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SPIA Ethiopia Report 2024: Building Resilience to Shocks

Solomon Alemu, Alemayehu Ambel, Amit Khanal, Frederic Kosmowski, James Stevenson, Lemi Taye, Asmelash Tsegay, Karen Macours

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Abbreviations

2WT	Two-wheel tractor
4WT	Four-wheel tractor
AgSS	Agricultural Sample Survey
AI	artificial insemination
AMF	Agricultural Mechanization Forum
ASS	Agricultural Sample Survey
ATA	Agricultural Transformation Agency
ATVET	Agriculture Technical and Vocational Education Training Center
AWM	agricultural water management
CA	conservation agriculture
CIAT	International Center for Tropical Agriculture
CIMMYT	International Maize and Wheat Improvement Center
CIP	International Potato Center
CSA	Central Statistical Agency
DSM	Direct Seed Marketing
DTMZ	drought-tolerant maize
EA	enumeration area
EIAR	Ethiopian Institute of Agricultural Research
ESPS	Ethiopia Socioeconomic Panel Survey
ESS	Ethiopian Socioeconomic Survey
ETB	Ethiopian birr
FAO	UN Food and Agriculture Organization of the United Nations
GOE	Government of Ethiopia
HA	Hectare
ICARDA	International Center for Agricultural Research in the Dry Areas
ICRAF	International Centre for Research in Agroforestry
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IFPRI	International Food Policy Research Institute
ILRI	International Livestock Research Institute
LSMS	Living Standards Measurement Study
MoA	Ministry of Agriculture
NGO	non-governmental organization

NRM	natural resource management
OFSP	orange-fleshed sweetpotato
OPV	open-pollinated variety
PATSPO	Provision of Adequate Tree Seed Portfolio in Ethiopia
PPR	Peste des Petits Ruminants
QPM	Quality Protein Maize
RBoA	Regional Bureaus of Agriculture
RRC	Rural Resource Center
SACCO	savings and credit cooperative
SAPLING	CGIAR Initiative on Sustainable Animal Productivity
SNNP	Southern Nations, Nationalities, and Peoples' Region
SPIA	Standing Panel on Impact Assessment
TSC	Tree Seed Center
USAID	United States Agency for International Development
WB	World Bank

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Executive Summary

Since the first SPIA country study report on Ethiopia (*Shining a Brighter Light: Comprehensive Evidence on Adoption and Diffusion of CGIAR-Related Innovations in Ethiopia* (Kosmowski, F., et al., 2020)) – hereinafter *SPIA's Country Study 2020* – the country has experienced a protracted civil conflict, repeated years of drought, a food security crisis, and the disruptions and shock of the COVID-19 pandemic. In this new report, we provide a unique national-level panel data perspective on the dynamic changes in the reach of agricultural innovations during these challenging times, leveraging the same nationally representative survey approach as we used in the 2020 report. This allows us to look at changes in the adoption and diffusion of agricultural innovations over the period 2018/19 to 2021/22.

This report updates the stocktaking of CGIAR-related innovations in Ethiopia and provides new estimates of adoption using the fifth wave of the Ethiopia Socioeconomic Panel Survey (ESPS 5). ESPS 5 is the product of a partnership among the Ethiopian Statistical Service (ESS, formerly Central Statistical Agency), the World Bank Living Standards Measurement Study (LSMS) team and the CGIAR Standing Panel on Impact Assessment (SPIA). Because conflict-affected areas could not be surveyed for ESPS 5 owing to the security situation, the dynamic analysis presented in this report concentrates on developments in 223 of the original 316 rural enumeration areas, with some data representativity in all major regions except Tigray. The main analysis in this report focuses on dynamic changes within the regions covered by the adjusted sampling frame, while also presenting amended estimates for 2018/19 to allow for panel comparisons.

The report documents the reach of CGIAR-related agricultural innovations in a comprehensive manner across the core domains of CGIAR research activity: animal agriculture; crop germplasm improvement; natural resource management; and policy research. To refresh the stocktaking exercise, SPIA carried out desk research and contacted focal points at the CGIAR Centers for updated information. To the 52 agricultural innovations identified in the 2020 report, we have added three additional innovations to the stocktake – the Healthy Baby Toolkit; community seedbanks; and participatory rangeland management – bringing the total to 55 innovations. To the 26 policy influence claims featured in the 2020 report, we have added nine additional claims, drawn from CGIARs outcome-impact case reports online collection. This brings the total to 35 policy influence claims.

The core of this report is the dynamic analysis of the scaling of innovations. The first and possibly most striking finding is that, despite three years in which the country suffered multiple compounded shocks, aggregate adoption rates for agricultural innovations have not fallen, and if anything, have increased. Second, while there continue to be a few innovations that are being adopted by multiple millions of rural households, the vast majority are only used by a much smaller number. The pattern of adoption hence continues to be represented by a skewed distribution, exactly what one should expect as an outcome from an effective innovation system. Third, the relative order of the innovations in terms of number of households reached, and notably the innovations reaching the highest number of households, has not changed. Fourth, there are a handful of innovations for which there have been strong increases in adoption rates, notably improved maize varieties (in particular, a large jump for drought-tolerant varieties), improved chicken breeds, improved forage grasses and planting of fruit trees. For maize and forages, in particular, evidence points to a role for intensive supply-side interventions as drivers for scaling. Fifth, we observe stability in the adoption rates for the landscape-level natural resource management (NRM) practices. And finally, dynamic changes show scaling pathways are not (always) monotonic, linear nor S-shaped. Partly as a result, different types of people continue to be reached by different types of innovations, with the reach for some innovations becoming more inclusive, while the opposite holds for others.

