority mass testing, with early work](#) clearly showing where the government should focus to contain the rapid spread of the disease; exploring different options to predict the [spread of the disease](#) as well as map the distribution of health facilities, stores, marketing centers, transport lines etc. to define [optimal route of](#)

[communication for emergency management](#); and developing ‘[web scraping and text mining](#)’ approaches to detect and manage mis and/or disinformation related to COVID-19. In Kenya, expertise from both the Livestock Genetics and Animal Health flagships contributed to Covid-19 polymerase chain reaction (PCR) testing in response to a request from the Kenyan Ministry of Health, with 23,500 tests performed to-date. See the Animal Health report for more details. In Uganda, in relation to the Flagship’s work on the pork value chain, assessments were performed on how smallholder pig keepers were affected by Covid-19, both in relation to their pig enterprise and more broadly, for example in relation to intrahousehold livelihoods and food security. Data capture is complete and analysis, synthesis and reporting underway.

FP2 - Livestock Health: Field work, including large animal experimentation, has been severely affected by COVID-19 constraints, thereby extending several milestones. Physical meetings have been replaced by virtual ones. On the positive side, COVID-19 has triggered the FP to create capacity development activities that can be available on the internet, for a wider audience. In response to the Kenyan Ministry of Health (MoH) request for support in the country’s surge capacity for COVID-19 testing, in June 2020 ILRI started to process polymerase chain reaction (PCR) tests. Funding for this effort was provided by the German Ministry for Economic Cooperation and Development (*Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung*, BMZ) and the project activity built on the availability of existing equipment, high containment laboratory space and staff expertise. A bio-secure workflow was implemented to receive, process and biobank samples with results reported back to the MoH. To date, just over 23,500 tests have been carried out using commercial PCR kits, with a turn-around time of approximately 24 hours. Staff from the FP2 Animal Health and FP1 Livestock Genetics flagships contributed to this effort. In order to reduce the cost of the testing, ILRI scientists developed and validated a kit re-constituted from individual PCR kit components. The use of these “in-house” reagents awaits approval by the MoH.

FP3 - Feeds and Forages: The flagship work was partly affected by COVID-19, requiring some of the originally planned deliverables (i.e., those involving field work, face-to-face meetings, or capacity building) to be extended to 2021. Additional outputs were developed as a result of the situation, including 2 publications on the impacts of COVID-19 on the Colombian cattle sector. This work was well received in Colombia and many other countries and promoted in several media outlets. As a result of the COVID-19 pandemic and restrictions, a 4-month weekly seminar series on sustainable cattle production, value chains and policies was also developed. While initially planned for a Colombian audience, the seminar series attracted an audience of 23,000 from 18 countries. Part of the seminar series dealt with the consequences and impacts of COVID-19 on the sector. In the bilateral ICT2Scale project, successful development of e-learning modules was a way to adjust to COVID-19, since face-to-face trainings were no longer possible. Online trainings have so far reached over 120 participants who obtained ICARDA online certificates. The modules covered topics on cactus production, supplementary irrigation, innovation platforms, project development, bee keeping, and andragogy. Five two-hour introductory workshops were organized for national extension and training staff to familiarize them with the new e-learning modules and show them how to register on the platform and navigate through the modules. Radio messaging (one-minute spots) was another way to adapt to COVID-19 to reach farmers. Following significant disruption and delays to the implementation of the Rwanda Dairy Development Project (RDDP), partnerships were re-engaged and re-ignited, resulting in the publication of six reports on FEAST.

FP4 - Livestock and the Environment: Under the RHoMIS platform, a set of households were surveyed with regard to the impact of COVID-19 on a range of activities and income. The findings will be published in 2021. The flagship also carried out an analysis on the impact of COVID-19 lockdowns on pastoralists in

Northern Kenya, and a study on how changes to livestock movement and numbers may affect greenhouse gas emissions in Northern Kenya.

FP5 - Livestock Livelihoods and Agri-Food Systems: Priority country work was much delayed due to COVID-19 restrictions - implementation could only start fully in Vietnam. When possible, online surveys were conducted and some COVID-19 questions were added, to guide project implementation on dairy and livestock in the Accelerated Value Chain Development (AVCD) project. The travel budget was underspent, although work continued using virtual tools and platforms.

1.2.3 Variance from planned program for this year

A) Have any promising research areas been significantly expanded?

FP1: The work on genomic selection based breeding programs for cross-bred dairy cattle, linked to natural sire and artificial insemination based delivery systems, in Tanzania and Ethiopia began scaling to other East African countries (Kenya, Uganda, Rwanda) based on demand from national partners, under bilateral funding. The work on heat-stress in Uganda also began expanding based on demand from stakeholders, particularly research and development organizations, largely supported by W1/2 funding.

FP3: Promoting cactus pear as a multipurpose crop to enhance the livelihoods of poor farmers was chosen as one of the 50 CGIAR innovations which will be featured in the year-long campaign in 2021. Significant cactus pear activities in different countries resulted in high demand for planting material and increased adoption by farmers.

FP5: The demand for support for implementation of the Women's Empowerment in Livestock Index (WELI) both within the CRP and outside the CGIAR is growing. The flagship started planning for the associated increase in staff time needed for this.

B) Have any research lines been dropped or significantly cut back?

FP1: Work on producing cattle transgenic for trypanoresistance was halted in 2020, due to both ongoing technical difficulties with the protocol and lack of human resource expertise (after the key scientist who was leading this work at ILRI left the Institute). As noted elsewhere, we were unable to establish pregnancies with ApoL1-modified blastocysts, despite earlier success with ApoL1-modified blastocysts in mice and blastocysts derived from unmodified cells of the same cell line in cattle. More research is now needed to understand the mechanisms responsible before repeating the experiment. This work is not expected to be reinitiated during the remainder (last year) of the CRP Livestock, but may be picked up again at some point in the future.

FP3: The activity on farmers access to market prices using mobile phone dialing a short number did not take off. The reasons for this were multiple but included the relatively high costs for each market price request (5 US cents), the weak capacity of farmers in using their phones to send requests, and the lack of understanding among farmers of the potential benefits of market price information (eg. strengthening negotiation power). Future funds will be used to develop a smart phone application with pictures, to replace the short number service.

The Vietnam priority country team cancelled a planned pilot of community based artificial insemination (AI) after establishing that existing AI capacity was too low for this to succeed, and instead redirected the funds to developing that capacity at community level.

C) Have any Flagships or specific research areas changed direction?

FP2: Given the current COVID-19 situation, the Flagship started to develop its capacity development activities in a digitalized format and make the materials available on the internet, thus reaching a wider audience. Despite the very high seroprevalence of Tunisian dromedaries for the Crimean-Congo Haemorrhagic Fever virus, the limited success achieved in detecting viral ribonucleic acid (RNA) in the dromedaries and the ticks infesting them using real-time PCR led flagship researchers to redirect their investigations towards the wild fauna that occupy the same ecological niche as the dromedary herds and may be reservoirs for the virus.

1.2.4 Altmetric and publication highlights

The total number of peer-reviewed publications in 2020 was higher than in previous years, potentially one of the few positive consequences of the COVID-19 pandemic. As per Altmetric scores, the top 20 research outputs represented research across all 5 flagships and comprised 18 peer-reviewed journal articles plus a working paper (published in both English and Spanish, thus counted as two separate outputs). Of the journal articles, 6 were from FP1 Livestock Genetics and 5 from FP4 Livestock and the Environment, with 3 each from FP3 and FP5 and 1 from FP2. The top-ranking article presenting genomic data on the origin and domestication of chicken (FP1), published in Cell Research, had an Altmetric Attention Score of 449, placing it in the top 5% of all global research outputs and the 99th percentile compared to other outputs of the same age. It was mentioned by 42 news outlets, 8 blogs, 80 twitter users, and 1 Wikipedia page and read by 71 people on Mendeley. The second article, published in Nature Genetics and with an Altmetric Attention Score of 310 (99th percentile), concerned the mosaic genome of indigenous African cattle (FP1). This paper was mentioned by 27 news outlets and 5 blogs, tweeted 101 times and read by 49 Mendeley users. The third article, published in Environmental Research Letters and with a score of 175 (98th percentile), concerned evidence-based solutions for sustainable livestock development (FP4), which was mentioned by 15 news outlets, 4 bloggers and 46 twitter users. The fourth highest article presented findings from the Rural Household Multiple Indicator Survey in 21 countries (FP4), published in Scientific Data. It had a score of 114 (97th percentile) and was mentioned by 5 news outlets, 6 bloggers and 61 tweeters. The fifth article, published in Nature Communications and with a score of 80 (96th percentile), concerned a whole genome analysis of water buffalo and global cattle breeds (FP1). The paper garnered 7 news mentions and was tweeted 31 times. The highest ranked output for the other flagships were: from FP2, an article on the legacy of the Infectious Diseases of East African Livestock (IDEAL) project, published in Preventive Veterinary Medicine (Altmetric score 26, CRP rank 19); from FP3, an article on achieving greenhouse gas emission reduction targets from livestock in Latin America (64, rank 7); and from FP5, a scoping review of feed interventions and livelihoods of small-scale livestock keepers (61, rank 8).

1.3 Cross-cutting dimensions (at CRP level)

1.3.1 Gender

A) List any important CRP research findings

Awareness of the lack of systematic gendered data in agriculture research increased in 2020. When reviewing papers on dairy genetics in Sub-Saharan Africa, FP5 found only 4 out of 45 (9%) included gender disaggregated data. Moreover, in a systematic review of how input and output value chain actors for crops and livestock benefit farmers vis-à-vis livelihood outcomes, few studies had adequate gender data .

Key research findings and outputs in 2020 included:

- A guide to integrate community conversation in extension for gender responsive animal health management (FP2);
- A report on gender analysis of needs for animal health services in Ethiopia, Kenya and Somalia (FP2);
- Gender perspectives on the adoption of the ECF vaccine in Kenya (FP2);
- A guide to integrate community conversation in extension for gender responsive animal health management (FP2);
- A study on armed conflict, post-conflict and livestock in Colombia, including gender aspects (FP3);
- The final report from a gender postdoctoral scientist was published, providing valuable information for Kenya and Ethiopia on livestock ownership structures and restrictions, fodder trait preferences, and fodder adoption decisions (FP3);
- A study showing that, contrary to what is widely believed in policy circles, women are involved in grazing management in Tunisia was accepted for the upcoming “The Joint International Grassland and International Rangeland Congress 2021” (FP4);
- Development of the Women Empowerment in Livestock Business Index (WELBI) tool to assess changes in the empowerment of women involved in livestock business (FP5).

B) What have you learned? What are you doing differently?

- FP1 found it very beneficial having a gender scientist embedded in the flagship team. Future assessments will be aimed at determining how to better benefit women in flagship activities, rather than just reaching women.
- A survey on the use of Information and Communications Technology (ICT) for agricultural development in Tunisia revealed that women have less access to technical messages sent to their mobile phones by short message service (SMS). The project therefore adjusted its ICT extension method to convey similar messages via one-minute radio spots (FP3).
- Also in Tunisia, interviews with women farmers showed that the availability of the introduced mobile seed cleaner units/mobile grinders reduced their workload, and the time gained was used for other income generating activities or studying (FP3).
- Gender work with the private dairy sector in the Latin America and Caribbean region highlighted the difficulties young female livestock producers face and how essential they are for effective scaling efforts (FP3).
- There is increased awareness of the importance of gender norms in affecting any equity outcome. In Ethiopia, community conversations using animal health as a starting point have shown to be an effective approach to transform gender norms (FP5).

C) Have any problems arisen in relation to gender issues or integrating gender into the CRP's research?

Due to understaffing, the gender team in 2020 could not meet increased demand and interest in gender issues by technical teams. The gender team was therefore expanded, including recruitment of a gender postdoctoral scientist funded by the CRP to coordinate gender research in the priority countries.

1.3.2 Youth and other aspects of social inclusion / "Leaving no-one behind"

- In the community conversations activities in Ethiopia, youth are specifically targeted (FP2).
- Seven young agripreneurs in Tunisia received CRP-funded grinders to develop their feed businesses. They were trained on technical issues like feed composition and two of them began selling their own produced feed comprising mixed ground maize, barley and faba beans (FP3).
- The CRP is working on the participation of youth and ethnic minorities in livestock activities in Vietnam (FP5).
- The Sustainable Landscape project in Nicaragua has continued a strong emphasis on the participation of women and youth, and promotion of women's entrepreneurship. Of the farmers participating in Farmer Field Schools, 52% were women.

A) List any important CRP research findings

- An in-depth analysis of the youth-centered education program for dairy producers in Colombia (partnership between CIAT and one of the largest national dairy companies, FP3) found that:
 - A quota system implemented for training events reduced barriers to women's participation;
 - Addressing key areas of disempowerment, identified in consultation with 14 female livestock keepers, enhanced women's decision making power in households and communities.
- Existing data from ILRI development projects is being used to analyze youth participation in livestock value chains (FP5).

B) What have you learned? What are you doing differently?

- For the Colombian private dairy sector, the age profile of dairy producers is one of the major concerns. This is why FP3 will support their youth-centered education program of dairy producers in 2021 with knowledge produced by this CRP.
- The Vietnam country team was forced to adjust locations, timing and modes of engagement to reach ethnic minorities.

C) Have any problems arisen in relation to youth issues or integrating youth into the CRP's research?

CRP research activities are largely reaching youth, rather than specifically targeting or benefitting them.

1.3.3 Capacity Development

The CRP reached a total of 30,930 individuals (33% women) during 2020. Of these, 23,128 people (35% women) were engaged in long-term training, the majority (23,100) through a 4-month weekly virtual seminar series on Sustainable Beef and Dairy in Colombia, and the remainder 1 intern and 27 students in formal education (of whom 6 women and 4 men completed PhDs). Participants in short-term training and other events were 7,802 (30% women).

Highlights included:

- Development of training course materials and guidelines for dairy cattle breeding in East Africa (FP1);
- Training of Ugandan herd health champions at SLU (FP2);
- Hybrid (remote/on site) training in prudent and medically rational use of antibiotics (FP2);
- Training to improve the knowledge, attitudes, and practices of women regarding hygienic milk production and handling in Ethiopia (FP2);
- Capacity building on CGIAR forage accessions for Latin American National Agricultural Research Systems (NARS) scientists (FP3);
- Two international webinars on cactus pear organized by the Food and Agriculture Organization of the United Nations (FAO)-ICARDA network (FP3);
- Virtual training on the CLEANED model for national partners in Ethiopia, Kenya, Nicaragua, Tanzania, Tunisia, Uganda and Vietnam (FP4);
- Training enumerators from the Northern Mountainous Agriculture and Forestry Science Institute (NOMAFSI) in Vietnam to use the RHoMIS and G-FEAST tools (FP4);
- Continued support to Livestock Vaccine Innovation Fund projects of the International Development Research Centre (IDRC) on utilizing the Women's Empowerment in Livestock Index (FP5);
- Training of Community Health and Environment Officers and Community Health Workers in Rwanda on the Feed the Future Innovation Lab for Livestock Systems nutrition intervention materials (FP5);
- Training Community Health Volunteers and caregivers in Samburu County in use of the app that collates nutrition information including mid upper arm circumference, reported as an innovation in this annual report (FP5).

1.3.4 Climate Change

The Livestock and the Environment flagship (FP4) focuses primarily on climate change. The work mapping the impacts of heat stress has been significant, as has the work on greenhouse gas (GHG) emissions. Under Feeds and Forages (FP3), mixed grass-legume forage diets were identified that reduce enteric methane emissions in vitro and emissions intensity in the field, and the role of secondary plant metabolites responsible for such reduction was analyzed. CIAT's involvement in the zero-deforestation value chains/platforms for beef and dairy continued in Colombia and Nicaragua, including support for the release of the "Aval GANSO", a certification for sustainably produced beef, which has been adopted by Grupo Éxito, a large Colombian supermarket chain with national coverage. The flagship provided a cost-benefit analysis for nitrogen-use-efficiency in improved forages, and the identification of new and improved varieties of forages and dual-purpose crops contributes directly to the adaptation, mitigation, and improved feed quality agendas.

2. Effectiveness and Efficiency

2.1 Management and governance

COVID-19 and preparation for closing out the CRP in 2021 were key issues facing CRP management. While successfully shifting to virtual interaction, management monitored impacts of the pandemic on research activities, especially field work, and opportunities to contribute to the response, mainly using ongoing surveys to understand household and market-level impacts. To prepare for the program's final year, a week-long CRP-wide virtual meeting was held to facilitate: taking stock of program achievements within a Theory of Change framing; ensuring key outputs are completed, reported and communicated; and making the case to position critical research for next steps post-CRP. These discussions informed planning for the 2021 Plan of Work and Budget. Cognizant of potential challenges given the One CGIAR transition and end of CRP operations in December 2021, the management committee decided to advance the final reporting cycle to fourth quarter 2021.

The Livestock CRP Review overseen by CGIAR Advisory Services was constructive and positive, noting the good-to-high quality of CRP research outputs. Several recommendations were taken on board and actioned (Table 11).

The CRP contributed to One CGIAR processes with the director 'dual-hatting' as co-steward of a Transition Advisory Group for six months.

The decision was made to acknowledge the limited role of GIZ in implementing the CRP by realigning its membership on the CRP management committee to observer status, allowing the CRP to continue benefitting from GIZ's unique development perspective.

After Nicoline de Haan's appointment to lead the GENDER Platform, Alessandra Galiè (ILRI) became gender coordinator and member of the management committee. Sadly, Michael Blummel (ILRI) passed away following a short illness; Jane Wamatu (ICARDA) has assumed his role as Cluster leader within FP3. FP5 also had two new Cluster leaders after the departures of Nicoline de Haan and Paula Dominguez-Salas, with Alessandra Galiè and Emily Ouma (ILRI) taking up their roles.