In aggregate, results show that between 5.8 million and 11.5 million Ethiopian households were being reached by agricultural innovations linked to CGIAR research in 2021/22. The upper-bound figure should be interpreted as the ‘potential reach’ of CGIAR in the country as many of the innovations in the upper bound are only weakly attributable to CGIAR’s efforts. Innovations with distinguishable markers of CGIAR effort, allowing for stronger attribution – namely, improved maize, Awassa 83 sweetpotato, orange-fleshed sweetpotato and kabuli-type chickpeas – returns the lower-bound figure of 5.8 million Ethiopian households. The lower bound needs to be interpreted in light of the fact that the data collection did not incorporate DNA fingerprinting data collection for other innovations expected to be at scale, such as improved bean and wheat varieties, owing to other studies being run featuring those crops. Initial national-level evidence for these innovations is starting to be provided from other sources, and we report on the results of separate DNA fingerprinting studies run by the Alliance of Bioversity International and CIAT, and CIMMYT, both carried out in collaboration with Ethiopia Institute for Agricultural Research.

In summary, we report continued progress on the scaling of agricultural innovations throughout a period of immense instability and multiple compounded shocks. For the estimated reach of agricultural innovations to have increased during this three-year period is a remarkable and surprising result, and points to the role these innovations play in households' and communities' resilience building.

Lobu village, Koromo, Hawassa Zuria district, Ethiopia 2015. Credit: CIMMYT/P. Lowe

Yosief Balewold general manager of Zereta-Kembata Seed multiplication and marketing union. Ethiopia, 2017. Credit: ILRI/ Apollo Habtamu

1. Introduction

SPIA's Country Study 2020 was the first to present SPIA's efforts to document the reach of CGIAR-related innovation comprehensively across the core domains of CGIAR research activity: animal agriculture; crop germplasm improvement; natural resource management; and policy research. To identify the right innovations, SPIA undertook a complete stocktaking exercise going back two decades, finding 52 agricultural innovations, and 26 claims of policy influence. Quantitative evidence on the extent of adoption of 18 of these innovations was obtained through the incorporation of relevant data collection approaches in the Ethiopian Socioeconomic Panel Survey (ESPS), a regionally and nationally representative panel survey of households. The report used some data from the third wave (ESPS 3, carried out in 2015/16), but our major focus was on ESPS 4 (2018/19).

These data also demonstrated the value of obtaining objective data on crop varietal identification by allowing an examination of the misclassification between self-reported data on adoption and the underlying true genetic identity of the varieties in farmers' fields established using DNA fingerprinting. Using self-reported data from farmers alone would have underestimated the adoption of improved maize varieties by 15 percentage points and would have led to erroneous conclusions about the characteristics of the adopters (SPIA's Country Study 2020; Alemu et al, 2024).

The main results from the report indicated that at least one innovation from each of the main domains of agricultural research (natural resource management, animal agriculture, and crop germplasm improvement) had been adopted at a significant national scale. For natural resource management, we observed widespread community-level adoption of soil and water conservation practices consistent with large-scale programs funded by the World Bank (WB) and other donors. In the case of animal agriculture, improved chicken breeds were found to be adopted by 13% of animal-owning households in 2018/19, up from only 5% in 2015/16. The report further documented relatively widespread adoption (63% of maize farmers) of CGIAR-related maize varieties, even as the age of varieties on farmers' fields was found to be quite high. On the other hand, the report also documented low adoption rates of many other innovations, despite a prior expectation that they may have scaled.

In this report, we revisit and update the analysis by drawing on a new source of data that allows us to document the dynamic changes in the reach of CGIAR-related innovations in Ethiopia. Building on the same collaboration as for Rounds 3 and 4 of ESPS (i.e. the Central Statistics Agency, now Ethiopian Statistics Service; World Bank Living Standards Measurement Study-Integrated Surveys of Agriculture (LSMS-ISA); and SPIA), SPIA incorporated the measurement of CGIAR-related innovations in the ESPS 5 survey (2021/22), allowing us to update estimates of adoption and reach of CGIAR-related innovations at the national and regional level, and to examine the changes over time.

This report provides an update to the 2020 report but does not replace it. The current report specifically focuses on the changes apparent in the data in the three years between the 4th and 5th survey waves – a period in which Ethiopia experienced a series of shocks affecting most aspects of economic life, including agriculture: namely, the COVID-19 pandemic; drought; a protracted civil conflict; and a food security crisis. This report therefore provides insights on the resilience of Ethiopian agriculture to such shocks.

2. Methods and Data

2.1 Overall Approach and Core Data Source

As discussed and motivated in *SPIA's Country Study 2020*[1], establishing the impact of CGIAR agricultural research for development requires documenting the reach of CGIAR-related innovations. While reach is not sufficient for impact, it is an important prerequisite. To document the adoption and diffusion of agricultural innovations linked to CGIAR research, SPIA developed a comprehensive, country-level framework (*SPIA's Country Study 2020*). This starts from a systematic stock-taking of all innovations resulting from the last two decades of CGIAR research, and an identification of which ones of those innovations are expected to have scaled sufficiently to be able to be observed in a nationally representative survey. It then builds on the incorporation of measurement tools for those innovations expected to have scaled into the household or community instruments of such a national representative data set, to provide independent rigorous estimates of the reach of each of the innovations separately, and of the portfolio of innovations together.

For the current report, SPIA continued its partnership with the Central Statistical Institute of Ethiopia (now the Ethiopian Statistical Service) and the World Bank's LSMS team to incorporate measurement of CGIAR-related innovations into Ethiopia's national panel survey, the Ethiopian Socioeconomic Panel Survey (ESPS). Taking advantage of the panel component of this survey enabled documentation of dynamic changes between ESPS 4 and ESPS 5. [2] While the first report allowed measurement of 18 different innovations and two policy-related influences, we built in additional measurement tools for the second version of the report, notably capturing three new innovations, resulting in a total of 23 innovations for which this document examines reach at scale with the ESPS data. Separately, we also included measurement improvements for three additional innovations aimed at better understanding their theory of change. As such, the ESPS dataset allows for analysis related to 26 innovations in total. For 17 of them, we have a measurement in at least two rounds (ESPS 4 or ESPS 3, and ESPS 5), which we use to document the dynamic changes (*Figure 1*). For the remaining innovations, such dynamic analysis will be possible with future rounds of the panel, if relevant measures are still incorporated and the survey continues being administered.

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[1] Given that this report provides an update of *SPIA's Country Study 2020*, we refer to it for a detailed discussion of the methods and approaches used, and we focus this section on the new elements relevant for the current report. The section, together with the annexes, aims to provide enough summary information so that the reader does not need to have the prior report at hand.

[2] The ESPS began as the Ethiopia Rural Socioeconomic Survey (ERSS) in 2011/12, which constitutes the first wave of a panel dataset of households from rural and small-town areas. Households that were interviewed in ESPS 1 in 2011/12 were tracked and re-interviewed in ESPS 2 (2013/14) and ESPS 3 (2015/16). The second and third waves are from rural, small towns, medium and large towns. In 2018/19 a new panel of households – ESPS 4 – started, and the sample extended to ensure the representativeness of regions that had previously been aggregated in an "Other region" category: Afar, Benishangul-Gumuz, Dire Dawa, Gambela, Harari, and Somali. These households were targeted to be revisited (forming a new panel) in 2021/22 for ESPS 5.

Figure 1: Innovation accounting

	2020 report	2024 report		
	ESS3 or 4	**ESS5 Second wave of panel data**	**New innovations in this round**	**Complementary measures** (re. impact pathway / theory of change)
Crop improvement	Maize (DNA)	Maize (DNA)		
	Barley (DNA)			Food vs malt
	Sorghum (DNA)			
	Orange-fleshed sweet potato (OFSP – Visual aid)	OFSP		
	Awassa-83 sweet potato	Awassa-83 sweet potato		
	Chickpea - *kabuli*	Chickpea - *kabuli*		Durum vs. bread
	Wheat			
Animal agriculture	Large ruminants	Large ruminants		Artificial insemination (better attribution)
	Small ruminants	Small ruminants		
	Improved chicken	Improved chicken		
	Improved forages	Improved forages		
Natural Resource Management	River dispersion	River dispersion		
	Motorized pumps	Motorized pumps		
	Treadle pumps	Treadle pumps		
	Soil and water conservation practices	Soil and water conservation practices		
	Broad-bed maker			
	Conservation agriculture (CA)	CA		
	Afforestation	Afforestation		
	Fruit tree cultivation	Fruit tree cultivation		
			2WT	
			Tree seed centers	
Policy	Productive safety net program (PSNP)	PSNP		
	Water user associations	Water user associations		
			Digital extension	

In addition, we report on estimates of reach for two other innovations – improved varieties of wheat and common bean – drawing on different data sources (Hodson et al, 2020; Habte et al, 2020).

The ESPS sample is a two-stage probability sample that was drawn for the 2018/19 survey (ESPS 4). The first stage entailed selecting primary sampling units, or Central Statistics Agency (CSA) enumeration areas (EAs), from the Agricultural Sample Survey (AgSS) sample of 1,600 enumeration areas (EAs). An EA usually consists of 150–200 households in rural areas (roughly corresponding to a village). EAs are the smallest subdivisions of the country for which agricultural census data are available. In each EA, 12 households are selected randomly from a complete listing of households. The ESPS 2018/19 was representative of all nine regions of Ethiopia and two administrative cities, Addis Ababa and Dire Dawa.

For ESPS 5, not all EAs from ESPS 4 could be revisited, due to the ongoing civil conflict. Of the 316 rural EAs targeted for data collection in ESPS 4, only 223 were included for data collection in ESPS 5. Most notably, all the EAs from Tigray were excluded from the sample, as well as conflict-affected EAs in other regions. In Afar, while 31 rural EAs had been covered by both the ESPS 4 agriculture and household modules, in ESPS 5 only 11 EAs were covered for both modules. During the fifth wave, security was also a problem in both the Amhara and Oromia regions, so there was a comparable reduction in the number of households and EAs covered there, (see Table 3.3. in ESS & World Bank, 2022). To adjust for the sample selection, we use the longitudinal and cross-sectional weights provided by the WB LSMS team for the relevant analysis. The ESPS 4 and ESPS 5 data, and its documentation, are publicly available (see World Bank).

2.2 Measurement

This report follows the same approach to measurement as *SPIA's Country Study 2020*, with some adaptations that reflect both the changed realities in 2021/22 and the lessons learned from the first report. Most notably, we continue to rely on DNA fingerprinting to measure the change in the reach of CGIAR-related maize varieties. To do so, we collected maize crop-cut samples from the same households from whom such samples were collected in 2018/19, using the same field protocols and relying on the same reference library and similar lab analysis. This provides us with a unique panel of maize DNA observations – the ideal dataset to quantify varietal turnover on farmers' fields. Appendix A and Alemu et al (in progress) provide full details of how we carried out maize varietal identification using DNA fingerprinting, details of the methods used to construct the panel and the panel selection issues that we needed to address.

While ESPS 4 also included DNA fingerprinting measures of sorghum and barley, the adoption rates of CGIAR-related varieties for both crops were shown to be low, and further research indicated this was unlikely to have changed in the short three-year period between the two survey waves. We therefore did not repeat sample data collection for these two crops, and we reserve the updating of the related adoption numbers for a later report. [3] As in ESPS 4, we rely on visual aids for crop varietal identification of sweetpotato varieties, and we re-incorporated visual aids for the crop varietal identification for chickpea (first measured in ESPS 3).