2.2 Partnerships

2.2.1. Highlights of External Partnerships

The CRP Livestock flagships worked with a number of new partners in 2020, including: the Kenyan Ministry of Agriculture, Livestock, Fisheries and Cooperatives on a review of veterinary laws to identify opportunities for private sector investment; Ceres 2030, through Cornell University, on a scoping review of feed interventions and livelihoods of small-scale livestock keepers; Corteva AgriScience and Land O Lakes on strengthening dairy production in central Kenya; Indian Council of Agricultural Research and other Indian institutes on new elite barley lines; Meru Agro Ltd on forage hybrid scaling in Kenya; iShamba on a television program for the dissemination of technical knowledge on tropical forages in Kenya; Farm.ink on dairy cattle breeding programs in East Africa; and Makere University and VetLine Services on co-ordination and implementation of the community based Artificial Insemination pilot under the Uganda priority country project. There were also multiple ongoing partnerships with National Agricultural

Research Systems organizations, universities, research institutions, private sector companies, and non-governmental organizations.

2.2.2. Cross-CGIAR Partnerships

New collaborations were established with: WorldFish, on joint modelling for livestock and fish master plans; ICRAF, on validation of NIRS instruments calibration; and PIM, on governance and land tenure in pastoral production systems. Ongoing collaborations included: with GLDC, on high throughput NIRS phenotyping for fodder quality; with the Genebank, on use of molecular technologies to describe the diversity held in CGIAR forage collections and identification of a core collection of buffel grass; and with CCAFS working across several CRP Livestock flagships on activities such as reducing greenhouse gas emissions from livestock production, small ruminant breeding in climate-smart villages in Ethiopia and Kenya, youth capacity building support for the Colombian dairy industry, and development of a policy brief on livestock feed and fodder development in Uzbekistan.

2.3. Intellectual Assets

Have any intellectual assets been strategically managed by the CRP (together with the relevant Center) this year?

N/A.

Indicate any published patents and/or plant variety right applications (or equivalent)

During 2020, the Alliance of Bioversity International-CIAT obtained the following registrations in cooperation with its private forage seed sector partner Papalotla / Grupo Nandi / Tropical Seeds:

- i) The interspecific hybrid of *Brachiaria* “CIAT Br02/1794” was registered for dissemination in Colombia, grant number “Acta 114-20-988”. The Intellectual property right over the hybrid belongs to the Alliance of Bioversity International-CIAT, while particular trademarks (in this case “Cobra®”) belong to the dissemination partner.
- ii) The interspecific hybrid of *Brachiaria* “GP 3025” was registered for dissemination in Colombia and Kenya. The Intellectual property right over the hybrid belongs to the Alliance of Bioversity International-CIAT, while particular trademarks (in this case “Camello®”) belong to the dissemination partner.
- iii) The interspecific hybrid of *Brachiaria* “GP 0423” was registered for dissemination in Colombia, grant number “Acta 114-20-988”. The Intellectual property right over the hybrid belongs to the Alliance of Bioversity International-CIAT, while particular trademarks (in this case “Cayman®”) belong to the dissemination partner.

List any critical issues or challenges encountered in the management of intellectual assets in the context of the CRP

N/A.

2.4 Monitoring, Evaluation, Impact Assessment and Learning (MELIA)

Several economic analyses were conducted for forage technologies (developed by CIAT and partners) in Colombia that show the economic potential of integrating improved forages into livestock production systems in Latin America. A literature review was conducted in East Africa to show how CGIAR forage materials are being adopted and used, focusing on the seed system and adoption evidence for Kenya and Uganda. In Tanzania and Vietnam, the ex-ante environmental impacts of livestock systems were evaluated with the CLEANED tool, and baselines were conducted to evaluate environmental footprints of small ruminant production in Ethiopia and the environmental footprint of pig systems in Uganda. These studies provide candidate indicators (e.g. greenhouse gas emissions, water use and soil health) for monitoring 'unintended consequences' in future livestock research. Two studies are ongoing of the lessons learned and outcomes from implementation of Index Based Livestock Insurance in Kenya and Ethiopia. A number of other MELIA activities planned across the flagships were delayed by COVID-19 and are also still ongoing.

2.5 Efficiency

Strong synergies were sought between FP3 Feeds and Forages, FP4 Livestock and the Environment, and CCAFS to jointly work on greenhouse gas emission assessments, youth integration and gender. This allowed optimal use of the time of the researchers involved in both CRPs and the operational funds available. In FP1 Livestock Genetics, increased investment was made in information technology (IT) solutions to reduce replicated efforts and allow a more agile detection and response to problems in implementation of large scale bilateral projects. Examples include: improved database architecture; use of cloud computing to remove the IT administration overhead; use of database driven dashboards to summarize project status; and integration of the IT systems of partners, notably National Animal Genetic Improvement Institute in Ethiopia and Green Dreams in Kenya and Ethiopia.

2.6 Management of Risks to Your CRP

Programmatic: The principal risk facing the CRP is not successfully completing activities before the CRP ends. Failure to do so would not allow results and achievements to be consolidated and the evidence base to be adequately documented, and therefore weaken the case for continuing these research lines going forward. The exceptional confluence of the pandemic and the One CGIAR transition are compounding the typical funding uncertainties and variable staffing and managerial capacities. To address this, the CRP is providing increased support for careful planning of the final year and will be increasing the intensity of monitoring progress to a monthly basis. The importance of successful completion of CRP work to ensure a smooth and successful One CGIAR transition is also stressed.

Given the priority to complete activities, the CRP decided to monitor but not act on warnings of a likely significant reduction in W2 funding from the UK government.

Contextual: COVID-19 required a number of adjustments in the timing and nature of relevant activities and meeting arrangements to minimize delays or adapt deliverables. The development of integrated interventions in Priority Countries has been most affected, with their final objectives now scaled down accordingly. To address continued travel restrictions, we are relying more on national partners and consultants on-site, but with challenges for quality assurance.

Institutional: While CIAT's merger with Bioversity was potentially disruptive to its contribution within the CRP, including demands on staff time and implications for contractual arrangements, it was carefully managed to not affect CIAT's participation within the CRP.

2.7 Use of W1-2 Funding

W1/2 funds were used to support key research activities and leverage bilateral support across all 5 flagships. For example:

- Poultry facilities and graduate students in Ethiopia (FP1);
- Project on dairy cattle phenotypes at ILRI Kapiti ranch in Kenya (FP1);
- Increased partnerships for research on virus-transmitted, zoonotic tick-borne diseases (FP2);
- Conceptual work on disease risk models, risk maps and disease impacts (FP2);
- Forage seed system analyses in the Latin America and Caribbean, South-East Asia and East African regions (FP3);
- A COVID-19 cattle sector analysis in Colombia (FP3);
- Forage hybrid breeding (*Urochloa humidicola*, *Urochloa brizantha*, *Megathyrus maximus*) and development of near infrared spectroscopy equations to estimate nutrition quality parameters of tropical forages (FP3);
- Assessment of forage grass germplasm collections for their ability to reduce greenhouse gas emissions due to their biological nitrification inhibition effect (FP4);
- Expansion of work on restoration of agrosilvopastoral production systems to a new site in Northern Tunisia (FP4);
- Support to national partners in Tunisia (Office of Livestock and Pastures, Arid Land Institute, and *Ecole Supérieure d'Agriculture*) (FP4);
- Foresight activities for better documentation of the role of livestock for economic development in Africa and Asia, based on macroeconomic statistical evidence (FP5);
- Baseline survey work in priority country projects (all flagships).

3. Financial Summary

The budget figures included in Table 13 are as per the submitted POWB 2020. Total expenditure in 2020 was \$45.8 million, of which 36% was W1/2 and 63% was W3/bilateral. W1/2 expenditure during the year was 22% lower than budgeted and W3/bilateral project expenditure was 15% lower than budgeted. No Center funds were expected to be required at the planning stage, but an actual expenditure of US\$136K was incurred by ILRI as co-financing for bilateral projects.

The major reason for underspending was the effects of the COVID-19 pandemic, which not only reduced operational expenditure (for travel and equipment) but also expenditure by partners on field activities. Implementation of the priority country projects was also hindered by the restrictions on field movements in all countries except Vietnam.

Part B. TABLES

Table 1: Evidence on Progress towards SLO targets (Sphere of interest)

SLO Target (2022)	Brief summary of new evidence of CGIAR contribution	Expected additional contribution before end of 2022	Geographical scope (with location)
SLO1: Reduce Poverty			
1.1 ADOPTION: 100 million more farm households have adopted improved varieties, breeds, trees, and/or management practices.	Updated results for 2020: CIAT's existing Urochloa hybrids were scaled on approximately 100,000 additional hectares in 2020, reaching a total of at least 1,100,000 hectares in 30 countries, with the highest areas planted being in Latin America (Argentina, Brazil, Colombia, Mexico, Venezuela), Asia (China, Laos, Malaysia, Thailand, Vietnam), and Africa (Democratic Republic of Congo, Ethiopia, Kenya, South Africa, Uganda). At the time of reporting, 2020 data has not yet been shared by the private sector partner but will be available later in 2021.	Further adoption of the Urochloa hybrids, on at least 100,000 hectares in 15 countries, is expected in 2021.	•Geographic Scope: Global.
1.2 EXIT POVERTY: 30 million people, of which 50% are women, assisted to exit poverty	No new evidence in 2020		
SLO2: Improve Food and Nutrition Security			
2.1 YIELD INCREASE: Improve the rate of yield increase for major food staples from current < 1% to 1.2-1.5% per year	No new evidence in 2020		
2.2 MINIMUM DIETARY REQUIREMENTS: 30 million more people, of which 50% are women, meeting minimum dietary energy requirements	No new evidence in 2020		
2.3 MICRONUTRIENT DEFICIENCIES: 150 million more people, of which 50% are women, without deficiencies in one or more essential micronutrients	No new evidence in 2020		

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SLO3: Improve Natural Resources and Ecosystems Services			
3.1 WATER AND NUTRIENT EFFICIENCY: 5% increase in water and nutrient efficiency in agroecosystems	N/A		
3.2 REDUCED GREENHOUSE GAS EMISSION: Reduction in 'agriculturally'-related greenhouse gas emission by 5%	No new evidence in 2020		
3.3 ECOSYSTEM RESTORED: 55 M ha degraded land area restored	No new evidence in 2020		
3.4 PREVENTION OF DEFORESTATION: 2.5 M ha forest saved from deforestation	N/A		

Table 2: Condensed list of policy contributions in this reporting year (Sphere of Influence)

Title of policy, legal instrument, investment or curriculum to which CGIAR contributed	Description of policy, legal instrument, investment or curriculum to which CGIAR contributed	Level of Maturity	Link to sub-IDOs	CGIAR cross-cutting marker score				Link to OICR (obligatory if Level of Maturity is 2 or 3) or evidence
				Gender	Youth	Capdev	Climate Change	
624 - National level policy for sustainable cattle production in Colombia	The policy has been drafted, with inputs from CGIAR scientists. It will be the first official document to define what environmentally, economically and socially sustainable cattle production means for Colombia.	Level 1	<ul style="list-style-type: none"> Adoption of CGIAR materials with enhanced genetic gains 	1 - Significant	1 - Significant	1 - Significant	1 - Significant	<p>CGIAR contributions to the technical guidelines for this policy were mainly around improved feeds and forages and management systems at primary producer level. The policy draft (confidential) was submitted to the Colombian Ministry of Agriculture in 2020 but due to COVID-19, priorities changed within the Ministry and the revision of the policy was postponed. In 2021, the Ministry will start revising the policy again and hopefully release it before the end of the year.</p> <p>https://hdl.handle.net/10568/111099</p>
625 - USAID invests USD\$30 million in scaling up of Participatory Rangeland Management (PRM) in Ethiopia	Participatory rangeland management (PRM) is an innovation developed by ILRI and partners in Ethiopia. USAID is investing USD\$30 million in scaling up PRM through its Resilience in Pastoral Areas project.	Level 2	<ul style="list-style-type: none"> More productive and equitable management of natural resources Increased access to productive assets, including natural resources Enhanced adaptive capacity to climate risks (More sustainably managed agro-ecosystems) 	0 - Not Targeted	0 - Not Targeted	0 - Not Targeted	0 - Not Targeted	<p>OICR3115</p>

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635 - Ethiopian Biodiversity Institute investment of USD 70,000 in in-situ conservation (based on utilization) following community-based breeding program guidelines	Ethiopian Biodiversity Institute has a mandate to conserve national animal genetic resources. They have invested in implementation of community-based breeding programs (CBBPs) for low input systems using the ICARDA guidelines.	Level 1	<ul style="list-style-type: none"> Increased conservation and use of genetic resources 	0 - Not Targeted	0 - Not Targeted	0 - Not Targeted	0 - Not Targeted	OICR3271
647 - Climate-induced heat stress incorporated in Ugandan government strategies supported by the Prime Minister Delivery Unit (PMDU)	The PMDU has expressed the intention to support the incorporation of heat stress issues into government policies and strategies and implementation	Level 1	<ul style="list-style-type: none"> Enabled environment for climate resilience 	0 - Not Targeted	0 - Not Targeted	1 - Significant	2 - Principal	<p>Projections of future heat stress expected under climate change were mapped across Uganda, and published in a peer-reviewed journal article (https://cgspace.cgiar.org/handle/10568/108152). Stakeholders ranked risks for men, women and youth along the pig value chain in Uganda (https://cgspace.cgiar.org/handle/10568/107882). Policy actions and messages were distilled and summarized in a policy brief (https://hdl.handle.net/10568/110342), which was shared and discussed with high-level policy and decision makers in December 2020 in Kampala (https://livestock.cgiar.org/news/climate-induced-heat-stress-pigs-will-require-joint-action-protect-and-sustain-pig-industry). The event was widely covered by media outlets (https://hdl.handle.net/10568/111299). Various stakeholders committed to follow-up actions, including the Ministry of</p>

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								Agriculture, Animal Industries and Fisheries (MAAIF), Ministry of Water and Environment (MWE), UNDP, and the World Bank. The PMDU invited the authors for a personal meeting with the Prime Minister early in 2021, expressing the intention to support the incorporation of heat stress issues into government policies and strategies and their implementation (https://hdl.handle.net/10568/111190).
662 - Inception meeting for the development of The Gambia Livestock Master Plan by the Ministry of Agriculture	The Livestock Master Plan inception process for The Gambia was launched in November 2020. ILRI leads the modelling component and sits on the technical committee (see https://www.ilri.org/livestock-master-plans for more information).	Level 1	• Conducive agricultural policy environment	0 - Not Targeted	0 - Not Targeted	0 - Not Targeted	0 - Not Targeted	https://www.ilri.org/news/%E2%80%9998lives-tock-master-plan%E2%80%9999-launched-transform-meat-milk-and-poultry-production-gambia
663 - Inception meeting for the development of the state of Odisha, India, Livestock Master Plan	The livestock master plan development process for the state of Odisha, India, was launched in October 2020. ILRI leads the modelling component and sits on the technical committee (see https://www.ilri.org/livestock-master-plans).	Level 1	• Conducive agricultural policy environment	0 - Not Targeted	0 - Not Targeted	0 - Not Targeted	0 - Not Targeted	https://www.ilri.org/news/india%E2%80%999s-odisha-state-starts-work-livestock-master-plan
664 - Concept Note design (led by the African Union Inter-African Bureau for Animal	AU-IBAR is now supporting the development of LMPs in 11 African countries, by providing technical expertise itself and funding	Level 1	• Conducive agricultural policy environment	0 - Not Targeted	0 - Not Targeted	0 - Not Targeted	0 - Not Targeted	The work started with Rwanda (follow up of the previous LMP work) and Egypt, with AU-IBAR supporting ILRI to develop concept notes in these 2 countries. There is no public link for this work at present, but email correspondence can be shared if needed,

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Resources) for next-generation Livestock Master Plans	ILRI to co-develop proposals with these countries.							
666 - Nutrition cards developed by ILRI and partners adopted by Government of Rwanda in its own community health workers curriculum	Government of Rwanda adopted nutrition cards developed by ILRI and partners (through a Feed the Future Innovations Lab for Livestock Systems research project) in its own community health workers curriculum.	Level 2	<ul style="list-style-type: none"> Increased access to diverse nutrient-rich foods 	0 - Not Targeted	0 - Not Targeted	0 - Not Targeted	0 - Not Targeted	OICR3916
668 - Engagement with Kenya Dairy Board on ex-ante impact assessment of proposed new regulations governing the national dairy sector	The ILRI contribution used a methodology adjusted from Kaitibie et al (2010). The report on data collected from milk traders will be finalized in 2021 (delayed due to COVID-19).	Level 1	<ul style="list-style-type: none"> Conducive agricultural policy environment 	0 - Not Targeted	0 - Not Targeted	0 - Not Targeted	0 - Not Targeted	ILRI staff from the Policies, Institutions and Livelihoods program, collaborating with the Animal and Human Health program, worked with the Kenya Dairy Board (KDB) on an ex-ante assessment of the planned regulations governing the dairy sector in Kenya (which include mandatory licensing of various dairy actors, new levies to be imposed and changes in the regulations concerning milk pasteurisation). The methodology followed by Kaitibie et al (2010) was adjusted for this exercise. Data collection was conducted at the level of milk traders and a report will be finalized in 2021. Interactions with the KDB were halted in 2020 due to the COVID-19 pandemic and resumed in early 2021.