We continue the measurement based on validated survey modules for innovations resulting from NRM research and animal agriculture research. On the latter, we extend the number of forages included, building on information regarding the types of forages frequently distributed

[3] DNA fingerprinting for wheat was not included to avoid duplication with a CIMMYT-led DNA study that we referenced in the earlier report (Hodson et al, 2020). DNA fingerprinting for beans was not included to avoid duplication with both an Alliance of Bioversity International and CIAT*-led DNA study and planned data collection under the IMAGE program. DNA fingerprinting for chickpea was not included as there was to be a simultaneous study by ICRISAT. See Section 2.4 on how we include insights that are available for the wheat and bean studies in this report.
** In 2020, Bioversity International and CIAT merged to form the Alliance of Bioversity International and CIAT, referred to hereinafter as the Alliance.*

by the ILRI forage genebank. We further incorporate new measurement tools for two-wheel tractors, Tree Seed Centers/Rural Resource Centers, and video-based extension. These represent two CGIAR-related NRM innovations and one policy innovation, for which scaling was believed to have occurred. Finally, we included several supplementary measurement improvements in the ESPS 5 instrument, including questions regarding direct seed marketing (DSM), wheat, and barley, designed to better understand the theory of change of the related CGIAR innovations. While the detailed analysis of such questions is beyond the scope of this report, we detail the measurement for future use. See Appendix B for details on the measurement tools and methods used.

2.3 Data Analysis

The tables and figures presented in this report summarize the main empirical results obtained through a detailed descriptive analysis of the relevant data collected as part of the ESPS 4 and ESPS 5 surveys. While the report focuses on the main trends, detailed results on which the tables are drawn, complementary empirical analyses, as well as all the program files are available for replication and further analysis. We broadly follow the statistical methods and calculations used in *SPIA's Country Study 2020* and described in Section 2.4 of that report.

The main difference with the first edition of the report is our strong focus on examining dynamic changes between the two survey waves. To do so, wherever possible, we leverage the panel component of the dataset (i.e. the sub-sample for which we collect data from the exact same households in both survey waves). We focus our interpretation in this report on the innovations for which the dynamic changes were the largest, which then prompted us to collect some key complementary data. Most notably for maize crop varieties, we bring in data regarding seed distribution from administrative sources, as well as data regarding weather conditions and shocks, explained in more detail in Alemu et al (2024b). To understand the dynamic changes in forages, we complemented our quantitative data analysis with targeted expert interviews and qualitative fieldwork in July 2023 (further detailed in Section 4.4).

2.4 Analysis of Data on CGIAR-related Innovations with National Representative Data in Other Datasets

In addition to the innovations directly measured in ESPS, two CGIAR-related innovations were measured in separate national-scale data collection efforts for which results are available. Notably, for wheat, bean, and chickpea varieties, CGIAR Centers collected DNA fingerprinting data during a period that coincided with the ESPS 4 survey (Habte et al, 2021; Hodson et al, 2020; Melesse, 2019)[4]. To assure completeness, Section 4 will discuss the insights derived from the CIMMYT, the Alliance, and ICRISAT data collection efforts, following (to the extent possible) a similar logic as those used for the other innovations. We note, however, that the selection of the samples is different for these studies, as is the available evidence and analysis that we can draw on, making comparisons to other innovations challenging.

[4] In addition, a new round of DNA data for beans was collected under the IMAGE program in 2021/22 but those data were not finalized for use in this report at the time of writing.

3. Agricultural Innovations in Ethiopia: Stocktake Update

To inform the analysis, and ensure appropriate data were collected, we start from an update of the 2020 stocktake. For the 52 innovations listed in the 2020 stocktake, we systematically checked for any updated information. This resulted in updated information being compiled for 33 innovations. In many cases this simply entails updating further dates and/or locations of activities that have taken place since 2018. In addition, three innovations were added to the stocktake: participatory rangeland management (identified by ILRI as being distinct from woreda participatory land use planning that had been included in the stocktake in 2018/19); community seedbanks (identified by the Alliance as a gap in the previous version of the stocktake); and the Healthy Baby Toolkit (identified by CIP as a new innovation used in emergency response). Of the 26 potential policy influences we outlined in the 2020 report, five have updated information. A further nine policy influence cases were added, drawn from CGIAR's outcome-impact case reports online collection[5], bringing the total to 35 policy influence claims: the food-based dietary guidelines; the potato and sweetpotato strategy; picture-based insurance; work on value chains influencing USAID investments; climate change nationally determined contributions; Peste des Petits Ruminants (PPR) surveillance; agricultural index insurance design; genome editing guidelines and the National Framework for Climate Services. In the online stocktake file[6], any new innovation or policy influence entries are shaded in light grey, and existing innovations/policy influences with new information are bolded.

In the rest of this section, we zoom in on three CGIAR-related innovations that had data collection protocols included in the ESPS 5 2021/22 round for the first time: two-wheel tractors (2WTs), video-based extension and Tree Seed Centers (TSCs)/Rural Resource Centers (RRCs).

3.1 Two-wheel Tractors (2WTs)

CGIAR research has focused both on the agronomic rationale for 2WTs in Ethiopia (e.g. Baudron et al, 2015) and on the business models for promoting them, the latter as part of the long-run Africa Rising program. Following the schematic laid out by Diao et al (2012) and data from Justice and Biggs (2013), Baudron et al (2015) outline how low rates of household ownership of 2WTs may be overcome by showing the parallel with Bangladesh. The use of 2WTs is thought to be widespread in Bangladesh, a country in which over 80% of the land area is being mechanically prepared. Yet only approximately 3% of farmers own one. Nearly every 2WT owner in Bangladesh appears to be a service provider to their neighbors.