Table 3: List of Outcome/ Impact Case Reports from this reporting year (Sphere of Influence)

Title of Outcome/ Impact Case Report (OICR)	Link to full OICR	Maturity level
OICR3115 - Participatory rangeland management (PRM) being piloted in Kenya and Tanzania covering 246,773 ha of pastoralists' communal grazing lands, and upscaled in Ethiopia (Updated 2020)	Link	Level 2
OICR3916 - Rwanda government adopts and integrates animal source foods consumption communication materials into the national maternal and child nutrition curriculum to improve nutrition outcomes	Link	Level 1

Table 4: Condensed list of innovations by stage for this reporting year

Title of innovation with link	Innovation Type	Stage of innovation	Geographic scope (with location)
1078 - Integrated package for sustainable restoration of silvopasture production systems in Tunisia	Production systems and Management practices	Stage 3: available/ ready for uptake (AV)	National
1097 - Toolbox for sustainable rehabilitation of rangelands in arid environments	Production systems and Management practices	Stage 2: successful piloting (PIL - end of piloting phase)	Regional: Central Asia, Northern Africa, Western Asia, Sub-Saharan Africa
1704 - Heat stress maps for pigs in Uganda	Research and Communication Methodologies and Tools	Stage 2: successful piloting (PIL - end of piloting phase)	National: Uganda
1751 - Updated Tropical Forages Selection Tool	Research and Communication Methodologies and Tools	Stage 3: available/ ready for uptake (AV)	Global
1753 - New forage variety Avena sativa AV25T, "Altoandina" to improve the efficiency of dairy farming systems in the Colombian high tropics	Genetic (varieties and breeds)	Stage 3: available/ ready for uptake (AV)	National: Colombia
1754 - Protocol for in-vitro introduction and multiplication of Urochloa	Biophysical Research	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
1755 - Digital imaging as scoring method for spittlebug tolerance in Urochloa humidicola hybrids	Biophysical Research	Stage 3: available/ ready for uptake (AV)	Global
1757 - Proximal sensing of Urochloa grasses to increase selection accuracy	Biophysical Research	Stage 2: successful piloting (PIL - end of piloting phase)	Global
1758 - Root length as proxy for high-throughput screening of waterlogging tolerance in Urochloa spp. grasses	Biophysical Research	Stage 2: successful piloting (PIL - end of piloting phase)	Global
1759 - First record of the presence of the spittlebug Aeneolamia reducta (Lallemand, 1924) (Hemiptera: Cercopidae) in Valle del Cauca (Colombia)	Production systems and Management practices	Stage 1: discovery/proof of concept (PC - end of research phase)	National: Colombia
1760 - Biological Nitrification Inhibition (BNI): Phenotyping of a core germplasm collection of the tropical forage grass Megathyrsus maximus under greenhouse conditions	Biophysical Research	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
1761 - A new genome allowing the identification of genes associated with natural variation in aluminium tolerance in Urochloa grasses	Biophysical Research	Stage 1: discovery/proof of concept (PC - end of research phase)	Global

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1762 - Population of advanced interspecific hybrids of Urochloa Br12 released to private sector partner for seed production viability study and further registration and dissemination	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
1763 - Population of advanced interspecific hybrids of Urochloa Br15 released to private sector partner for seed production viability study and further registration and dissemination	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
1764 - Population of advanced interspecific hybrids of Urochloa Bh16 released to private sector partner for seed production viability study and further registration and dissemination	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
1765 - Near infrared reflectance spectroscopy as a low-cost method for analysis of the nutritional quality of Urochloa humidicola in breeding selections	Biophysical Research	Stage 2: successful piloting (PIL - end of piloting phase)	Global
1769 - New barley variety "Ay" released by National Agricultural Research Systems (NARS) in Turkey	Genetic (varieties and breeds)	Stage 3: available/ ready for uptake (AV)	National: Turkey
1770 - 4 new dual-purpose barley elite genotypes shared with the Institut National de la Recherche Agronomique (INRA) in Morocco for validation and potential release	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	National: Morocco
1771 - 5 new elite feed barley genotypes shared with Lebanese Agricultural Research Institute (LARI) to start the variety registration process	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	National: Lebanon
1772 - 198 new elite multi-purpose barley genotypes for food, feed, forage, and malt shared with Indian Institute of Wheat and Barley Research (IIWBR) for multi-location testing	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	National: India
1773 - 321 new multi-purpose barley genotypes for food, feed, forage, and malt shared with National Agricultural Research Systems (NARS) partners and collaborators for final evaluation and potential release	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
1774 - Forage seed business development for cooperatives in Tunisia using mobile seed cleaning and treatment units	Production systems and Management practices	Stage 3: available/ ready for uptake (AV)	National: Tunisia
1775 - Use of locally available ingredients to produce small ruminant feed in pellet form in Tunisia	Production systems and Management practices	Stage 3: available/ ready for uptake (AV)	National: Tunisia
1789 - 5 new elite food-feed barley genotypes shared with India	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	National: India

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1790 - Promotion of cactus pear as a multipurpose crop to enhance the livelihood of poor farmers in dry areas of Northern Africa and Western Asia	Production systems and Management practices	Stage 3: available/ ready for uptake (AV)	Regional: Northern Africa, Western Asia
1792 - New barley variety Guldeste released by National Agricultural Research Systems (NARS) in Turkey	Genetic (varieties and breeds)	Stage 3: available/ ready for uptake (AV)	National: Turkey
1797 - New knowledge on antibiotic resistance genes in Ethiopian indigenous chickens	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	National: Ethiopia
1851 - New knowledge on major genetic switches that took place during the evolution of modern buffaloes.	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
1853 - New information on the ancestry of modern South American chicken	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Regional: South America
1854 - New knowledge on the evolutionary history of domestic chickens	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
1855 - New knowledge on the demographic history of sheep	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
1856 - Ovine single-nucleotide polymorphisms (SNPs) of the Y-chromosome male-specific region	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
1857 - New knowledge on how wild introgression shapes the adaptive genome landscape of native populations.	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
1859 - New knowledge on the origin of domestication genes in goats	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
1862 - Identification of causative mutation for the white coat phenotype in swamp buffalo.	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
1863 - New knowledge on divergent domestication traits in swamp and river buffalo	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Global

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1865 - New knowledge on how dairy cattle milk yield is affected by heat stress, in smallholder systems in East Africa.	Production systems and Management practices	Stage 1: discovery/proof of concept (PC - end of research phase)	Multi-national: Ethiopia, Tanzania, the United Republic of
1866 - Identification of the most profitable combination of breed-type and management system for smallholder dairy cattle keepers in Senegal	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	National: Senegal
1867 - Newly developed index for genomic breeding value based selection of dairy cattle in Tanzania	Genetic (varieties and breeds)	Stage 3: available/ ready for uptake (AV)	National: Tanzania, the United Republic of
1873 - Improved challenge model for contagious bovine pleuropneumonia (CBPP) using intranasal spray.	Research and Communication Methodologies and Tools	Stage 2: successful piloting (PIL - end of piloting phase)	Regional: Sub-Saharan Africa
1874 - Identification of the relationship between coat color and growth performances in Menz sheep	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	National: Ethiopia
1875 - Methodology to determine the resistance of sheep to infestation by ticks and infection by piroplasms under field conditions in Tunisia	Genetic (varieties and breeds)	Stage 2: successful piloting (PIL - end of piloting phase)	National: Tunisia
1876 - Breeding programs for goats in pastoral areas of Ethiopia	Genetic (varieties and breeds)	Stage 3: available/ ready for uptake (AV)	National: Ethiopia
1877 - List of live attenuated vaccine candidates for African Swine Fever (ASF)	Research and Communication Methodologies and Tools	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
1878 - List of candidate subunit vaccine antigens for African Swine Fever (ASF)	Research and Communication Methodologies and Tools	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
1896 - Epidemiology and Control of Peste des Petits Ruminants (ECo-PPR) Study Design and Toolbox: A suite of tools toward understanding epidemiology and socio-economic impact of peste des petits ruminants (version 2).	Production systems and Management practices	Stage 2: successful piloting (PIL - end of piloting phase)	Global
1897 - Training YouTube channel for Epidemiology and Control of Peste des Petits Ruminants (ECo-PPR) toolbox	Production systems and Management practices	Stage 2: successful piloting (PIL - end of piloting phase)	Global
1898 - Field researcher manual for peste des petits ruminants (PPR) surveys, in French and English	Production systems and Management practices	Stage 2: successful piloting (PIL - end of piloting phase)	Global
1899 - Risk maps on ticks and tick-borne diseases in sheep in Tunisia	Production systems and Management practices	Stage 2: successful piloting (PIL - end of piloting phase)	Regional: Northern Africa
1900 - Risk maps on ticks and tick-borne diseases in dromedaries in Tunisia	Production systems and Management practices	Stage 2: successful piloting (PIL - end of piloting phase)	National: Tunisia

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1901 - Training and coaching plan for Ethiopian animal health resource centre managers	Production systems and Management practices	Stage 2: successful piloting (PIL - end of piloting phase)	National: Ethiopia
1902 - Guide to integrate community conversation training approach into Ethiopian extension system for gender responsive animal health management	Production systems and Management practices	Stage 2: successful piloting (PIL - end of piloting phase)	National: Ethiopia
1903 - One Health community of practice monthly webinar series	Research and Communication Methodologies and Tools	Stage 2: successful piloting (PIL - end of piloting phase)	Global
1904 - A toolkit to guide facilitation of multi-stakeholder platforms in Ethiopia	Production systems and Management practices	Stage 2: successful piloting (PIL - end of piloting phase)	National: Ethiopia
1906 - A practical guide to herd health management in pigs, dairy and small ruminants	Production systems and Management practices	Stage 3: available/ ready for uptake (AV)	Global
1907 - Improved sporozoite neutralization assay for East Coast fever	Biophysical Research	Stage 1: discovery/proof of concept (PC - end of research phase)	Regional: Eastern Africa
1946 - Mainstreaming of participatory systems modeling	Social Science	Stage 2: successful piloting (PIL - end of piloting phase)	Global
1955 - Gender at scale (feminization of agriculture project and Livestock Master Plans)	Social Science	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
1956 - Using community conversations on animal health as a Gender Transformative Approach	Social Science	Stage 3: available/ ready for uptake (AV)	Global
1957 - Women's Empowerment in Livestock Business Index (WELBI) tool	Social Science	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
1958 - A mobile app for recording children's food consumption and Mid-Upper Arm Circumference data in Kenya	Social Science	Stage 2: successful piloting (PIL - end of piloting phase)	National: Kenya
1959 - Process to better involve men in social and behavioural change communication, Rwanda	Social Science	Stage 1: discovery/proof of concept (PC - end of research phase)	National: Rwanda
1970 - Livestock productivity module for the Rural Household Multi-Indicator Survey (RHoMIS)	Research and Communication Methodologies and Tools	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
1971 - COVID-19 module for the Rural Household Multi-Indicator Survey (RHoMIS)	Research and Communication Methodologies and Tools	Stage 2: successful piloting (PIL - end of piloting phase)	Global

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1972 - Pig Smart integrated extension system (combining genetics, health, feed and environmental components) for the pig value chain in Uganda	Research and Communication Methodologies and Tools	Stage 1: discovery/proof of concept (PC - end of research phase)	National: Uganda
1976 - Across-country genetic evaluation of dairy cattle in Sub-Saharan Africa	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Regional: Sub-Saharan Africa

Table 5: Summary of status of Planned Outcomes and Milestones (Sphere of Influence-Control)

FP	FP Outcomes 2022	Sub-IDOs	Summary narrative on progress against each FP outcome this year.	Milestone	2020 milestones status	Brief Explanation	Link to evidence
F1	F1 Outcome: Outcome 1.1: Data on livestock diversity and systems, including from a gendered lens, used to develop or refine genetic improvement and / or conservation strategies by policymakers, national research and development partners, and the private sector, in 5 CRP priority countries and other locations.	<ul style="list-style-type: none"> Increased conservation and use of genetic resources Closed yield gaps through improved agronomic and animal husbandry practices 	A mobile application to capture dairy cattle performance, and provide feedback, was developed and is in use by more than 140,000 farmers in Ethiopia, Kenya and Tanzania (milestone 1.1.7). Baseline genome characterization data for sheep and goats in Ethiopia (milestone 1.1.6) was collected but analysis and writing up are ongoing, so this milestone was extended. The evidence for identification of genomic regions strongly associated with tolerance to <i>Theileria parva</i> infection in cattle was delayed due to issues with the patenting process, so this milestone (1.1.8) was also extended to 2021.	2020 extended to 2021 - 1.1.6 Baseline genome characterization information of existing small ruminants populations including genome sequencing available for Ethiopia, Sudan, Tanzania	Extended	The genome data will be used to investigate genetic diversity, structure and relationships, and signatures of selection associated with traits of economic and adaptive significance. Such information can be used to formulate appropriate breeding and conservation strategies. In Ethiopia, the data has been generated for sheep (analysis completed and manuscript drafted, for publication in 2021) and for goats (analysis is ongoing by a PhD student, but was not completed due to a delay in sequencing the samples and political conflict in Tigray where the student was based). It is unlikely that a publication will be available for goats before the end of the CRP in December 2021. For Sudan, the data was generated but is owned by a national partner and not available to the Flagship	-

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						until it is published. For Tanzania, sampling was not possible in 2020 due to the COVID-19 pandemic. Given this, we have changed the milestone from Ethiopia, Tanzania and Sudan to Ethiopia only and extended it to 2021.	
				2020 - 1.1.7 Farmer friendly mobile application for dairy cattle performance data capture and feedback developed and in use in Ethiopia and Tanzania by a minimum of 2000 farmers in each country.	Complete	Completion of a mobile application to capture dairy cattle performance and provide feedback to farmers, which is being used by 140,000 farmers across Ethiopia, Kenya and Tanzania.	https://hdl.handle.net/10568/98250 https://hdl.handle.net/10568/108942 https://www.adgg.ilri.org/uat/auth/auth/login https://portal.adgg.ilri.org/
				2020 extended to 2021 - 1.1.8 Identification of genomic regions strongly associated with tolerance to Theileria para infection in cattle	Extended	The genomic regions have been identified, but the deliverables - a journal article and patent application - have been delayed due to procedural issues with the patenting process. This is expected to be resolved in the first half of 2021.	-
	F1 Outcome: Outcome 1.2 Genetic improvement strategies for improved	• Closed yield gaps through improved agronomic and	Updated breeding objectives and selection indexes have been developed	2020 - 1.2.4 Availability of zebu x taurine admixture	Complete	Despite significant efforts, a genotyping company willing to commercialize this assay	https://cgspace.cgiar.org/handle/10568/89717

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	livestock genetics implemented by national research and development partners, and the private sector in 6 CRP priority countries and other locations.	animal husbandry practices <ul style="list-style-type: none"> • Increased livelihood opportunities • Increased conservation and use of genetic resources 	for the dairy cattle breeding program in East Africa, which will be used by the breeding program moving forward (milestone 1.2.6). Successful establishment of breeding programs has been achieved for pastoral production systems (milestone 1.2.5, ongoing). The milestone of availing a zebu x taurine admixture single-nucleotide polymorphism (SNP) chip for determining the underlying breed composition of cross-bred dairy cattle is complete (milestone 1.2.4), despite not being able to find a company interested in commercializing this tool as was originally intended (this will be revisited in the future).	SNPs chips for screening of dairy cattle crossbreed in Ethiopia and Tanzania by August 2018.		has not been found. The results of the assay are however published, and stakeholders will be able to use this information to utilize the assay should they wish to do so.	
				2020 extended to 2021 - 1.2.5 Breeding strategies for pastoral production systems established in Ethiopia and Sudan	Extended	The paper on framework for community-based breeding programs in pastoral regions has been submitted and is being reviewed. We expect this to be published in 2021.	-
				2020 - 1.2.6 Breeding objectives defined	Complete	The breeding objective and associated selection index	https://africadgg.files.wordpress.com/2020/0

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				for smallholders dairy production systems in Eastern Africa and used to select future breeding values by the private sectors and governmental breeding companies.		has been developed and stakeholders trained on its use.	8/adgg-tzn-index-2020.pdf https://portal.adgg.ilri.org/sites/default/files/ADGG-training-PRA-dodoma-202012.pdf
				2020 extended to 2021 - 1.2.7 National genetic improvement strategy for pigs in Uganda endorsed by stakeholders	Extended	Extended due to inability to obtain stakeholder input in 2020 resulting from Covid-19 related issues, including travel restrictions. The ministry has requested ILRI to convene a joint stakeholder workshop in 2021 where this can be addressed.	-
	F1 Outcome: Outcome 1.3 Business models for multiplication and delivery of improved livestock genetics, to resource poor women and men livestock keepers, implemented by national research and development partners, and the private sector in five CRP priority countries and other locations.	<ul style="list-style-type: none"> Technologies that reduce women's labor and energy expenditure adopted Adoption of CGIAR materials with enhanced genetic gains Increased livelihood opportunities 	Through a public-private initiative, business models for fixed-time (synchronized) artificial insemination for enhanced delivery of improved dairy cattle genetics to farmers in emerging dairy regions of Kenya and Tanzania were developed and implemented (milestone 1.3.4). A network of reproductive technology labs, run by National Agricultural Research Organizations	2020 - 1.3.3 A network of reproductive technology labs to improve fertility and the delivery of improved genetics established for sheep in Ethiopia (9 laboratories) and goat in Tanzania (2 laboratories).	Complete	7 reproductive platforms have been established in Ethiopia and 2 in Tanzania (as previously reported). Additional reproductive platforms were planned in Ethiopia in 2020, but this was delayed due to the Covid-19 pandemic and it is unclear whether this will be possible in 2021. We thus propose to change the milestone to "A network of reproductive	https://repo.mel.cgiar.org/handle/20.500.11766/10835

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			(linked to small ruminant (SR) community-based breeding programs run by co-operatives), were established to improve delivery of improved SR genetics to SR keepers in Ethiopia and Tanzania (milestone 1.3.3). Due to ongoing technical difficulties, ILRI has not been successful in producing a transgenic trypanoresistant calf and the related milestone (1.3.6) has been cancelled.			technology labs to improve fertility and the delivery of improved genetics established for sheep in Ethiopia (7 laboratories) and goat in Tanzania (2 laboratories)". This milestone is thus changed and complete.	
				2020 - 1.3.4 Business models for delivery of improved genetics relevant to Ethiopia, Tanzania, and Kenya established by October 2019 and tested in Kenya	Complete	The models for fixed-time and conventional artificial insemination technologies have been designed and successfully piloted in Kenya.	https://cgspace.cgiar.org/handle/10568/111149
				2020 extended to 2021 - 1.3.5 First indigenous ecotype recovered from cryopreserved PGC	Extended	The project activities were delayed due to the unreliability of external egg suppliers, enhanced by COVID-19 restrictions. To overcome this, the project established its own chicken flock, which extended the delay. The deliverable is now expected to be produced in 2021.	-