Action research by CGIAR partners and government agencies, and a series of government incentives, subsidies, and transfers, aimed to facilitate a shift from animal-drawn ploughing for land preparation (an ancient practice in Ethiopia) towards a system relying on service provision

[5] https://cgspace.cgiar.org/collections/4be13e90-af48-42a7-bc68-90ab4d2ccc1a

[6] The updated detailed stocktake is posted online as supplementary material to this report. Available here: https://cgspace.cgiar.org/bitstreams/fd0ccc66-4b74-44b4-9d96-05cc79307097/download

of small mechanization, following the Bangladeshi model. For example, in 2018 the Ethiopian government bought 100 2WTs and distributed them to service providers in 18 woredas. METEC, a government-owned company, later imported 3,000 2WTs that were then sold to private service providers in Amhara, Oromia, Tigray, and the Southern Nations, Nationalities, and People's Region (SNNP). During this time, the Agricultural Mechanization Forum (AMF) was formed in 2017 under the Ministry of Agriculture, with CIMMYT making financial and technical contributions. The objective of the forum is to bring different stakeholders together from the entire mechanization value chain to try and ease bottlenecks and facilitate uptake of the technology.

Berhane et al (2017) suggest that mechanization is rapidly increasing but from a very low base. Using ESPS data from 2013/14, they show that land preparation is dominated by the use of either livestock or hand hoes, with tractors of any kind representing only approximately 1% of plots. To what extent the efforts outlined above have shifted land preparation towards small mechanization on the ground and at scale is an open question. We, therefore, included a visual aid for 2WTs in the ESPS 5 2021/22 survey round, to detect use of 2WTs in land preparation (as distinct from ownership of these machines - see Appendix C).

3.2 Video-based Extension

IFPRI researchers conducted a randomized control trial of the effectiveness of a pilot program of video-based extension, implementing the study design and collecting data in 347 kebeles in 2017 (reported in Abate et al, 2023). The pilot was a collaboration between Digital Green, the Ethiopian Ministry of Agriculture (MoA), and the Regional Bureaus of Agriculture (RBoAs) in Amhara, Oromia, Tigray, and SNNP regions. The IFPRI-led impact evaluation found that video-based extension led to higher levels of agricultural knowledge and associated take-up of technologies across a wider audience than conventional extension approaches.

Following these evaluation results, the agencies involved in the pilot have worked to institutionalize the approach and scale its digitally enabled extension approach within the public system. Video-based extension is formally included in the Government of Ethiopia's second Growth and Transformation Plan and second Agricultural Growth Program, which paved the way for the MoA and the four Regional Bureaus of Agriculture (RBoAs) to procure equipment to scale up the approach into 45 districts in addition to the 71 project-supported districts (source: Digital green website) representing 115 out of 670 rural districts. Furthermore, five Agriculture Technical and Vocational Education Training centers (ATVETs) proceeded to incorporate video-enabled extensions into their training curriculum, and video-based extension was formally included in the digital transformation strategy in Ethiopia for 2025 as well as the Ten-Year Development Plan (2020-2030).

As part of the digital transformation strategy in Ethiopia for 2025, in 2019 the MOA launched FarmStack 'Digitizing Agricultural Advisory Services, a country-wide project' (2019-2024) influenced by early findings from the IFPRI study presented to them in 2018. FarmStack is a digital platform which will deliver location- and time-specific advice to farmers across multiple channels (video, SMS (via 8028), radio, etc.).

Digital Green has their own monitoring system (CoCo – Connect Online, Connect Offline) in which estimates of reach and adoption are tracked with administrative data. As of 2021, in an evidence review of Digital Green (ID Insight, 2021), the CoCo system reported 438,488 farmers as having been "reached", of which 249,259 were considered to have acted on information transmitted through this channel (corresponding to a rate of adoption of 57%, conditional on having been reached by the program). At the time of writing (November 11th, 2024), the most recent statistics presented on the Digital Green website for Ethiopia report that 36,600 farmer development groups have been reached in 13,000+ villages and that over 2 million farmers have been reached (34% female).

To obtain an independent estimate of the reach of digital extension, a targeted module was included in the community survey of the ESPS 5 2021/22 survey round to measure the presence/exposure to video-based extension. The household survey, in addition, asks about farmers' use of the digital hotline.

3.3 Rural Resources Centers/Tree Seed Centers

The first of their kind, Rural Resource Centers (RRCs) introduced to Ethiopia by ICRAF were piloted in semi-arid and sub-humid parts of Ethiopia. They produced 101,000 tree seedlings (e.g., Avocado, Guava, Mango, Papaya, and multipurpose and ornamental trees). The RRCs are implemented by youth groups in collaboration with MASHAV (a private company based outside of Ethiopia). ICRAF also played a substantial role in the 'Provision of Adequate Tree Seed Portfolio' in Ethiopia (PATSPO, 2017-20), supporting the Government of Ethiopia (GoE) in promoting and strengthening existing Tree Seed Centers (TSCs) and supporting the establishment of additional private and government seed dealers.