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				2020 - 1.3.6 First transgenic trypanoresistant calf born at ILRI facility	Cancelled	This deliverable has encountered unexpected technical difficulties compounded by the departure of the lead scientist. Work on this is suspended pending new funding and staff.	-
	F1 Outcome: Outcome 1.4 Women and men resource poor livestock keepers sustainably utilizing improved livestock genetics, both productive and adapted, in 3 priority countries and other locations.	<ul style="list-style-type: none"> • Increased livelihood opportunities • Adoption of CGIAR materials with enhanced genetic gains • Technologies that reduce women's labor and energy expenditure adopted 	Scaling of the Community-based breeding program in Ethiopia was initiated and will continue in 2021 (milestone 1.4.2, ongoing). This is a follow up of the piloting that has been completed, with the focus being dissemination of improved (for both productive and adaptive attributes) sires from established CBBPs through both natural mating and artificial insemination to the base population.	2020 extended to 2021 - 1.4.2 Community-based breeding program upscaled in four regions of Ethiopia (Amhara, Oromia, South and Tigray) with more than 10,000 households participating	Extended	This upscaling was initiated in 2020 but progressed slower than expected due to the COVID-19 pandemic restricting access to the field, and conflict in the Tigray region. Due to this delay and uncertainties around whether this can be achieved in 2021, we propose to change this milestone to "Community-based breeding program upscaled in three regions of Ethiopia (Amhara, Oromia, and South) with more than 3,000 households participating". This milestone is thus changed and extended.	-
F2	F2 Outcome: Outcome 2.1 Assessment tools for significance of animal diseases and risk maps for emergence of animal	<ul style="list-style-type: none"> • Reduced livestock and fish disease risks associated with 	Additional evidence has been generated on the importance of endemic diseases, to contribute to changing the discourse on animal health	2020 - 2.1.2 The findings from the use of assessment tools for significance of animal diseases and	Complete	The peste des petits ruminants (PPR) tools have been used by 70 national level researchers, papers on models accessed (check	https://www.youtube.com/channel/UC5VTqbJDapg7bnPSfiZT1rw?view_as=subscriber https://hdl.handle.net/

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	diseases are used by 100 local and national and 50 international research partners and donors to prioritise research and development interventions to reduce livestock disease risks for livestock keepers.	intensification and climate change	priorities. The peste des petits ruminants (PPR) assessment tool has been launched and used by a wide group of stakeholders outside the CGIAR. Other important achievements are: the mapping of sheep and dromedary ticks in Northern Africa including characterization of the dynamics and phylogeny; and identification of knowledge and information gaps about respiratory diseases of swine in Africa as well as economic impacts of the various pathogens. All these are helping policymakers to make better prioritize animal health activities.	risk maps for emergence of animal diseases are used by 75 national and 25 international research partners and major donors, in both priority countries and other locations, to prioritise research and development interventions		altmetrics), endemic/production diseases taken up as an important issue in the ILRI 2025 research agenda, and data generated used in the Global Burden of Animal disease project (University of Liverpool). The original milestone was overly ambitious, particularly given the disruption caused by the COVID-19 pandemic. The milestone target was therefore revised to 15 national and 8 international research partners and major donors, which has been achieved.	10568/109077 https://hdl.handle.net/10568/109075 https://hdl.handle.net/10568/106625
				2020 extended to 2021 - 2.1.7 Epidemiological data on Bluetongue Virus (BTV) prevalence from various areas in Kenya provided by ILRI Scientist to the scientific community and public services	Extended	Due to COVID-19 there was limited access to the lab.	n/a
				2020 extended to 2021 - 2.1.8	Extended	Extended due to delays related to COVID-19. Data	n/a

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				Harmonised data collection for gender sensitive modelling for peste des petits ruminants (PPR) control in high risk transboundary areas implemented in Kenya, Uganda, Tanzania, Ethiopia, Senegal, Mali and Burkina Faso		collection had started in most sites, but was delayed by approximately 8 months.	
				2020 - 2.1.9 Tick distribution in North and East Africa mapped	Complete	We have successfully characterized the dynamics of ticks in sheep and dromedaries, their phylogeny and also the main tick-transmitted diseases in these 2 important livestock species in drylands.	https://repo.mel.cgiar.org/handle/20.500.11766/12505 https://repo.mel.cgiar.org/handle/20.500.11766/12299 https://repo.mel.cgiar.org/handle/20.500.11766/12411 https://repo.mel.cgiar.org/handle/20.500.11766/10838 https://repo.mel.cgiar.org/handle/20.500.11766/12319 https://pubmed.ncbi.nlm.nih.gov/32854747/
	F2 Outcome: Outcome 2.2 Context specific herd health management packages adopted by farmers, extension and	• Closed yield gaps through improved agronomic and animal husbandry practices	Experiences on integrating interventions has been made in different production systems (pigs in Uganda, all species in Vietnam, small	2020 - Tool to determine herd health packages for the pig value chain in	Complete	A herd health management framework has been developed and published by the flagship and is being rolled out in Ethiopia in	https://cgspace.cgiar.org/handle/10568/110502 https://cgspace.cgiar.org/handle/10568/11042

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	animal health workers in priority countries and other locations.		ruminants and dairy in Ethiopia). The flagship has launched a freely available guide to herd health management for dairy, pigs and small ruminants and developed a digital tool (mobile app) to monitor productivity parameters in livestock.	Uganda developed by the end of 2018.		dairy and small ruminants and in pigs in Uganda.	6 https://hdl.handle.net/10568/108309
				2020 - 2.2.3 Critical short-comings in pig herd health in Uganda identified by Flagship researchers	Complete	The primaryshortcomingsidentified are: reproductive management, parasite control and feed quality as presented in this thesis.	https://pub.epsilon.slu.se/17468/
				2020 extended to 2021 - 2.2.5 Herd health services in pigs used and evaluated in Uganda	Extended	Travel to Uganda was not possible due to COVID-19, resulting in delays.	n/a
				2020 - Integrated herd health interventions in small ruminants in Ethiopia implemented	Complete	Vaccination and deworming at community level, combined with capacity development through community conversations, is being implemented. (Monitoring is ongoing, some evidence has been published in early community conversation modules).	https://hdl.handle.net/10568/110498 https://hdl.handle.net/10568/110213 https://hdl.handle.net/10568/110398 https://cgspace.cgiar.org/handle/10568/107144 4 https://hdl.handle.net/10568/109885

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	<p>F2 Outcome: Outcome 2.3 Livestock keepers have necessary knowledge of anti-microbial resistance (AMR) and anti-parasitic resistance (APR) to change their practices accordingly, piloted in two priority countries (Uganda and Vietnam).</p>	<ul style="list-style-type: none"> • Reduced biological and chemical hazards in the food system • Closed yield gaps through improved agronomic and animal husbandry practices 	<p>Three different kinds of trainings on using antimicrobials in a responsible and prudent way have now been successfully established and rolled out in priority countries. The emphasis now is on making this Capacity Development material available to a larger audience. The AMUSE tool to assess antimicrobial use was used in Uganda, Vietnam, Ethiopia, Burkina Faso, Benin, and Kenya, with more stakeholders expressing interest. The long-term impact of trainings in Ethiopia on prudent use of antimicrobials will be assessed in 2021.</p>	<p>2020 - 2.3.2 Policymakers in at least two priority countries engage in discussion on AMR monitoring-based on the research outputs</p>	<p>Cancelled</p>	<p>This milestone was cancelled, since during the course of the CRP it has become evident that we do not have a comparative advantage in this area.</p>	<p>n/a</p>
				<p>2020 - 2.3.4 Potential areas identified for interventions for improvement of the use of antibiotics in three CRP countries</p>	<p>Complete</p>	<p>In Uganda a first round of trainings (hybrid virtual and on-site) was completed, with two more scheduled in 2021. Training material has been made available online. In Vietnam one round of training with 20 vets and 110 farmers on antibiotic use took place. In Ethiopia trainings were provided through community conversations, which will continue in other CRP sites in 2021 through the priority</p>	<p>Report at SLU Global https://hdl.handle.net/10568/111658 https://cgspace.cgiar.org/handle/10568/107957 https://hdl.handle.net/10568/107007</p>

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						country program. This will enable us to monitor changes in attitudes and practices.	
	F2 Outcome: Outcome 2.4 National and international research partners, government agencies and the private sector use 2 novel diagnostic assays and vaccines for control of ASF, CBPP, CCPP, ECF and PPR in at least 6 countries.	<ul style="list-style-type: none"> Closed yield gaps through improved agronomic and animal husbandry practices 	There has been considerable progress in the laboratories regarding development of vaccines for African swine fever (ASF) as well as East Coast fever (ECF). However, the planned validation and further testing of this progress by partners or in the field was halted due to COVID-19 pandemic restrictions.	2020 extended to 2021 - 2.4.3 Research partners use novel assays and point-of-care diagnostics in priority countries	Extended	Work with partners was put on hold due to COVID-19, but a presentation on literature review of rapid nucleic acid based diagnostic technologies was produced.	https://hdl.handle.net/10568/111289
				2020 extended to 2021 - Agreements with at least 2 private partners to commercialise improved diagnostic tests for CBPP in Kenya, Uganda, Ethiopia, Tanzania and Mali by the end of 2018.	Extended	The commercial company IDvet has taken up the contagious bovine pleuropneumonia (CBPP) elisa diagnostic developed by ILRI and partners. A prototype kit has been developed by IDvet but have yet to decide on commercialization of this test. A market-needs analysis for the lateral flow	n/a

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						CBPP test is ongoing under the bilateral Transformation of Animal Health Services and Solution in Low to Middle Income Countries (TAHSSL) project, for which data has been generated but not yet fully analyzed.	
				2020 extended to 2021 - Production of recombinant viral vectors expressing 8 African swine fever virus (ASFV) antigens for testing in pigs	Extended	Eleven viral genes have been prioritized for testing as subunit vaccines using AdHu5 and MVA as vaccination vehicles. Five AdHu5 constructs have been made. This is an outsourced activity to the Jenner Institute and has been delayed because of COVID-19.	Lab books, Donor reports
				2020 extended to 2021 - 2.4.11 Several African swine fever virus (ASFV) vaccine candidates produced, with 30 tested for attenuation in pigs and at least 2 tested in protection experiments	Extended	Ten modified candidate attenuated viruses were constructed using CRISPR/cas9 technology. This is a gene editing technology by which genes can be deleted to obtain attenuation. An attenuated vaccine consists of live, whole bacterial cells or viral particles which have been treated to reduced their virulence so they can be used safely to provoke an immune response. Testing	n/a

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						of these vaccine candidates in pigs was delayed in 2020 because of COVID-19.	
				2020 extended to 2021 - Improved in-vitro assays systems to measure correlates for East Coast fever (ECF)	Extended	A qPCR test using the Theileria parva p104 gene has been validated. Sporozoites and host cells for infections have been stockpiled and antibodies to test in the neutralization assay have been purified. Validation of this test was delayed because of COVID-19.	n/a
	F2 Outcome: Outcome 2.5 Improved access to livestock-related health services and products for female and male livestock keepers in the 4 priority countries (Ethiopia, Tanzania, Uganda and Vietnam)	<ul style="list-style-type: none"> • Closed yield gaps through improved agronomic and animal husbandry practices • Technologies that reduce women's labor and energy expenditure adopted 	Market analyses and analyses of the role of the private sector in delivery of animal health services in general, and vaccines in particular, has provided crucial information to policy makers in some priority countries. In other countries, these analyses have been delayed due to COVID-19 but are ongoing.	2020 extended to 2021 - 2.5.3 Government, development and private sector actors? use tested sustainable delivery models to provide products and services to livestock keepers in 4 priority countries	Extended	Evaluation of developed models delayed because of COVID-19. An article was published on the role of gender in adoption of the infection and treatment method in the control of East Coast fever in Kenya and a gender context analysis conducted for the One Health for Humans, Environment, Animals and Livelihoods (HEAL) project.	https://cgspace.cgiar.org/handle/10568/110090 https://hdl.handle.net/10568/111329
				2020 extended to 2021 - Market for diagnostics in Kenya, Uganda, Tanzania, Ethiopia and Mali assessed and cost	Extended	An analysis of the role of the private sector for delivering vaccines in Kenya has been concluded as has a study of willingness to vaccinate and pay in Mali. In	https://www.ilri.org/news/private-sector-can-deliver-veterinary-vaccines-kenya-1 https://hdl.handle.net/10568/106167

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				effectiveness of producing thermostable PPR vaccine analysed by July 2018.		other countries, these analyses have been delayed due to COVID-19.	
F3	<p>F3 Outcome: Outcome 3.1 - Local, national and international research and development partners, the private sector, decision-makers and livestock producers are able to diagnose feed constraints and opportunities and to effectively prioritize and target feed and forage interventions, resulting in: a 10% improvement in utilization of feeds and forages, a 20% increase in animal production using improved feed and forage technologies, a 10% accuracy increase for biomass and quality estimation and at least 250,000 annual visitors to global databases, repositories, interactive tools and maps and the Tropical Grasslands/Forrajes Tropicales journal website.</p>	<ul style="list-style-type: none"> • Closed yield gaps through improved agronomic and animal husbandry practices • Technologies that reduce women's labor and energy expenditure adopted 	<p>The access to our databases has increased since the Animal Feed Analysis Web Application (AFAWA) and Tropical Forages v2 were released. Feed constraints were analyzed in several countries in Africa and Asia by using the (gendered) Feed Assessment Tool ((G-)FEAST). We pilot tested the animal diet balancing tool (OFA) in India and placed it in the Google Playstore - now we will extend its use to other countries. We updated the Sub-Saharan Africa feeds database 'SSA Feeds' which now contains the nutritive values of over 44,000 samples of some feeds commonly used in the region.</p>	<p>2020 - The ICARDA Animal Feed Analysis Web Application (AFAWA) has reached at least 5,000 users by the end of 2018.</p>	Cancelled	<p>The Animal Feed Analysis Web Application (AFAWA) has progressively incorporated new functionalities to enhance user friendliness. Portfolio for the AFAWA web application system is undergoing development to enable handling of laboratory analysis requests. Codes have been developed and configured to enhance security and cope with vulnerabilities. Meanwhile integration with MEL is ongoing; Total visitors are now at 20,456.</p>	https://afawa.icarda.org/

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				2020 - 3.1.12 Access of research partners to CRP generated knowledge on forages increased through 3 issues of the Tropical Grasslands journal (January, May, September) and 1 released and updated tool (SoFT)	Complete	The online journal Tropical Grasslands-Forrajes Tropicales published 3 issues in 2020. The new version and mobile app of the Tropical Forages Selection Tool were launched in 2020, contributing to increased user numbers.	https://hdl.handle.net/10568/111104 www.tropicalgrasslands.info https://hdl.handle.net/10568/111102 www.tropicalforages.info
				2020 - 3.1.13 Feed Assessment Tool (FEAST) and Gendered Feed Assessment Tool (G-FEAST) are applied by non-CGIAR researchers in at least 1 priority country (Vietnam) and 2 other countries (Burkina Faso and Rwanda)	Complete	We made legacy Feed Assessment Tool (FEAST) data from 14 countries publicly available as visualizations or for data download. Our project partner in 'Nourishing Prosperity Alliance', Land O'Lakes Venture37, is now routinely using FEAST assessments to guide its work in Kenya and Tanzania and will make reports available to us for publishing on CGSpace in 2021. We have finalized FEAST data collection and developed intervention plans for Vietnam.	https://livestockdata.org/data-object/what-livestock-eat-low-and-middle-income-countries https://cgspace.cgiar.org/handle/10568/111524
				2020 - 3.1.14 2 Updated Selection of	Complete	The Tropical Forages Tool was consulted by on	https://hdl.handle.net/10568/111102

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				Forages for the Tropics (SoFT) and AFAWA tools being used by at least 100,000 users globally		average 120,000 users every month. As reported, total visitors to the Animal Feed Analysis Web Application (AFAWA) are now 20,456. We pilot tested the animal diet balancing tool (OFA) in India and made it available on Google Playstore, with plans underway to adapt it in Rwanda. We updated the Sub-Saharan Africa feeds database 'SSA Feeds', which now contains the nutritive values of over 44,000 samples of some feeds commonly used in the region. The values presented will help support the design of scientifically based, best-cost rations for African livestock nutrition.	www.tropicalforages.info https://afawa.icarda.org/ https://play.google.com/store/apps/details?id=org.ilri.ilrifedadvisor https://feedsdatabase.ilri.org/
F3 Outcome: Outcome 3.3 - National and international research and development partners and the private sector are using CRP developed forage and rangeland resources (with enhanced traits), in 30 countries and reaching producers who plant over 2 million ha, to increase the rate of genetic gain and exploit	<ul style="list-style-type: none">• Closed yield gaps through improved agronomic and animal husbandry practices• Technologies that reduce women`s labor and energy expenditure adopted	CIAT`s existing Urochloa hybrids were scaled on approximately 100,000 additional hectares in 15 countries in 2020. The total area sown with CIAT hybrids is estimated to be 1,100,000 hectares in 30 countries in 2020. A	2020 - 3.3.10 Already available forage hybrids scaled with private sector partner in at least 15 countries on 100,000 additional hectares (calculated based on seed sales). Total area of hybrids scaled will have reached 1,100,000 hectares	Complete	CIAT`s existing Urochloa hybrids were scaled on approximately 100,000 additional hectares in 15 countries in 2020. The total area sown with CIAT hybrids is estimated to be 1,100,000 hectares in 30 countries in 2020. We will get the evidence data from our commercial partner by mid-2021. New promising hybrids were sent to our	2019 data on Urochloa hybrids - https://www.slideshare.net/secret/ppHBN2tPBReATb https://hdl.handle.net/10568/111238 https://hdl.handle.net/10568/111315 https://hdl.handle.net/10568/109013	