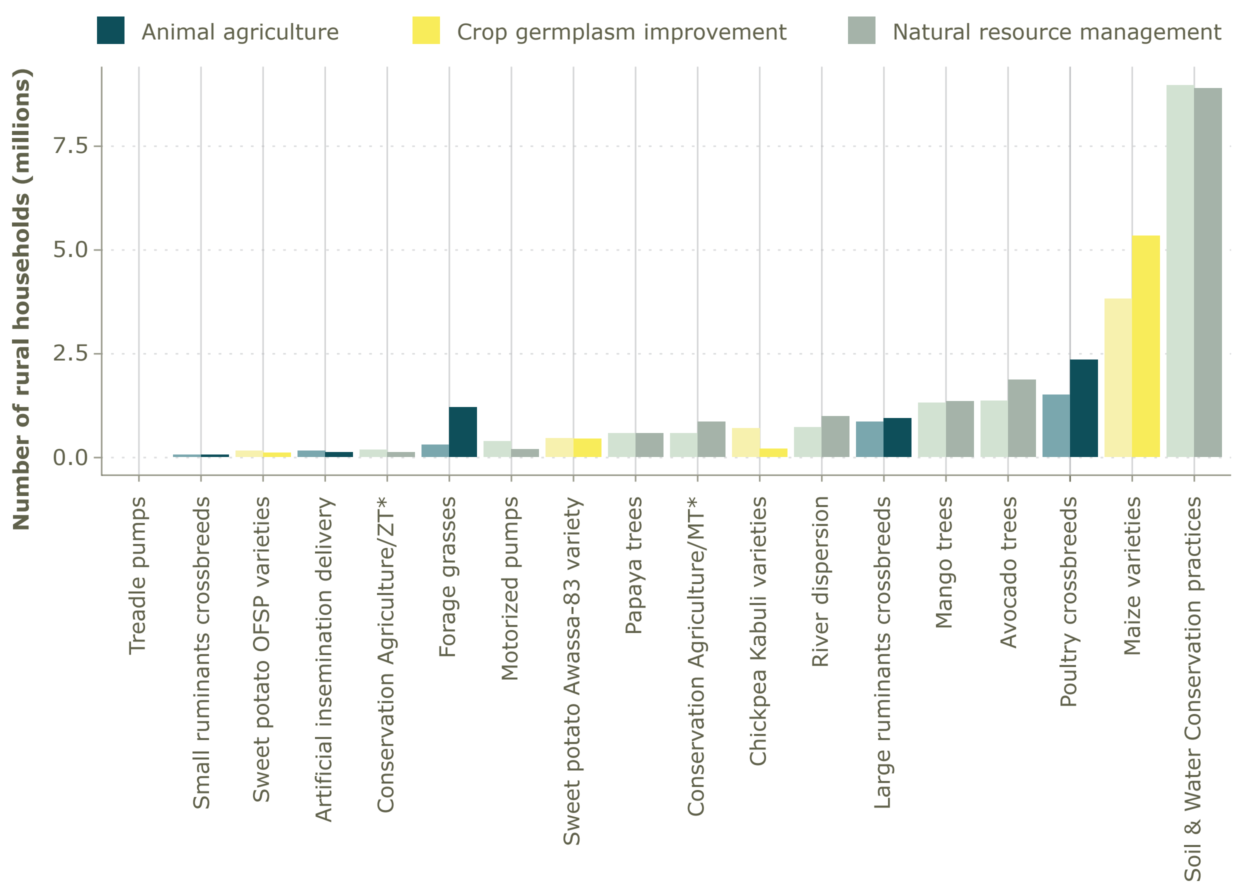
A question was included in the ESPS 5 2021/22 survey round to measure the availability of these RRCs and TSCs at the EA level. The question asks for the source of seedlings/plants of tree crops planted in the last five years. Answers related to "Youth Groups", "NGOs" (MASHAV is perceived as such in the field) or "Research Center" capture the contribution of RRCs. Answers related to "Government" or "Private nursery centers" may possibly have benefited from ICRAF's support through PATSPO.

4. Adoption Rates and Changes: The Dynamic Reach of CGIAR-related Innovations

4.1 Key Empirical Highlights

The availability of the panel data between 2018/19 and 2021/22 allows for an analysis of dynamic changes over time. For each of the 18 CGIAR-related innovations first measured in 2018/19, Figure 2 shows the number of rural households using those innovations in both 2018/19 (light bars) and 2021/22 (bold bars). This perspective allows us to draw several important conclusions. First, despite three years in which the country suffered multiple compounded shocks – violent conflict; the COVID-19 pandemic; drought; and a food security crisis – adoption rates for agricultural innovations have not fallen, and if anything, have increased. *Prima facie*, this speaks directly to the contributions that these agricultural innovations make in enhancing the resilience of Ethiopian's rural households.

Figure 2: Number of rural households adopting each CGIAR-related innovation in Ethiopia in 2018/19 (lighter bars) and 2021/22 (bold bars)



Note: Calculation based on longitudinal weights. For Chickpea Kabuli varieties comparison is between 2015/16 (ESS3) and 2021/22 (ESS5)

Second, note that the skewness of the distribution of adoption estimates that characterized the 2018/19 data is still present in 2021/22. In other words, while there are a few innovations that are being adopted by multiple millions of rural households, the vast majority of innovations are only used by a much smaller number. As discussed in *SPIA's Country Study 2020*, such a skewed distribution is exactly what one should expect as an outcome from an effective innovation system where investments in many innovations are being made, to allow a few of them to demonstrate themselves as being particularly demanded by many households.

Third, the relative order of the innovations in terms of number of households reached, and notably the innovations reaching the highest number of households, has not changed. Landscape-level NRM, improved maize varieties, crossbred poultry and improved fruit trees are still the innovations with the largest reach. The evidence continues to illustrate the importance of CGIAR as a system of innovations with selected efforts from its different centers all leading to large adoption rates. As discussed in more detail in *SPIA's Country Study 2020*, in all cases there is a clear narrative of scientific advances together with policy-related research feeding into specific government policies and programs that can help explain the scaling of these innovations. The persistence of high adoption levels for these individual innovations, despite the multiple shocks affecting the rural households during this period, speaks to the ability and the choices of households and communities to maintain investments in these innovations, once they have decided to adopt them.

Fourth, there are a handful of innovations for which there have been strong increases in adoption rates, notably improved maize varieties (in particular, a large upward jump for drought-tolerant varieties), improved chicken breeds and improved forage grasses. While the first two already had high adoption rates (i.e. they go from strength to strength), the jump in forage grasses is remarkable given the low initial levels in 2018/19. On the other hand, we observe a notable reduction of improved chickpea varieties. We focus on each of these developments below. Appendix D shows figures for the region-specific dynamic changes for improved maize, fodder and improved chicken.

Fifth, we note the stability of adoption rates of the landscape-level NRM practices. As many of these practices take time to materialize (as they involve tree planting or significant movement of earth, water and/or rocks) the stability of these measures is as expected, and therefore, arguably provides us with an indicator of high data quality (i.e. test, re-test validity).

Sixth, the dynamic changes show pathways are not (always) monotonic, linear nor S-shaped. While some innovations seem to suddenly increase from low levels, others decline or are stagnant.