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	the genetic diversity of forages and rangeland species to enhance stress-tolerance, biomass productivity and nutritive value.		new barley variety was released in Turkey. A pipeline of new promising hybrids exists for both grasses and barley - many of which have been sent to public or private sector partners for further trials and release.			private sector forage seed partner for further trials and release. Over the last four years (2016-19), 14 ILRI accessions have been released and registered by the Ministry of Agriculture in Ethiopia.	
				2020 - 3.3.11 10 Barley genotypes with higher biomass, higher grain yield, better tolerance to biotic and abiotic stresses validated by NARS partners in field stations in Morocco and Ethiopia.	Complete	Four New dual-purpose barley elite genotypes shared with Institut National de la Recherche Agronomique (INRA) Morocco for validation and potential release. Five new elite food-feed barley genotypes were shared with Lebanese Agricultural Research Institute (LARI) to start the variety registration process in Lebanon. Five new elite food-feed barley genotypes shared with India. One new barley variety "Ay", originating from ICARDA germplasm, released in Turkey by NARS. 321 New elite barley genotypes were shared with NARS in Morocco for testing. Ethiopia will receive a special set in 2021.	https://repo.mel.cgiar.org/handle/20.500.11766/12595 https://dx.doi.org/20.500.11766/12560 https://dx.doi.org/20.500.11766/12561 https://dx.doi.org/20.500.11766/12562 https://repo.mel.cgiar.org/handle/20.500.11766/12630

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	<p>F3 Outcome: Outcome 3.4 - New forage and crop cultivars, superior to local (based on food, feed and fodder traits weighted according to target domains), made available by development partners, government agencies and the private sector and applied by farmers in 7 priority counties and other locations.</p>		<p>We made strong advances with new materials, i.e. through the release of a new barley variety "Guldeste" in Turkey and the use of the sorghum variety "CoFS-29" in India. 321 new multi-purpose barley genotypes were shared with NARS and collaborators in 23 countries for final evaluation/potential release, which makes us confident of reaching higher user numbers soon. Two dual-purpose maize hybrids bred under CIMMYT-ILRI collaboration now occupy more than 100,000 hectares in India.</p>	<p>2020 extended to 2021 - 3.4.1 Identified dual-purpose crops (food and feed) applied by 100,000 farmers in at least one country.</p>	Complete	<p>A new forage sorghum variety (CoFS-29) has been diffused to over 600 farmers in India in the initial location and has spread to several other villages, though estimates of numbers are not available. There is an increasing demand for the seed of CoFS-29, which is now met by promoting farmers as seed entrepreneurs. Two dual-purpose maize hybrids bred under CIMMYT-ILRI collaboration occupy now much more than 100,000 hectares (estimated by seed production/sales data) in India. 198 new elite multi-purpose (Food, Feed, Forage and Malt) barley genotypes were selected and shared with IIWBR-Karnal for multi-location testing across India. 321 new multi-purpose (Food, Feed, Forage and Malt) barley genotypes were shared with NARS and collaborators in 23 countries for final evaluation/potential release.</p>	<p>https://doi.org/10.1016/j.cpb.2020.100191 https://dx.doi.org/20.500.11766/12562 https://dx.doi.org/20.500.11766/12561</p>

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				2020 extended to 2021 - 3.4.5 Identified dual-purpose crops (food and feed), superior to local feeds made available by development partners, government agencies and the private sector and applied by 150,000 farmers in at least one country and at least one new additional dual purpose cultivar will be released and 3 new promising cultivars tested in 3 new countries	Complete	ILRI contribution: uptake of multi-cut sorghum (CoFS-29) by a 24,000 strong women's dairy cooperative in Mulukanoor, India. ICARDA contribution: A new food and fodder barley variety was released in Turkey (Guldeste) in 2020. Testing was done in 2020 by collaborators in 23 countries by sharing 26 new elite food and fodder barley genotypes. In Ethiopia, more than 460,000 households have adopted new ICARDA barley varieties.	https://www.ilri.org/news/annual-report/making-milk-in-24-hours https://www.forbes.com/sites/andrewwright/2020/08/02/how-are-indian-women-using-milk-and-tech-for-better-lives/?sh=c20cb9c45f02 https://repo.mel.cgiar.org/handle/20.500.11766/12630 https://cas.cgiar.org/sites/default/files/images/Publications/Ethiopia%20Strategic%20Review%20SPIA%202020.pdf
F3 Outcome: Outcome 3.5 - National and international development partners, government agencies and extension services, the private sector and community-based organisations in 3 priority countries are using CRP-related research outputs for better utilization of existing and novel feed and forage resources. This	<ul style="list-style-type: none">• Closed yield gaps through improved agronomic and animal husbandry practices• Technologies that reduce women's labor and energy expenditure adopted• More efficient use of inputs	We made strong advances in India by piloting the deconstruction of straws/stovers using steam and chemical treatment methods in association with the Indian Institute of Chemical Technology. Total Mixed Rations for small ruminants were used by	2020 extended to 2021 - 3.5.6 Training and feed certification system piloted and monitored in Uganda and one least cost diet designed and tested including aflatoxin binder inhibition effects with private sector and regulatory organs in Ethiopia	Extended	Arrangements are in process to ensure activity is completed after untimely death of PI.	n/a	

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	will be through (a) scalable processing technologies, (b) management strategies to conserve and rehabilitate rangelands and (c) diet formulation that increases productivity while reducing overall feed and forage costs and environment impacts.		a private feed company. Our work on training and feed certification systems in Uganda as well as least cost diets in Ethiopia had to be cancelled due to the untimely passing of the ILRI Principal Investigator.				
				2020 - 3.5.7 Commercial least cost diet for intensified small ruminant fattening in India developed and branded and one pilot treatment unit/plant established in India	Complete	Our results were used by a private feed company to formulate commercial Total Mixed Rations (TMR) for small ruminants. Piloted the deconstruction of straws/stovers using steam and chemical treatment methods in association with the Indian Institute of Chemical Technology.	https://hdl.handle.net/10568/106657 https://hdl.handle.net/10568/111121 https://hdl.handle.net/10568/106826
	F3 Outcome: Outcome 3.6 - Livestock producers in 3 priority countries: apply management strategies to conserve and rehabilitate rangelands and pastures while ensuring ongoing ability to produce, preserve and store feed biomass and use diets that increase productivity while reducing overall	<ul style="list-style-type: none"> • More efficient use of inputs • Technologies that reduce women's labor and energy expenditure adopted 	ICARDA developed a suite of best-bet agronomic practices to maximize productivity and to change farmers' attitudes and practices regarding cactus pear in West Asia and North Africa. Through trainings and dissemination material, end-users were incentivized and trained on the use of these practices.	2020 - 3.6.4 Agronomic practices for selected forage accessions developed and made available for Lebanon and Morocco	Complete	ICARDA developed a suite of best-bet agronomic practices to maximize productivity and to change farmers' attitudes and practices regarding cactus pear in the West Asia and North Africa region. Through trainings and dissemination material, end-users were incentivized	https://hdl.handle.net/20.500.11766/12374 https://hdl.handle.net/20.500.11766/12373 https://hdl.handle.net/20.500.11766/12339 https://hdl.handle.net/20.500.11766/12338 https://hdl.handle.net/20.500.11766/12372 https://hdl.handle.net/20.500.11766/10558

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	feed and forage costs and environmental impacts (with the environment and livelihoods flagships).					and trained on the use of these practices.	https://hdl.handle.net/20.500.11766/11835 https://hdl.handle.net/20.500.11766/12321 https://hdl.handle.net/20.500.11766/11728
	<p>F3 Outcome: Outcome 3.8 - Increased delivery and uptake of feed and forage resources through proof-of-concept scaling, business model development and value-chain approaches by development partners, the private sector (feed and forage traders, feed processors) and (1 million by 2022) farmers across diverse environments in priority countries and other locations in Latin America, North and East Africa and South and Southeast Asia.</p>	<ul style="list-style-type: none"> • More efficient use of inputs • Closed yield gaps through improved agronomic and animal husbandry practices • Technologies that reduce women's labor and energy expenditure adopted 	<p>Strong advances were made in our business models and extension approaches in all the regions where we work (Central America Caribbean, South America, East Africa, North Africa and Western Asia, South(east) Asia). Although COVID-19 affected our work, in many cases we re-orientated our efforts to a more virtual sphere. A notable success was the seminar series on sustainable livestock in Colombia, which had 23,000 visualizations all over the globe.</p>	<p>2020 - 3.8.15 ICARDA, ILRI and CIAT in collaboration with national and international development partners and other value chain actors pilot test and evaluate at least four extension approaches using new media (e.g. apps, SMS, e-learning) in at least 1 priority country and 2 other countries</p>	Complete	<p>Achievements include: Seminar series (Colombia), radio transmissions on improved forages (Kenya), forage fact sheets extension material (East Africa), lessons learned from establishment of demo-plots with improved forages and field days for farmers and dairy cooperatives (Kenya), extension approaches to promote forage cultivation (Kenya and Uganda), forage demo plots and farmer training (Haiti), Tropical Forages Selection Tool Training (India), feed training and certification scheme (Uganda), and e-learning courses on feeds and forages from ICARDA.</p>	https://hdl.handle.net/10568/111099 https://hdl.handle.net/10568/111316 https://hdl.handle.net/10568/111505 https://hdl.handle.net/10568/111369 https://hdl.handle.net/10568/111373 https://ciat.cgiar.org/ci-at-projects/towards-improved-animal-feed-availability-in-the-nord-and-nord-est-departments-of-haiti/ https://hdl.handle.net/10568/111498 https://hdl.handle.net/10568/111383 https://hdl.handle.net/10568/110324 https://elearning.icarda.org https://elearning.icarda.org/course/view.php?id=80 https://elearning.icarda.org/course/view.php?id=80

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							d=83 https://elearning.icarda.org/course/view.php?id=82 https://elearning.icarda.org/course/view.php?id=77 https://elearning.icarda.org/course/view.php?id=81 https://mel.cgiar.org/reporting/outputsreport/id/8318
				<p>2020 - 3.8.16 At least 2 inclusive business models for forage seed production and conservation identified in Uganda, Kenya and Colombia, and 1 existing seed business model evaluated and 1 seed processing business model developed for Tunisia</p>	Complete	<p>Achievements include: 2 cost-benefit analyses (Colombia), 4 forage business cases (Kenya/East Africa), making money with sustainable intensification, forage seed business model (India), Ethiopian Forage Seed Consortium collaboration for drafting new Quality Declared Seed (QDS) guidelines for forages, business model for poultry/goat feeding (Malawi), business ideas for forages (Ethiopia), forage seed business development through seed cleaning unit (MENA region), feed production in form of pellets (MENA region) and cost-benefit analysis of</p>	https://hdl.handle.net/10568/111107 https://hdl.handle.net/10568/111505 https://hdl.handle.net/10568/109163 https://hdl.handle.net/10568/100484 https://www.icrisat.org/auctions-in-markets-herald-higher-incomes-for-malawis-crop-livestock-farmers/ https://hdl.handle.net/10568/110394 https://mel.cgiar.org/reporting/report/id/8318/del_id/23359 https://hdl.handle.net/20.500.11766/12323 https://mel.cgiar.org/reporting/report/id/8318

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						nitrogen use efficiency in improved forages.	/del_id/23348 https://hdl.handle.net/10568/111554
				2020 - 3.8.17 Technical basis for the Colombian Policy on Sustainable Bovine Livestock submitted to the policy makers in Colombia	Complete	The technical baselines developed by the Colombian Roundtable for Sustainable Beef and Dairy together with CIAT were submitted to the Ministries of Agriculture and Environment in early 2020 and a policy is currently being revised. The COVID-19 pandemic and changed priorities in the Colombian ministries resulted in shifting the initial plan of having a policy in place in 2020 to 2021.	https://hdl.handle.net/10568/111099
				2020 extended to 2021 - 3.8.18 At least 3 regional multi-stakeholder feeds and forages platforms established in Kenya and at least 10 regional livestock roundtables functioning on their own in Colombia	Extended	Colombia: There are currently 12 Colombian Roundtables for Sustainable Beef and Dairy in all the main cattle regions of the country. CIAT was involved in establishing them and providing technical knowledge support. Kenya: Due to COVID-19, no advances could be made in 2020.	https://hdl.handle.net/10568/111099
F4	F4 Outcome: 4.1 Environmental concerns	• More productive and equitable	CLEANED-X (Comprehensive Livestock Environmental	2020 - 4.1.4 Technology	Complete	The CLEANED-X version 2 has been downloaded 184	https://dataverse.harvard.edu/dataset.xhtml?p

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	are considered in decision making across at least 10 priority countries and other locations, by national and international development partners, government agencies and extension systems, including technology developers seeking to improve cattle, small ruminant and pig production.	management of natural resources • Land, water and forest degradation (Including deforestation) minimized and reversed • Increased resilience of agro-ecosystems and communities, especially those including smallholders	Assessment for Improved Nutrition, a Secured Environment, and Sustainable Development along Livestock and Fish Value Chains) version 3 was released, which will allow more users to have access to the application. The tool has been disseminated in five countries (Uganda, Ethiopia, Tanzania, Vietnam and Tunisia).	developers take environmental issues into account in research priority setting in 5 countries		times. The CLEANED-X version 3 tool has been disseminated in five countries (Uganda, Ethiopia, Tanzania, Vietnam and Tunisia) and its use by national partners documented.	ersistentId=doi:10.7910/DVN/G0G8IY https://doi.org/10.7910/DVN/4EB5XT https://ciat.cgiar.org/ci-at-projects/environmental-assessments-of-livestock-systems-using/ https://alliancebioversityciat.org/news_and_blogs/virtual-trainings-for-sustainable-livestock-production/ https://cleanedtraining.netlify.app https://hdl.handle.net/10568/111300 https://hdl.handle.net/10568/110323 https://hdl.handle.net/10568/110578 https://hdl.handle.net/10568/111409 https://hdl.handle.net/10568/111490 https://hdl.handle.net/10568/111491 https://hdl.handle.net/10568/111446 https://doi.org/10.7910/DVN/4EB5XT
	F4 Outcome: 4.2 Targeted solutions are used by	• Agricultural systems diversified	Several reports were produced on heat stress	2020 - 4.2.2 Quantification of	Complete	RHoMIS and the bilateral funded Livestock Yield Gaps:	

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	research and development partners, across at least 10 priority countries and other locations, to increase the productivity of cattle, small ruminants and pigs in the face of ongoing environmental changes.	and intensified in ways that protect soils and water <ul style="list-style-type: none"> • Reduced net greenhouse gas emissions from agriculture, forests and other forms of land-use (Mitigation and adaptation achieved) • Land, water and forest degradation (Including deforestation) minimized and reversed 	impacts in East and West Africa. The Rural Household Multi-Indicator Survey (RHoMIS) database was used in two different analyses that looked at pathways to sustainable intensification and trade-offs.	environmental impacts guides the development and selection of productivity-enhancing options by at least one research and development partner in three priority countries to identify win-win options		Increasing household nutrition security and incomes (LiveGAPS) project analyses have contributed to the completion of the milestone this year. The link on the right is to an article on Rwanda. Work in other countries is reported under milestone 4.1.4.	https://cgspace.cgiar.org/handle/10568/108304
				2020 - 4.2.4 Quantification of environmental impacts guides development/ selection of productivity enhancing options in five countries	Extended	Analyses conducted of heat stress impacts in East and West Africa, but so far there is only evidence of uptake of research results in one country (Uganda). Work in other countries was delayed due to the COVID-19 pandemic.	https://cgspace.cgiar.org/handle/10568/111299 https://cgspace.cgiar.org/handle/10568/107882
	F4 Outcome: 4.3 Government agencies and development partners at local and national levels across at least 10 priority countries and other locations are promoting	• More productive and equitable management of natural resources	Rangeland management interventions continue to be disseminated through the Sustainable Rangeland Management Toolbox.	2020 - Five sustainable rangelands interventions in Kenya, Tanzania, Tunisia and Ethiopia are identified, tested	Complete	The flagship has been developing a toolbox for sustainable rehabilitation and management of rangelands in arid environments based on an integrated and	https://hdl.handle.net/20.500.11766/11918 https://hdl.handle.net/20.500.11766/11830 https://hdl.handle.net/20.500.11766/12331 https://hdl.handle.net/

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environmental management options.			and disseminated to livestock producers by the end of 2018.		<p>multidisciplinary approach. Additional sustainable rangeland management (SRM) practices were completed in partnership with IUCN including grazing management and direct seeding. More SRM practices will be added in 2021, when the toolbox is expected to be completed. In Tunisia, science-based rangeland monitoring and evaluation became the standard since national partners (development agencies) sensed the urgent need to improve their methodology and requested technical backstopping from ICARDA, provided in the form of on-the-job training. This behaviour change is directly linked to their conviction of the need to rely on scientific data (4 criteria) developed earlier under this CRP, which are now being taken up by government agencies in Tunisia for sustainable management of the restored rangeland sites. Furthermore, 2 ISI papers were published in 2020 related to rangeland</p>	20.500.11766/10498 https://hdl.handle.net/20.500.11766/11832 https://hdl.handle.net/20.500.11766/11900
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						revegetation and governance.	
	F4 Outcome: 4.5 National government agencies across at least 5 priority countries design and implement key policies to improve the environmental management of livestock systems	<ul style="list-style-type: none"> • Land, water and forest degradation (Including deforestation) minimized and reversed • Increased resilience of agro-ecosystems and communities, especially those including smallholders • More productive and equitable management of natural resources 	We continued to promote the rangelands agenda in the Global Landscapes Forum. We promote Participatory Rangeland Management (PRM) through the Rangelands Initiative	2020 - 4.5.6 Tools, frameworks and processes for improved rangeland governance and management available in two countries	Complete	We published a paper on policy engagement about rangeland management in Tunisia, a blog about Participatory Rangeland Management, a briefing paper that summarizes CGIAR contributions to rangeland governance, and guidelines on PRM. We also made a film documenting land use planning for rangelands in Tanzania.	https://hdl.handle.net/20.500.11766/12302 https://avcdkenya.net/2020/02/20/when-participatory-approaches-mess-up-your-plans/ https://hdl.handle.net/10568/109533 https://www.youtube.com/watch?v=ISiCq-8jYgl https://hdl.handle.net/10568/109910
	F4 Outcome: 4.6 Evidence generated by the flagship influences key global livestock agendas (IPCC, Global agenda for Sustainable Livestock)	<ul style="list-style-type: none"> • Reduced net greenhouse gas emissions from agriculture, forests and other forms of land-use (More sustainably managed agro-ecosystems) • Increased resilience of agro-ecosystems and communities, especially those 	An event was organized on rangelands advocacy and a study was completed on the feasibility of Index Based Livestock Insurance (IBLI).	2020 - Feasibility of Index Based Livestock Insurance (IBLI) assessed in four countries	Extended	A study was published on expanding IBLI in Ethiopia. Feasibility study reports for Senegal, Niger, Mali and Burkina Faso are being finalized with the World Bank and the feasibility assessment process is underway in Sudan. Delays were caused both by the COVID-19 pandemic and issues with remittance of donor funding.	https://cgspace.cgiar.org/handle/10568/108964