4.2 Improved Maize Varieties

The ESPS 5 incorporated a new round of DNA analysis on maize, providing a unique national-level panel data set for crop varietal identification. While genetic turnover on farmers' fields is often thought to be a slow process, the panel shows a remarkable number of changes in crop varieties between 2018/19 and 2021/22. Maize crop varietal turnover in this period led to a large increase of maize varieties with CGIAR germplasm (from 62 to 75% of households), reaching more than 90% of EAs in Ethiopia's main maize producing areas (Table 1). Even more remarkably, the presence of drought-tolerant maize varieties almost doubled, with the share of maize producing households with drought-tolerant varieties jumping from 24 to 40%, and drought-tolerant varieties found in close to half of the EAs. These increases are mostly driven by large increases in Oromia and Harar (Appendix D, Figure 7). Given the frequent occurrence of drought in many of Ethiopian maize-producing areas, and the recurring concerns regarding the food security situation in the country, this points to an overall encouraging development.

Table 1: Summary of adoption rates at enumeration area (EA) and household levels (in %), and estimates for the absolute numbers of households (panel)

Innovation	Conditions applied	Adoption rate ESS5		Estimated number of adopting households ESS5	Adoption rate ESS4	
		% of EAs	% of households		% of EAs	% of households
Animal agriculture						
Artificial insemination use	Animal-owning households	5.6	1	**104,827**	4.5	1.4
Crossbred large ruminant	Animal-owning households	22.3	7.1	**919,105**	18.1	7,4
Crossbred small ruminant	Animal-owning households	3.7	0.4	**44,339**	2.1	0.4
Crossbred poultry	Animal-owning households	53.2	17.9	**2,340,820**	45.7	12.2
Forage grasses	Animal-owning households	42.8	21.5	**2,577,978**	N/A	N/A
Forage gras (Elephant, Sesbaniya, Alfalfa & Rhodes)	Animal-owning households	31.8	9.8	**1,189,717**	4.3	2.7
Crop germplasm improvement						
CGIAR maize varieties	Maize-cultivating households	87.8	75.1	**5,329,143**	75.7	62.6
Drought-tolerant maize varieties	Maize-cultivating households	47.3	39.6	**2,600,989**	32.4	23.7
Chickpea kabuli varieties	Crop-cultivating householdsa	4.4	1.3	**188,621**	16.3	4.7
Orange-fleshed sweet potato varieties	Crop-cultivating householdsa	6.8	0.7	**85,668**	6.2	1.2
Awassa-83 sweet potato varieties	Crop-cultivating householdsa	10.2	3.9	**429,917**	11.3	4.3
Durum wheat	Wheat-cultivating households	7.4	3.7		N/A	N/A
Malt barley	Barley-cultivating households	21.2	15.7		N/A	N/A
Natural resource management						
River diversion	Crop-cultivating householdsa	15.8	5.8	**977,793**	16.9	5.6
Motorized pumps	Crop-cultivating householdsa	13.6	1.1	**184,033**	10.2	1.7
SWC practices	Households with cultivated, pasture, fallow, or forest landa	78.5	68.9	**8,898,037**	78.5	71.6
Conservation agriculture (min. tillage)	Households with cultivated, pasture, fallow, or forest landa	20.3	6.7	**841,295**	18.1	4.3
Conservation agriculture (zero tillage)	Households with cultivated, pasture, fallow, or forest landa	4	0.7	**101,126**	6.2	0.9
Afforestation	Households with cultivated, pasture, fallow, or forest landa	28.8	13.6	**1,593,312**	24.9	10.1
Mango	Crop-cultivating householdsa	40.1	12	**1,323,471**	37.3	11.5
Papaya	Crop-cultivating householdsa	30.5	5	**560,803**	27.1	4.6
Avocado	Crop-cultivating householdsa	31.1	16.5	**1,857,049**	29.4	12.5
2WT		4.3	N/A		N/A	

Innovation	Conditions applied	Adoption rate ESS5		Estimated number of adopting households ESS4	Adoption rate ESS4	
		% of EAs	% of households		% of EAs	% of households
Policy influences						
Tree seed centers (Youth, NGO & research centers)	Rural EAs	1	N/A		N/A	N/A
Video-mediated extension services	Rural EAs	3.7	N/A		N/A	N/A
Productive Safety Net Program (PNSP)	Rural households	47.4	N/A		38.9	N/A
Water users associations	Rural EAs	50	N/A		57.7	N/A

Note: Note: All estimates are based on panel households in ESPS 5. All estimates use sampling weights to calculate the shares of EAs and households over the populations defined in the "conditions applied" column.

Sample includes all rural EAs, except for animal agriculture innovations, for which the sample includes rural and urban EAs.

[a] Where crops include both seasonal and permanent crops.

N/A: not available

2WT= two-wheel tractors, EA = emumeration areas, NGO = non-governmental organization

The increased use of CGIAR germplasm and drought-tolerant varieties goes hand in hand with a very noticeable decrease in the estimated genetic purity of the crop-cut samples over the same period.[7] Declines in genetic purity are observed for both hybrids and open-pollinated varieties (OPVs) and are particularly noticeable for the latter. The decline in genetic purity is observed for farmers reporting procuring seeds from governmental or related sources, as well as those obtaining them from the market or informal sources. Not surprisingly, the decline is steeper for the latter group (Alemu et al, *work in progress*).