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		including smallholders					
				2020 - Synthesis of practices to consider when developing measurement, reporting and verification (MRV) for livestock greenhouse gas emissions in Latin America	Complete	We published a paper on achieving greenhouse gas emission reduction targets in the livestock sector of Latin America.	https://hdl.handle.net/10568/108246
F5	F5 Outcome: 5.1 National and international research partners and policymakers use analyses of livestock-sector dynamics, investment and ex-ante impact assessments to guide priority setting, investment and policy development for the livestock sector in 5 priority countries and within the Livestock CRP	• Conducive agricultural policy environment	Outcome 5.1 on analyses to guide livestock related priority setting, investment and policy development – two Livestock Master Plans (LMPs) were started (Odisha and The Gambia) and the Kenya LMP was initiated. ILRI engagement in the United Nations Food Systems Summit (UNFSS) started early to ensure that the contribution of livestock in sustainable food systems is well recognized.	2020 - 5.1.6 National and international research partners use analyses of livestock sector dynamics, investment and ex-ante impact assessments to guide priority setting for the livestock sector in 3 priority countries	Complete	Two Livestock Master Plans (LMPs) were started in 2020, in The Gambia and Odisha (India), while training was conducted to facilitate development of a LMP in Kenya (to start in 2021). Partners in the LMP work included CIRAD and FAO, plus national ministries in the countries of implementation.	https://www.ilri.org/news/%E2%80%98livestock-master-plan%E2%80%99-launched-transform-meat-milk-and-poultry-production-gambia https://www.ilri.org/news/india%E2%80%99s-odisha-state-starts-work-livestock-master-plan
				2020 - 5.1.7 National partners and their donors participate in new Livestock	Complete	Similar to the previous milestone, two Livestock Master Plans (LMPs) were started in 2020 in The	https://www.ilri.org/news/%E2%80%98livestock-master-plan%E2%80%99-

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				Master Plan development in 3 priority countries, based on bilateral support, and begin to adjust investments accordingly		Gambia and Odisha (India), while training was conducted to facilitate development of a LMP in Kenya (to start in 2021). Partners in the LMP work included CIRAD and FAO, plus national ministries in the countries of implementation. Expecting immediate impact on investment was overly ambitious and will not be achieved during the lifetime of the CRP.	launched-transform-meat-milk-and-poultry-production-gambia https://www.ilri.org/news/india%E2%80%99s-odisha-state-starts-work-livestock-master-plan
	F5 Outcome: 5.2 International researchers and agencies use improved livestock system modelling tools and apply them to new problems based on their mandate areas		Outcome 5.2 on improved livestock modelling tools; progress on new modeling platforms – multisector and value chain – to support Livestock Master Plans and more general impact assessment work, with piloting and application ongoing. Work began on the development of the legacy product on training programs that institutionalize use and build capacity.	2020 - 5.2.4 Beta version of improved models for value chain analysis and national livestock sector analysis developed for revised Livestock Sector Investment and Policy Toolkit (LSIPT)”	Complete	Progress was made on enhanced outputs and models used in the context of livestock master plans (see report).	https://hdl.handle.net/10568/106330
				2020 - 5.2.2 Improved data protocols, impact	Complete	A stand-alone environmental module that uses data from the Livestock	https://hdl.handle.net/10568/106330

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				indicators and new model structures developed and documented		Sector Investment and Policy Toolkit (LSIPT) to calculate greenhouse gas emissions and water use from livestock has been developed (see report).	
				2020 extended to 2021 - 5.2.3 Livestock system modelling tools and databases improved with national and international partners to fit needs in 3 priority countries	Extended	The tool will be further developed in 2021. The lack of face to face meetings in 2020 due to the COVID-19 pandemic reduced scientists' opportunities to brainstorm.	n/a
	F5 Outcome: 5.3 Policy- or decision-makers in 4 countries use the packages developed and the evidence on the benefits of including gender equity considerations In the development of livestock projects and planning at community and national level (Ethiopia, Kenya, Nicaragua, Vietnam)	<ul style="list-style-type: none"> • Gender-equitable control of productive assets and resources • Improved capacity of women and young people to participate in decision-making 	Outcome 5.3 on gender equity considerations in livestock interventions. We progressed with integration of gender considerations across other flagships e.g. gender analysis of intensification in the Uganda pig value chain; gender considerations integrated in community conversations for animal health and management; gender considerations in nutrition interventions in Rwanda; literature review of gender analysis in dairy breeding in Sub-Saharan Africa. We completed a	2020 extended to 2021 - 5.3.3 Benchmark publication on gender and livestock to identify frontiers in research and development published by December 2018.	Extended	The work is progressing; the protocol has been published. Extension was required because the number of papers included in the screening was higher than expected (above 20,000). There was also issues in keeping staff motivated during the difficult COVID-19 pandemic times.	https://osf.io/sjwp9/

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			review of gender and livestock datasets.				
				2020 extended to 2021 - 5.3.2 CRP Gender strategy published by June 2018.	Extended	The draft strategy was developed and received comments from members of the CRP Livestock Program Management Committee. The lead author left for a new role and the strategy wasn't completed in 2020; it will be published in mid-2021.	n/a
				2020 extended to 2021 - 5.3.4 Policy or decision makers in 2 priority countries use evidence on the benefits of including gender equity considerations	Extended	In Ethiopia and Tanzania, the "women in chicken business" project is working with national partners, research and private sector, to identify ways to get more women involved in the poultry value chain and increase the benefits they derive from these activities. Field work and stakeholder engagement was delayed in 2021 due to COVID-19 restrictions (Ethiopia and Tanzania) and political unrest (Ethiopia).	n/a
				2020 - 5.3.5 Gender responsive livestock innovations tested and their impact	Complete	The community conversations are more about transforming gender relations but are also about integrating gender in animal	https://hdl.handle.net/10568/110620 https://hdl.handle.net/10568/110090

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				assessed in 2 priority countries		health work in Ethiopia. The other innovation that was analyzed is the infection and treatment method (ITM) against East Coast fever in Kenya.	https://hdl.handle.net/10568/110127
	F5 Outcome: 5.5 Local and national development actors, government agencies, and the private sector invest in and adopt the most successful approaches for enhancing livestock-mediated nutritional impact, including institutional arrangements and behavioural change, in 3 priority countries.	<ul style="list-style-type: none"> Increased availability of diverse nutrient-rich foods 	Outcome 5.5 on nutrition sensitive livestock interventions- The Rwanda National Early Childhood Development Program revised its national Maternal Infant and Young Child Nutrition (MIYCN) counselling cards and adopted one of the Feed the Future Innovation Lab for Livestock Systems (LSIL) nutrition project intervention cards for their own use. A follow up project “Engaging men in supporting maternal and child consumption of milk and other animal source foods in Rwanda’ was approved by the LSIL as a follow up of the Rwanda Reach nutrition project.	2020 - 5.5.4 Local and national development actors and government agencies adopt tailored options for nutritional impact through livestock development, including cost-effective institutional arrangements and behavioural approaches, within communities in Kenya	Complete	For the past four years, in partnership with government departments in health, education and agriculture, the Accelerated Value Chain Development (AVCD) project has been supporting agri-nutrition training by community health volunteers (CHVs) in communities in Garissa, Isiolo, Marsabit, Turkana and Wajir counties of Kenya. The CHVs have passed on messages to mothers and caregivers about the value of consuming nutritious food and promoting dietary diversity to reach households with children below 2 years of age. These efforts have created public awareness on the nutrition value of diverse, safe and nutritious foods that include leafy green vegetables, fruits, tubers, nuts, grains and animal products,	https://avcdkenya.net/2020/04/16/diversification-of-diets-a-community-led-solution-that-improves-nutritional-outcomes-in-kenyas-pastoral-communities/ https://cgspace.cgiar.org/bitstream/handle/10568/98538/dialogue_cards_ot.pdf?sequence=1&isAllowed=y

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						enabling community members to make informed choices on their food consumption to cover their nutritional needs. Through this work, community ownership and sustainability of agri-nutritional interventions has increased.	
	F5 Outcome: 5.6 Livestock communities across 4 priority countries apply tested technologies, management strategies and institutional arrangements, taking the multiple functions of livestock into account	<ul style="list-style-type: none"> Increased livelihood opportunities 	For Outcome 5.6 on technologies and multi function of livestock, the priority country work in Ethiopia, Tanzania, Uganda and Vietnam was delayed by the COVID-19 pandemic. We developed a new module on livestock productivity for the Rural Household Multiple Indicator Survey (RHoMIS) to be used by the priority country teams.	2020 extended to 2021 - 5.6.4 Livestock communities across 2 countries (Ethiopia and Kenya) apply tested technologies and management strategies based on CRP related research	Extended	This will be documented for 2021. There were delays in implementation in both Ethiopia and Kenya in 2020 due to COVID-19 restrictions affecting data collection.	n/a
	F5 Outcome: 5.7 Development partners, private sector and government agencies across 4 priority countries apply innovative institutional arrangements to enhance competitiveness and inclusiveness	<ul style="list-style-type: none"> Reduced market barriers Increased livelihood opportunities 	Implementation activities related to Outcome 5.7 on institutional arrangements were also delayed, while the Frontiers special issue on delivery systems for improved livestock value chain performance progressed. A series of surveys on the short term effects of COVID-19	2020 extended to 2021 - 5.7.3 Development partners, private sector and government agencies in 2 priority countries apply innovative institutional arrangements to raise	Extended	This will be documented for 2021. There were delays in implementation in both Ethiopia and Kenya in 2020 due to COVID-19 restrictions affecting data collection.	n/a

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			were conducted and results presented in various forums.	competitiveness and inclusiveness			
				2020 - 5.7.4 A paper on organizational and business approaches for improved dairy and small ruminant livestock value chain performance, based on field testing and impact assessment in 1 priority country	Complete	The milestone was changed to include only one value chain, the paper is about the business approach for small ruminants in Ethiopia.	https://hdl.handle.net/10568/113067

Table 6: Numbers of peer-reviewed publications from current reporting period (Sphere of control)

	Number	Percent
Peer-Reviewed publications	227	100.0%
Open Access	204	89.87%
ISI	194	85.46%

Table 7: Participants in CapDev Activities

Number of trainees	Female	Male
In short-term programs facilitated by CRP	2,314	5,488
In long-term programs facilitated by CRP	8,012	15,116
PhDs	6	4

Table 8: Key external partnerships

Lead FP	Brief description of partnership aims	List of key partners in partnership	Main area of partnership
F1	Collaboration on pig genetics in Uganda, including determining breed composition of pigs kept by smallholders and insights into genetic background of the local pig	• BOKU - University of Natural Resources and Life Sciences	• Research
F1	Collaboration on genomics of chicken and sheep: a number of high impact publications in 2020	• CAS - Chinese Academy of Sciences	• Research
F1	Collaborating on dairy cattle breeding East Africa: in 2020 partnership with this ICT company supporting development of tools for farmer driven data capture and feedback using USSD and SMS technology.	• GDT - Green Dream TECH Ltd	• Capacity Development • Delivery
F1	Collaboration on dairy cattle breeding programs in East Africa: in 2020, development of two digital training courses on dairy cattle management (on calving management and hygiene practices).	• Farm.ink	• Delivery
F1	Collaboration on dairy cattle breeding programs in East Africa: in 2020, demonstration of the feasibility of using low-density marker panels for genotype imputation and genomic prediction of crossbred dairy cattle.	• UNE - University of New England	• Research • Delivery
F1	Collaboration on cattle genomics: access to the knowledges and skills of cutting-edge bioinformatician. In 2020, the collaboration resulted in a highly cited Nature Genetics paper.	• SNU - Seoul National University	• Research
F1	Support to Vietnam priority country initiative: overall project support re partnership and expert knowledge on ethnic minorities; co-ordination of all genetics activities	• NIAS - National Institute of Animal Sciences	• Research • Delivery
F1	Support to Uganda priority country initiative: co-ordination and implementation of the community based Artificial Insemination pilot	• Makerere University • VS - VetLine services	• Delivery • Research • Capacity Development

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F1	This partner supports small ruminant breeding activities in Tunisia (based on introgressing a fecundity mutation into Barbarine sheep) by availing their flock to act as a multiplier herd.	<ul style="list-style-type: none"> • OEP - Office de l'Elevage et des Pâturages 	<ul style="list-style-type: none"> • Delivery • Research
F1	Collaboration on reproductive technologies: exchange visits in 2020 resulted in core spermatogonial stem cell technology being established at ILRI	<ul style="list-style-type: none"> • WSU - Washington State University 	<ul style="list-style-type: none"> • Research
F1	Key partners supporting implementation of community based breed programs in Ethiopia and Tanzania: these partners will facilitate continuation of the programs on Flagship exit	<ul style="list-style-type: none"> • ARARI - Amhara Regional Agricultural Research Institute • OARI - Oromia Agricultural Research Institute • TARI - Tigray Agricultural Research Institute • EIAR - Ethiopian Institute of Agricultural Research • TALIRI - Tanzania Livestock Research Institute • MoANR - Ministry of Agriculture and Natural Resources (Ethiopia) 	<ul style="list-style-type: none"> • Delivery • Capacity Development • Research
F1	Collaboration on cattle and poultry genomics (including health genomics), reproductive technologies, bioinformatics	<ul style="list-style-type: none"> • CTLGH - Center for Tropical Livestock Genetics and Health 	<ul style="list-style-type: none"> • Research
F2	Booting of the synthetic genome and cell toxicity assay development	<ul style="list-style-type: none"> • FLI - Friedrich-Loeffler-Institut (FLI) 	<ul style="list-style-type: none"> • Research
F2	Partner in the Transforming Animal Health Solutions and Services (TAHSSL) platform responsible for assessing the demand for a lateral flow test and product and market development via public-private partnerships	<ul style="list-style-type: none"> • GALVmed - Global Alliance for Livestock Veterinary Medicines 	<ul style="list-style-type: none"> • Delivery
F2	Leading the vaccine testing of the Sub unit vaccine in the IDRC project	<ul style="list-style-type: none"> • KALRO - Kenya Agricultural and Livestock Research Organization 	<ul style="list-style-type: none"> • Research
F2	Leading the review of Veterinary laws to identify opportunities for private sector investments.	<ul style="list-style-type: none"> • MALF - Ministry of Agriculture, Livestock, Fisheries and Cooperatives (Kenya) 	<ul style="list-style-type: none"> • Policy

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F2	Implementing partner of HEARD bilateral project in Ethiopia representing the private veterinary sector, working on Continuing Professional Development program for Ethiopian veterinary professionals	<ul style="list-style-type: none"> • EVA - Ethiopian veterinary Association 	<ul style="list-style-type: none"> • Capacity Development • Delivery
F3	Nourishing Prosperity Alliance: aims to strengthen dairy production in central Kenya by helping smallholder dairy women to advance sustainable farming practices and to ease shortage of dairy products.	<ul style="list-style-type: none"> • Land O Lakes • Corteva AgriScience 	<ul style="list-style-type: none"> • Capacity Development
F3	Using the Burkina Faso near-infrared spectroscopy (NIRS) instrument for analyzing forage and grain samples in their research projects working on sorghum, cowpea, millet, peanut and the African cereal crop, fonio.	<ul style="list-style-type: none"> • INERA - Institut de l'Environnement et de Recherches Agricoles (Burkina Faso) 	<ul style="list-style-type: none"> • Research
F3	Developing business around forage seed and feed production in Tunisia	<ul style="list-style-type: none"> • OEP - Office de l'Elevage et des Pâturages 	<ul style="list-style-type: none"> • Capacity Development
F3	ICAR India: sharing new elite barley lines and phenotyping them for the benefit of Indian and Worldwide farmers	<ul style="list-style-type: none"> • ICAR - Indian Council of Agricultural Research • IIWBR - Indian Institute of Wheat and Barley Research • RARI - Rajasthan Agricultural Research Institute • ANGRAU - Acharya N. G. Ranga Agricultural University • BHU - Banaras Hindu University 	<ul style="list-style-type: none"> • Research • Delivery
F3	Bonn University: sharing core barley lines from the Global Barley Breeding Program for drought tolerance phenotyping for gene mining and genomic selection strategies.	<ul style="list-style-type: none"> • University of Bonn 	<ul style="list-style-type: none"> • Research
F3	Forage hybrid scaling in Kenya	<ul style="list-style-type: none"> • Meru Agro Ltd. 	<ul style="list-style-type: none"> • Delivery
F3	Implementation partnership for forage scaling in Kenya	<ul style="list-style-type: none"> • Send a Cow 	<ul style="list-style-type: none"> • Delivery
F3	Assessment of forage seed sector (policy, value chains, technology) and potential to use forages in particular to overcome seasonal feed limitations and avoid future feed emergencies	<ul style="list-style-type: none"> • CRS - Catholic Relief Services 	<ul style="list-style-type: none"> • Delivery • Research

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F3	Television program for the dissemination of technical knowledge on tropical forage in Kenya	<ul style="list-style-type: none"> • iShamba 	<ul style="list-style-type: none"> • Delivery
F3	Development of joint proposals on gender, youth and conflict in the forage-based cattle sector of Colombia	<ul style="list-style-type: none"> • UofG - University of Glasgow • bristol - University of Bristol 	<ul style="list-style-type: none"> • Research
F4	We continue a strong partnership with IUCN on rangelands management and restoration.	<ul style="list-style-type: none"> • IUCN - International Union for Conservation of Nature 	<ul style="list-style-type: none"> • Research • Policy
F4	We maintain a strong relationship on rangeland advocacy.	<ul style="list-style-type: none"> • GLF - Global Landscapes Forum 	<ul style="list-style-type: none"> • Policy
F5	collaboration for Ceres2030 regarding the evidence synthesis https://ceres2030.org/research-teams/	<ul style="list-style-type: none"> • Cornell University 	<ul style="list-style-type: none"> • Research
F5	Collaboration on a SPIA funded project on "Demand and Liquidity Coordination to Foster the Adoption for Livestock Vaccinations: An Experiment with Small-Holder Dairy Cooperatives in Kenya"	<ul style="list-style-type: none"> • UCSC - University of California Santa Cruz 	<ul style="list-style-type: none"> • Research

Table 9: Internal Cross-CGIAR Collaborations

Brief description of the collaboration	Name(s) of collaborating CRP(s), Platform(s) or Center(s)	Value added
FP1 partnered with CCAFS in relation to small ruminant breeding in Ethiopia and Kenya in climate smart villages. In Ethiopia, the initiative supported dissemination of improved genetics from established community based breeding programs to new sites. In Kenya, the initiative supported the introduction of improved indigenous breeds (with one of these breeds - the Red Maasai - being shown to have superior growth in comparison to other breeds).	CCAFS	Kenya: research; Ethiopia: Innovation scale-out
FP3 collaborated with CCAFS on multiple activities, including: youth capacity building support for the Colombian dairy industry; with FP4 on reducing greenhouse gas emissions from livestock production, exchange of a wide range of down-scaled climate projections for better assessments, and targeting of adaptation needs and potentials; and development of a policy brief on livestock feed and fodder development in Uzbekistan.	CCAFS	Scientific, efficiency
Tools for improvement of Genetic Gains in Tropical forages program: Advice on Slow Growth Storage implementation and simulations for optimization.	EiB	Efficiency
Work on the Women's Empowerment in Livestock Index (WELI)	Gender	Scientific interactions
In collaboration with the Genebank Platform, further progress was made in employing molecular technologies to reveal and describe the diversity held in CGIAR forage collections. Key outcomes include identifying the association between agronomic performance and nutritional quality traits with regions in the Napier grass genome, which revealed significant variation for forage biomass yield and feed nutritional quality traits in the collection, and identifying molecular markers that can discriminate high biomass yielding Napier grass genotypes. A second initiative on genetic diversity analysis of buffel grass generated a large number of single-nucleotide polymorphism (SNP) markers for genetic analysis of this grass and related species and identified a core collection.	Genebank	Scientific
The CRP-GLDC invested in high throughput (near-infrared spectroscopy or NIRS) phenotyping for fodder quality in breeding pipelines of sorghum, pearl millet, groundnut and other mandate crops, and collaborated in a learning and support initiative to develop market opportunities that increase the adoption of research outputs.	GLDC	Scientific, efficiency
As part of the comparison of near infra-red spectroscopy (NIRS) performance and for cross-validation of instruments, the core sample set of 550 validated samples was shared with ICRAF Kenya and used to validate the calibrations on their Bruker and handheld instruments.	ICRAF	Scientific, efficiency

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Governance and tenure in pastoral systems.	PIM	Scientific
Joint modelling for livestock and fish master plans	WorldFish	Scientific interactions

Table 10: Monitoring, Evaluation, Learning and Impact Assessment (MELIA)

Studies/learning exercises planned for this year (from POWB)	Status	Type of study or activity	Description of activity / study	Links to MELIA publications
S3033 - A cost-benefit analysis of nitrogen-use-efficiency in different forages in Colombia	Completed	Ex-ante, baseline and/or foresight study	The objective was to characterize the efficiency in the use of nitrogen (UEN) of six grasses: Urochloa humidicola, U. hybrid cv cobra, U. hybrid cv cayman, U. decumbens, Megathyrsus maximus cv mombasa and Cynodon nlemfuensis with respect to different commercial nitrogen fertilizers. Agronomic, productive and nutritional quality evaluations were carried out at times of maximum and minimum rainfall, and soil samples were taken to determine the flow of soil-plant nitrogen. The findings indicate that the use of nitrogen fertilizers significantly improves the productive performance of forage species.	https://hdl.handle.net/10568/111554
S3034 - Cost-benefit analyses of improved forage technologies (Avena altoandina, Arachis pintoi CIAT 22260) in Colombia	Completed	Ex-ante, baseline and/or foresight study	The financial viability of two new forage options released in Colombia, Avena Altoandina and Arachis pintoi CIAT 22260, were evaluated from an economic perspective. The methodology adopted a discounted free cash flow model, estimation of financial feasibility indicators, and an analysis based on Monte Carlo simulation, to consider the risk level of critical variables. In the case of Arachis, potential impacts of climate change were included in the model. The results provide a valuable information source for livestock producers, extensionists, policy and other actors for making informed decisions on whether or not to invest in these new technologies.	https://hdl.handle.net/10568/111107 https://hdl.handle.net/10568/111083 https://hdl.handle.net/10568/111087
S3516 - Lessons from Community Based Breeding Programs in Ethiopia	On Going	Synthesis (secondary) study	Community Based Breeding Programs for small ruminants are being implemented in different sites representing different agro-ecologies and production systems. This study will compile lessons from these different production systems.	
S3526 - Baseline environmental footprint for the Ethiopian small ruminant production system	On Going	Ex-ante, baseline and/or foresight study	Baseline environmental footprint for the Ethiopian small ruminant production system using the Comprehensive Livestock Environmental Assessment for improved Nutrition, a secured Environment and sustainable Development along livestock value chains (CLEANED) tool. CLEANED is an easy-to-use Excel-based tool that allows users to explore multiple impacts	

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			of developing livestock production systems. It models the impacts of changes in different livestock enterprises on productivity, land and water use, greenhouse gas emissions and soil health.	
S3528 - Environmental impacts associated with different types of pig enterprises in Uganda	On Going	Ex-ante, baseline and/or foresight study	Application of the Comprehensive Livestock Environmental Assessment for improved Nutrition, a secured Environment and sustainable Development along livestock value chains (CLEANED) tool in the baseline environmental footprint analyses for the Uganda priority country interventions. CLEANED is an easy-to-use Excel-based tool that allows users to explore multiple impacts of developing livestock production systems. It models the impacts of changes in different livestock enterprises on productivity, land and water use, greenhouse gas emissions and soil health.	
S3529 - Preliminary ex-ante environmental assessment for Vietnam priority country activities	On Going	Ex-ante, baseline and/or foresight study	Report on application of the Comprehensive Livestock Environmental Assessment for improved Nutrition, a secured Environment and sustainable Development along livestock value chains (CLEANED) tool for Vietnam (baseline footprints). CLEANED is an easy-to-use Excel-based tool that allows users to explore multiple impacts of developing livestock production systems. It models the impacts of changes in different livestock enterprises on productivity, land and water use, greenhouse gas emissions and soil health.	
S3530 - Ex-ante assessment of farm-level impacts of best-bet forage options in Tanzania	On Going	Ex-ante, baseline and/or foresight study	Application of the Comprehensive Livestock Environmental Assessment for improved Nutrition, a secured Environment and sustainable Development along livestock value chains (CLEANED) tool for the Southern Highlands as part of International Fund for Agricultural Development (IFAD) project. The project aims to achieve sustainable intensification of smallholder dairy production through developing appropriate context-specific forage solutions with participating farmers. It builds on CIAT expertise through the use of multipurpose tropical forage genotypes with high nutritional value, resistance to major pests and diseases, and suitability to major physical constraints (e.g. low soil fertility and drought).	
S3532 - Impact of Community Conversations as a gender	Completed	Program/project adoption or impact assessment	Paper on the impact of Community Conversations (an ILRI innovation) as a gender transformational approach in small ruminant production in Ethiopia. The paper synthesizes change stories and reflections of community	https://cgspace.cgiar.org/handle/10568/110213

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transformational approach in small ruminant production in Ethiopia			members and partners captured in activity reports and the before- and after-community conversation knowledge, attitude and practice surveys.	
S3533 - Gender perspectives on the adoption of the East Coast fever vaccine in Kenya	On Going	Program/project adoption or impact assessment	A paper describing gendered estimation of actual and potential adoption of the East Coast fever (ECF) vaccine among smallholder dairy farmers in Kenya.	
S3534 - Study reporting the lessons learned from implementing the Kenya Livestock Insurance Program (KLIP) with the goal of building financial resilience in pastoral communities in Africa	On Going	Synthesis (secondary) study	This study, jointly conducted by ILRI and the World Bank (WB), summarizes the impacts and lesson learned from the Kenya Livestock Insurance Program (KLIP), a national level implementation program of the Index Based Livestock Insurance (IBLI) innovation introduced by ILRI in 2010. The study is aimed at providing guidance to governments/organizations wishing to implement similar solutions and to support the scaling agenda in the Intergovernmental Authority on Development (IGAD) region that the WB, African Development Bank and the European Union launched in 2019. The report will be published by the WB in 2021.	
S3535 - Study summarizing the outcomes of Index Based Livestock Insurance (IBLI) implementation in Ethiopia and its transition toward a national policy agenda	On Going	Program/project evaluation/review	This study summarizes the evolution of index-based livestock insurance (IBLI) in Ethiopia, showing how the innovation introduced by ILRI in 2012 has been adopted by the United Nations World Food Program in the Somali region and is now under consideration for a nationwide government-led initiative. The study also highlights the role of ILRI in creating a conducive environment for IBLI adoption and scaling.	
S3536 - Evaluation of the use of Interactive Voice Recording (IVR) for dissemination of biosecurity messages on pig health in Uganda	On Going	Qualitative Outcome Study: (mainly to substantiate contribution to policy or similar)	The study proved that Interactive Voice Recording (IVR) is an innovative way to deliver important advisory information, such as biosecurity messages, to farmers. The scalability of IVR could further be explored and its feasibility assessed for wider use by the extension systems in Uganda and elsewhere.	https://www.frontiersin.org/articles/10.3389/fvets.2021.611263/abstract
S3537 - Assessment of sustainability options for Innovation Platforms (IPs) in Mali	Completed	Synthesis (secondary) study	This paper shows that stakeholder engagement in the vaccination process through facilitated Innovation Platforms (IP) was successful in fostering participation of farmers and increasing vaccine coverage in Mali. However, a sustainable vaccination strategy for Mali would benefit from consolidating	https://cgspace.cgiar.org/handle/10568/105820

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			the IP model, supported by Government investment to strengthen and adjust the underlying public-private-partnership.	
S4085 - Impact of Girinka program on child nutritional status and household food security	Completed	Correlates of adoption/impact study	The Government of Rwanda and its partners (including ILRI) have since 2006 been implementing a livestock asset transfer program, “Girinka”, to improve incomes, nutrition, soil fertility and social integration. Evidence of the impact of the program on nutrition outcomes was lacking, so a study was undertaken to compare nutrition outcomes in Girinka households with those who are eligible for Girinka but have not yet received a cow. The results have not yet been published in a peer-reviewed journal but a brief is available.	https://cgspace.cgiar.org/handle/10568/110200 ; https://livestocklab.ifas.ufl.edu/media/livestocklabifasufledu/pdf-/Nutrition-study-brief_LSIL-JH-clean.pdf

Table 11: Update on Actions Taken in Response to Relevant Evaluations

Name of the evaluation	Recommendation number	Text of recommendation	Status of response to this recommendation	Concrete actions taken for this recommendation	By whom	When	Link to evidence
CRP 2020 Review: Livestock	1	CRP quality managers need to ensure that 100% of peer-reviewed research outputs are open access (where commercially possible) and in ISI-indexed journals.	On Going	Sensitization of researchers and managers on the CGIAR requirement for journal articles to be published as Open Access.	CRP Program Management Unit	April 2021	N/A
CRP 2020 Review: Livestock	2	The CRP should improve the content and consistency of communications products and ensure a clearer association of content with research aims.	Complete	No action planned.	N/A	N/A	N/A
CRP 2020 Review: Livestock	3	To the extent possible, flagship achievements should be pushed to the next level within the remaining time frame - e.g., innovations currently at level 2 should be pushed to level 3, and policies at level 1 should be pushed to level 2.	On Going	Follow up with flagship leaders on their assessment of the potential for step increases in indicators.	CRP Program Management Unit	April 2021	N/A
CRP 2020 Review: Livestock	4	Exit strategies need to be developed immediately to ensure the smooth continuation of the country programs. Useful lessons from the “Cross-Country Learning Week” should be widely disseminated.	On Going	Issue Brief on the fit of priority country activities within One CGIAR Initiatives	CRP Director	June 2021	N/A
CRP 2020 Review: Livestock	5	The CRP should conduct a strategic review of capacity development to provide clear guidance on its aims and on its relationship with other key actors - such as national universities and national agricultural research systems (NARSs) -in achieving these aims. It	On Going	Capacity Development synthesis study	CRP Capacity Development Advisor	June 2021	N/A

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		should review its targets for capacity development, determine how it will measure progress, and align its efforts with national-level needs.					
CRP 2020 Review: Livestock	6	For postgraduate students, pooling resources between centers and CRPs to create doctoral training colleges with clear learning structures and research themes/aims would benefit student experience and build a future cadre with a sense of identity aligned to the overall aims of the system.	Complete	No action planned.	N/A	N/A	N/A

Table 12: Examples of W1/2 Use in this reporting period (2020)

Specific examples (including through set aside strategic research funds or partner funds)	Broad area of use of W1/2
COVID-19 cattle sector analysis in Colombia	Research
Forage hybrid breeding (<i>Urochloa humidicola</i> , <i>Urochloa brizantha</i> , <i>Megathyrsus maximus</i>)	Research
Development of near infrared spectroscopy (NIRS) equations to estimate nutrition quality parameters of tropical forages (crude protein, fiber content, digestibility)	Research
Field work to collect additional epidemiological indicators virus-transmitted, zoonotic tick-borne diseases	Research
Operational expenses for the expansion of work on restoration of agrosilvopastoral production systems to a new site in Northern Tunisia	Research
Support to national partners in Tunisia to evaluate the impact of high intensity short duration grazing on private rangelands and conduct surveys related to agrosilvopastoral production systems and cactus pear	Partnerships
Expert workshop to discuss the importance of the genus <i>Hedysarum</i> in pastoral improvement	Research
Baseline survey work in CRP Livestock priority country projects	Other Monitoring, learning, evaluation and impact assessment (MELIA)
Foresight activities for better documentation of the role of livestock for economic development in Africa and Asia	Other Monitoring, learning, evaluation and impact assessment (MELIA)
Project on dairy cattle phenotypes at ILRI Kapiti ranch in Kenya	Research

Table 13: CRP Financial Report

Flagship	Planned Budget 2020*			Actual expenditure 2020*			Difference*			Comments
	W1/W2 US\$	W3/Bilateral US\$	Total US\$	W1/W2 US\$	W3/Bilateral US\$	Total US\$	W1/W2 US\$	W3/Bilateral US\$	Total US\$	
FP1 - Livestock Genetics	3,844,655	6,104,202	9,948,857	3,340,593	5,586,455	8,927,048	504,062	517,747	1,021,809	-
FP2 - Livestock Health	3,896,809	5,498,790	9,395,599	3,180,823	4,488,806	7,669,629	715,986	1,009,984	1,725,970	-
FP3 - Livestock Feeds and Forages	3,380,122	4,380,300	7,760,422	2,825,479	3,609,371	6,434,850	554,643	770,929	1,325,572	-
FP4 - Livestock and the Environment	2,429,412	2,564,803	4,994,215	2,161,552	2,995,408	5,156,960	267,860	-430,605.00	-162,745.00	-
FP5 - Livestock Livelihoods and Agri-Food Systems	3,423,308	15,716,373	19,139,681	2,646,176	12,296,587	14,942,763	777,132	3,419,786	4,196,918	-
Strategic Competitive Research grant	2,100,000	0	2,100,000	255,882.00	.00	255,882.00	1,844,118	0	1,844,118	The Strategic Investment Fund budget was deliberately kept to a minimum, to allow the CRP to cover the 2020 budget cut.
CRP Management & Support Cost	2,267,198	0	2,267,198	2,318,450	0	2,318,450	-51,252	0	-51,252	-
CRP Total	21,341,504	34,264,468	55,605,972	16,728,955	28,976,627	45,705,582	4,612,549	5,287,841	9,900,390	

* Source: Lead and partner Centers financial reports (non-audited)

Annexes

Table Annexes

FP	Detailed Annex
F1: Livestock Genetics	<p>Major pieces of work. The major lines of work supported by the flagship are: (1) genomic selection based breeding programs for cross-bred dairy-cattle, linked to natural sire and artificial insemination based delivery systems, in Tanzania and Ethiopia; (2) community-based breeding programs for small ruminants, linked to natural sire and artificial insemination based delivery systems, in Tanzania and Ethiopia; (3) genetic improvement programs based on breed substitution for chickens, linked to distribution systems for the improved breeds, in Tanzania, Ethiopia and Nigeria; and (4) genetic improvement strategy for pigs, linked to community based artificial insemination delivery systems, in Uganda. From this work, 2 policies, 17 innovations and 5 completed milestones are reported.</p> <p>Outcomes and milestones. [1.1] (data). A mobile application to capture dairy cattle performance and provide feedback to farmers was developed and is now used by 140,000 farmers across Ethiopia, Kenya and Tanzania (1.1.7). Approval is pending for a patent application for genomic regions strongly associated with tolerance to <i>Theileria parva</i> infection in cattle (ECF), which would allow for tolerant animals to be selected using genomic approaches (1.1.8). [1.2] (genetic improvement strategies). Updated breeding objectives and selection indexes (used to rank breeding animals on genetic merit) for the CRP supported dairy-cattle breeding program in Tanzania were completed and henceforth adopted by the breeding program (1.2.6). Breeding programs for pastoral production systems in Ethiopia were successfully established (1.2.5, ongoing, journal paper submitted). The zebu x taurine admixture SNP chip for determining the underlying breed composition of cross-bred dairy-cattle was completed (1.2.4), though the search for a company to commercialize the tool was unsuccessful. A ‘willingness to pay’ study revealed that the chip could be used as part of crossbred bull and cow genomic certification procedures, though current demand is insufficient to incentivize private sector investment. The flagship is exploring ways to combine this SNP chip with other SNP sets that could be used as markers for other traits of importance, to potentially improve its marketability. Meanwhile, the larger subset of the panel is being used to assign the percentage of exotic breed or “dairyness” as part of ongoing bull certification. [1.3] (delivery systems). Here we report the development and testing of mixed private-public business models for sustainable delivery of improved dairy-cattle genetics in emerging smallholder dairy systems in Kenya using the fixed-time artificial insemination technology (1.3.4), including a network of nine reproductive technology labs to disseminate improved small ruminants genetics from the CRP-supported breeding programs for small ruminants in Tanzania and Ethiopia (1.3.3). On production of transgenic trypanoresistant cattle (1.3.6) we were not successful in establishing pregnancies with the ApoL1-modified blastocysts, despite earlier success with ApoL1-modified blastocysts in mice as well as blastocysts derived from unmodified cells of the same line in cattle. This milestone has thus been cancelled. More research is needed to understand the mechanisms responsible before repeating the experiment.</p>

	<p>Innovations. The flagship reported 17 innovations. Of these, two are available for uptake by next users: breeding programs for goats in pastoral areas of Ethiopia; and, newly developed selection index (for ranking of animals on genetic merit) for the CRP-supported dairy-cattle breeding program in Tanzania. Other innovations of note are: new knowledge on the evolutionary history of domestic chickens; quantification of heat-stress effects on dairy-cattle milk yields in smallholder systems in East Africa; identification of the most profitable combination of breed-type and management system for smallholder dairy-cattle keepers in Senegal; a methodology to determine resistance of sheep to infestation by ticks and piroplasms under field conditions; and a demonstration of the feasibility of an across-country breeding program for dairy-cattle in Sub-Saharan Africa.</p> <p>Policies. The flagship reported two policies. One is investment by a national partner in flagship innovations (in-situ conservation of livestock breeds via use of community-based breed approaches, into which the Ethiopian Bioversity Institute invested) and the second is on policy influence in Uganda, where issues of livestock heat-stress are now on the agenda for incorporation into national policies (jointly reported with FP4).</p> <p>Major course corrections. Work on producing cattle transgenic for trypanoresistance was halted (see above). Although the COVID-19 pandemic delayed several flagship activities in 2020, particularly those involving working with communities, we aim to complete these in 2021. Due to ongoing conflict in Tigray, Ethiopia, some delays in our small ruminant breeding programs were incurred.</p> <p>Cross flagship linkages. Key cross-flagship linkages include that with the Livestock Livelihoods and Agri-food Systems Flagship on integrating of gender into flagship activities, and with the Livestock and the Environment Flagship in relation to livestock heat-stress in Uganda (for which a policy was jointly reported). Furthermore, the flagship has collaborated with all other flagships in relation to the CRP priority country initiatives.</p>
F2: Livestock Health	<p>CoA 1 (evaluating health constraints and developing tools to assess the significance on animal diseases and disease risk models and maps) generated evidence on swine respiratory diseases in Africa, Hepatitis E virus and prevalence of production diseases in pigs in Vietnam, an African Swine fever disease model, disease priorities in Ethiopia and, related to this, discussion of small ruminants for food security. In Uganda, a systematic review was conducted on the status of research on respiratory diseases of swine in Africa and highlighted knowledge and information gaps on epidemiologic aspects, including economic impacts of the various pathogens. A disease transmission simulation model framework developed in Vietnam was adapted to Porcine Reproductive and Respiratory Syndrome (PRRS) in Lira district, Uganda. To continue work on assessing burden of animal diseases in the long term, ILRI became a key partner in the Global Burden of Animal Disease project, managing the case study in Ethiopia. PPR, with its global eradication program, remained a priority disease and the ECO-PPR survey toolbox was field tested, refined and digitalized. Trainings of field researchers consisted of virtual training sessions, a training manual in both French and English and pre-recorded training sessions that were made available for streaming through a dedicated YouTube channel. In Tunisia, assessment of disease risks potentially caused by ticks and tick-borne diseases (TBD's) resulted in determining an unexpected high seroprevalence of the Crimean-Congo Hemorrhagic Fever virus in</p>

	<p>dromedaries in the Sahara of Tunisia. Zoonotic, virus-transmitted diseases by ticks also revealed the presence in sheep of the tick-borne encephalitis virus. Our work on developing risk maps for ticks and tick-borne diseases succeeded in building a model to predict habitat suitability of ticks of <i>Rhipicephalus sanguineus</i> group to raise awareness about ticks and tick-borne pathogens in Tunisia.</p> <p>CoA2 (developing herd health packages to reduce the negative impact of disease) saw the continuation of implementation of herd health packages in Ethiopia. Also in Ethiopia we analyzed factors affecting use of antimicrobials and we showed differences in use patterns in different production systems. A paper on community conversations highlighted the importance of involving communities in defining acceptable solutions. The herd health management framework began roll-out in Ethiopia and Uganda through CRP and bilateral projects and in Uganda linked to a champions training for veterinarians. Five Ugandan pig herd health champions were trained in Uppsala in early March 2020. Also in Uganda, a training module on prudent and efficient use of antibiotics in pigs was developed and is currently running repeatedly. Also, analyses of options for improved herd health management in small pig farms were conducted and a novel tool helped to study perceptions of veterinary drug sellers in Uganda, highlighting important capacity gaps. In Vietnam, 110 farmers participated in two herd health related trainings – one focused on biosecurity, use of vaccine and antibiotics, and the other on farm management. Another training of 108 animal health professionals focused on common animal diseases, biosecurity, vaccines and antibiotics, outbreak investigation and management as well as risk communication.</p> <p>CoA3 (developing vaccines and diagnostics against target diseases – ASF, CBBP, CCPP and ECF) ten modified candidate attenuated African swine fever viruses (ASFV) were constructed using CRISPR/cas9 technology. Based on T-cell assays, eleven viral genes have been prioritized for testing as subunit vaccines using AdHu5 and MVA as vaccination vehicles. For CBBP, we described a novel intranasal challenge model that is less stressful to cattle. A novel way of inactivating CCPP was tested to simplify formulation of a bacterin vaccine. For ECF, we described two nanoparticle technologies to improve the p67C vaccine.</p> <p>In CoA4 (improving access to livestock health products and services) A study on ‘willingness to vaccinate’ and the ‘willingness to pay’ in Mali provided important insights for future policy discussions to increase vaccine uptake. In Ethiopia, Kenya and Somali an in-depth vulnerability assessment was conducted to define the scope of One Health Units to improve service deliveries in pastoralist areas. In Ethiopia, a total 46,000 vaccine doses to prevent pasteurellosis in sheep and goats and PPR in goats were administered, while 28,000 sheep were treated against GI parasites and lungworms in CRP intervention sites.</p>
F3: Livestock Feeds and Forages	<p>In 2020, FP3 committed to achieve 15 milestones contributing to six outcomes (3.1, 3.3, 3.4, 3.5, 3.6 and 3.8) and two Sub-IDs (1.3.4 and 1.4.2). Thirteen of these milestones were fully achieved while two were partially achieved and extended to 2021. Given the number of milestones, it was not possible to reference them individually in the summary narrative, but they are clearly referenced in this detailed annex.</p> <p>Regarding Outcome 3.1, all four milestones were achieved. For milestone 3.1.12, the Online Journal Tropical Grasslands-Forrages Tropicales (TGFT) launched three issues and the new Tropical Forages Selection Tool (TF) was released in August 2020. TF is now being</p>

used by approximately [120,000](#) people/month and at reporting, the [AFAWA tool](#) was consulted by 17,900 people (milestone 3.1.14). A new animal diet balancing tool was piloted in India and is now available as a [mobile app](#). We updated the [Sub-Saharan Africa feeds database](#), which now contains >44,000 samples of feeds used in the region. (G-)FEAST [visualizations](#) were developed with data from 14 countries and (G-)FEAST was [used](#) by partners in Kenya, Tanzania and Vietnam (milestone 3.1.13).

Regarding **Outcome 3.3**, both milestones were achieved. For milestone 3.3.10, CIAT's existing *Urochloa* hybrids were scaled by the private sector on approximately 100,000 additional hectares in >15 countries (evidence to be made available shortly). Advances were made on *Megathyrsus* and *Urochloa* breeding and new generations of [Br12](#), [Br15](#) and [Bh16](#) hybrids were sent to our private seed sector partner for further trials and release. The new forage variety [Avena sativa AV25T, "Altoandina"](#), was released by the Colombian NARS Agrosavia in collaboration with CIAT (Colombian Forages Network). We provided a report on the 14 Napier grass accessions released and registered in [Ethiopia](#) since 2016. In collaboration with researchers in China, we sequenced the Napier grass [genome](#), revealing the genetics underlying its rapid growth and productivity, including an abundance of genes involved in photosynthesis and hormone signaling. For milestone 3.3.11, 4 new dual-purpose barley elite genotypes and [321 new elite barley genotypes](#) were shared with NARS Morocco for validation and potential release, 5 new elite food-feed barley genotypes were shared with NARS in Lebanon to start the variety registration process, and the new barley variety "Ay" was released in Turkey.

Regarding **Outcome 3.4**, both milestones were achieved. Two dual-purpose maize hybrids bred under a CIMMYT-ILRI collaboration now occupy more than 100,000 hectares (estimated by seed production/sales data) in India (milestones 3.4.1 and 3.4.5), the new forage sorghum variety "[CoFS-29](#)" has been diffused to >600 farmers in India, 198 new elite multi-purpose (food, feed, forage and malt) barley genotypes were selected and shared with Indian NARS for multi-location testing and [321](#) new multi-purpose (food, feed, forage and malt) barley genotypes were shared with NARS and collaborators in 23 countries for final evaluation/potential release (milestone 3.4.1). A new food and fodder barley variety (Guldeste) was released in Turkey (milestone 3.4.5).

Regarding **Outcome 3.5**, one milestone was achieved and one extended. Milestone 3.5.6 was extended due to the untimely passing of the principal investigator; most of the planned activities could not be conducted. For milestone 3.5.7, our research was used by a private feed company to formulate commercial [Total Mixed Rations \(TMR\)](#) for small ruminants. We [piloted](#) the [deconstruction](#) of straws/stovers using steam and chemical treatment methods with the Indian Institute of Chemical Technology. Regarding Outcome 3.6, the only milestone planned (3.6.4), was fully achieved. We developed a suite of best-bet agronomic practices to maximize cactus pear productivity in western Asia and northern Africa. To incentivize their adoption by livestock producers, a series of capacity development activities was conducted, including [two videos](#), [two webinars](#), [presentations](#), [manuals](#), [trainings](#), [expert meetings](#), or [posters](#).

Regarding **Outcome 3.8**, three milestones were completely achieved and one extended. For milestone 3.8.15, several new forages extension approaches were piloted, including radio broadcasts ([Kenya](#)) and e-learning courses ([global](#)). New extension material was developed (i.e. factsheets, [East Africa](#)), and forage demo plots and trainings ([Haiti](#), [Uganda](#), [India](#), [Kenya](#)) and a virtual [seminar series](#) on

	<p>sustainable cattle (>23,000 visualizations from 18 countries) were organized. For milestone 3.8.16, several business cases were described (Kenya/East Africa, India, Malawi, Ethiopia, middle East and northern Africa, synthesis), focusing on multiple types of forage businesses, including hay making, silage making, pelleting, and seed production. Additionally, various cost-benefit analyses were conducted on integrating improved forages into dairy and beef systems (Colombia) and Quality Declared Seed guidelines for forages drafted (Ethiopia). The technical basis for the Colombian Policy on Sustainable Cattle - developed with involvement of CRP researchers - was submitted to the Ministry of Agriculture and is currently under revision (milestone 3.8.17). Milestone 3.8.18 was partially achieved: The Colombian Roundtable for Sustainable Beef includes twelve independent regional roundtables. The establishment of three regional multi-stakeholder feeds and forages platforms in Kenya was postponed to 2021 due to COVID-19 lockdown measures.</p>
F4: Livestock and the Environment	<p>Progress was made towards milestone 4.1.4 (technology developers take environmental issues into account in research priority setting): the database of parameterized systems from CLEANED-X version 2 has been downloaded 184 times, while the CLEANED-X version 3 tool has been disseminated in five countries, with usage documented by national partners.</p> <p>The major tool contributing to milestone 4.2.2, quantification of environmental impacts guides the development and selection of productivity-enhancing options, is RHoMIS. Engagement with new partners (eg. McKnight Foundation) has enabled expansion of the tool's reach to new sites. Work on several analyses to identify pathways for sustainable intensification across different production systems continues, with one new analysis published in 2020.</p> <p>Our work on heat stress is the main contribution to milestone 4.2.4. (quantification of environmental impacts guides development/selection of productivity enhancing options in five countries). Two articles on quantifying the impacts of heat stress in East and West Africa were published, while a workshop and policy briefing on the potential effects of heat stress on pig production in Uganda were held.</p> <p>Considerable progress was made towards milestone 4.3 (five sustainable rangelands interventions in Kenya, Tanzania, Tunisia and Ethiopia are identified, tested and disseminated to livestock producers). The flagship is developing a toolbox for sustainable rehabilitation and management of rangelands in arid environments based on an integrated and multidisciplinary approach, with additional sustainable rangeland management (SRM) practices completed in partnership with IUCN including grazing management and direct seeding. More SRM practices will be added to the toolbox in 2021, when the toolbox is expected to be completed. In Tunisia, science-based rangeland monitoring and evaluation became the standard since national partners (development agencies) sensed the urgent need to improve their methodology and requested technical backstopping from ICARDA, which was provided in the form of on-the-job training. This change in behaviour is directly linked to their conviction of the need to rely on scientific data (4 criteria) developed earlier under this CRP, which are now being taken up by government agencies in Tunisia for sustainable management of the restored rangeland sites. Furthermore, two ISI papers were published in 2020 related to rangeland revegetation and governance.</p>

	<p>We also have made progress towards milestone 4.5.6 (tools, frameworks and processes for improved rangeland governance and management available in two countries): participatory rangeland management is being promoted through the Rangelands Initiative; a paper on policy engagement about rangeland management in Tunisia was published; a blog on Participatory Rangeland Management was posted; a briefing paper that summarizes CGIAR contributions to rangeland governance was completed; a film documenting land use planning for rangelands in Tanzania was produced; and, guidelines on PRM have been published.</p> <p>Finally, we made progress towards milestone 4.6 with the publication of a study analyzing the feasibility of Index Based Livestock Insurance (IBLI) in Ethiopia. The second contribution is a paper covering a synthesis of practices to consider when developing measurement, reporting and verification (MRV) for livestock greenhouse gas emissions in Latin America.</p>
F5: Livestock Livelihoods and Agri-Food Systems	<p>Regarding outcome 5.1 on analyses to guide livestock related priority setting, investment and policy development, two Livestock Master Plans (LMPs) were started (Odisha and the Gambia), while the Kenya LMP was initiated (milestones 5.1.6 and 5.1.7). ILRI engagement in the United Nations Food Systems Summit (UNFSS) started early to ensure that the contribution of livestock in sustainable food systems is well recognized and balanced.</p> <p>Outcome 5.2, closely linked to outcome 5.1, focuses on improved livestock modelling tools. Good progress was made on new modelling platforms – multisector and value chain – to support LMPs and more general impact assessment work, with piloting and application ongoing, also using online platforms. Work began on the development of the legacy product on training programs that institutionalize use and build capacity.</p> <p>The flagship progressed well with integration of gender considerations across other flagships (outcome 5.3 on gender equity considerations in livestock interventions), as illustrated with the completion of milestone 5.3.5 and a paper on using community conversations to transform gender relations in livestock communities in Ethiopia, including two papers on using a gender lens to improve the uptake of the infection and treatment method in the control of East Coast fever in Kenya (https://hdl.handle.net/10568/110090 and https://hdl.handle.net/10568/110127). Other progress under this outcome relates to the completion of a review of gender and livestock datasets that provides guidelines for improved collection and analysis of gender data in livestock systems.</p> <p>For the outcome 5.4 on Gender Transformative Approaches, the Women's Empowerment in Livestock (WELI) tool was applied in a project in Ghana and a study initiated on explorations of gender norms around women's involvement in chicken business in Tanzania. A brief on the gender transformative potential of seed systems was published. The Women's Empowerment in Livestock Business Index (WELBI) was further developed and tested it in Ghana; it is one of the Innovations reported by the flagship.</p> <p>Regarding outcome 5.5 on nutrition sensitive livestock interventions, an OICR is reported regarding the Rwanda National Early Childhood Development Program that revised its national maternal infant and young child nutrition (MIYCN) counselling cards based on research conducted as part of a Feed the Future Innovation Lab for Livestock Systems (LSIL) nutrition project intervention. A follow</p>

	<p>up project “Engaging men in supporting maternal and child consumption of milk and other animal source foods in Rwanda” was approved by the LSIL as a follow up of the Rwanda Reach nutrition project.</p> <p>For outcome 5.6 on technologies and multi functionality of livestock, the priority country work was delayed by the COVID-19 pandemic. A new module on livestock productivity for the Rural Household Multi-Indicator Survey (RHoMIS) was developed to be used by the priority country teams.</p> <p>Implementation activities related to outcome 5.7 on institutional arrangements were also delayed, while the Frontiers special issue on delivery systems for improved livestock value chain performance progressed. A series of surveys were conducted on the short-term effects of COVID-19 on the activities (production levels, sales) of livestock keepers and other actors in livestock value chains and results presented in various forums. Milestone 5.7.4 was completed, presenting the case of market sheds as a mechanism to improve market participation and earnings of small ruminant keepers in Ethiopia.</p>
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