The availability of panel data provides an important opportunity to measure varietal turnover in a very direct way. Table 2 shows that 20% of households switched from non-CGIAR to CGIAR-related varieties, but also 6% with the opposite switch. And while 36% of farmers switched to a more recently released variety, there are also 18% of farmers who in fact switched to an older variety. As a result, and accounting for the fact that there is a difference of three years between data collection rounds, the average age of maize varieties on farmers' fields remains 20 years. This implies that the dynamism observed does not reflect large-scale adoption of the most recent varieties, and further, that the pathway from release to large-scale adoption remains very long. Among other things, this means that recent breeding targets, such as for weather- and disease- or pest-related resilience traits, or protein enhancement, are not yet leading to results at a large scale. For instance, we failed to find any quality protein maize (QPM) varieties in farmers' fields. In 2018/19 we detected six cases of QPM adoption (varieties released in 2013 and 2016), but in 2021/22 the DNA analysis identified none of the samples collected as being of the QPM varieties.

Table 2: Calculation made on maize DNA panel incorporated in ESPS 5

		2021-2022	
		Not CGIAR germplasm	**CGIAR germplasm**
2018-2019	Not CGIAR-germplasm	16.10%	20.20%
	CGIAR-germplasm	5.80%	57.90%

See Alemu et al (work in progress) for details.

At the variety level, we do see large shifts for certain other varieties, with large increases for BH-661 and Limu (hybrids released in 2011 and 2012 respectively) but also for Kulani (an OPV released in 1995). The largest declines were found for Gibe1 (an OPV released in 2001) and for AMH-850 (Wenchi - a hybrid released in 2008). This pattern confirms there is no systematic shift to more recent varieties. Instead, the changes in the maize varietal mix observed can in part be explained by government-led distribution of specific varieties for the 2020/21 season.

This coincided with the transition of the Ethiopian Agricultural Transformation Agency (ATA) to an institute within the Ministry of Agriculture (called ATI since 2022). The program of seed system liberalization reforms known as Direct Seed Marketing (DSM), implemented in 235 maize-growing woredas in four main regions (Amhara, Oromia, Tigray, and SNNP), with important implications for maize seed availability, was implemented through ATA. While it is a bit unclear how the transition affected DSM and the related seed distribution on the ground,

[7] Collection of DNA samples and processing followed the same steps in 2018/19 and 2021/22. The same reference library was used, and the same laboratory performed the analysis. Changes in purity level therefore do not result from the data collection and analysis, but rather reflect real changes in the purity level of maize varieties found on farmers' fields.

the transition implies that there is no woreda-level data on the roll-out of DSM for 2020 or later which would allow more direct analysis. We do however have access to regional administrative data on variety-level seed distribution for the seasons of both survey rounds.

Using the regional-level administrative data on seed distribution we can analyze to what extent the changes in varieties in farmers' fields reflect changes in the varieties distributed by the government agencies at the regional level. Alemu et al (*work in progress*) show that regional changes in the varieties distributed by the government are predictive of the changes in varieties observed (through DNA) on farmers' fields. This is consistent with the government seed distribution likely playing a role in the varietal turnover observed.

Are the drought-tolerant varieties reaching the areas that are most likely to benefit from them? Alemu et al (in progress) shows that drought-tolerant varieties were indeed more likely to be found in areas where rainfall conditions were less favorable in the 2020-21 season. This could either point to optimal allocation of the government distribution efforts or could also partly respond to household demand. Apart from responding to climate conditions in the 2020-21 season, both the government, private sector actors and households may also base adoption decisions on recent drought experiences. Alemu et al (in progress) shows some evidence that supports this argument too. Together this suggest that drought-tolerant maize varieties are indeed found where they can expect to have a high return, a finding that supports the possibility that these varieties helped to boost climate resilience.

4.3 Poultry Crossbreeds

The positive dynamic in the adoption of poultry crossbreeds is a continuation of a strong positive trend discussed in *SPIA's Country Study 2020*, which showed an increase in adoption rates from 5 to 13% between 2015/16 and 2018/19. By 2021/22 the rate further increased to 18% of animal-owning households (Table 1). As discussed in the prior report, these positive dynamics can be explained by the diffusion of improved chicken breeds through public-private partnerships and ties in with interventions promoted by Ethiopia's Livestock Master Plan. As both the African Chicken Genetic Gains project and the Livestock Master Plan continued to 2020, it is likely that continued growth stemmed from a similar dynamic. Moreover, under the CGIAR Initiative on Sustainable Animal Productivity (SAPLING), at-scale delivery of improved chicken breeds in partnership with private-sector breeding companies remained a priority. The increase in adoption of poultry crossbreeds can be observed for almost all regions, with the shifts being the largest for Oromia (from 11 to 20% of households) and Benishangul Gumuz (7 to 17%), where adoption rates in 2018/19 had been still relatively low (Appendix D).

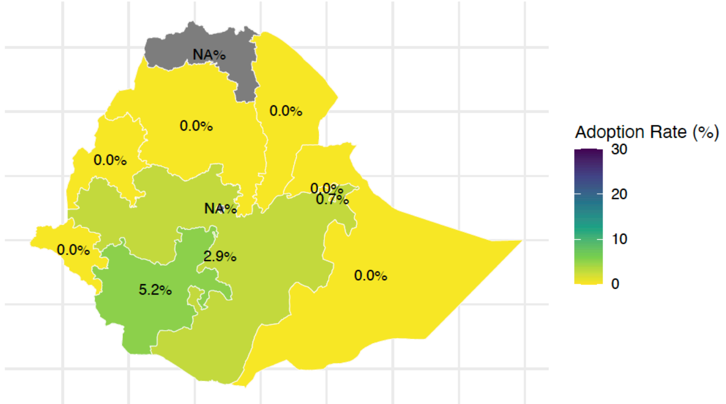
4.4 Forage Grasses

The increase in the use of forage grasses is arguably one of the most striking dynamic changes in the period between 2018/2019 and 2021/2022. The share of households reporting using a selected set of forages (Elephant, Sesbaniya, Alfalfa & Rhodes) nearly quadrupled from 2.7 to 9.8%. When a larger set of forages that can be linked to the ILRI genebank is considered, the share jumps further to 21.5%. Equally strikingly, the number of villages with the selected set of forages being used jumped from 4.3 to 31.8%, a seven-fold increase in a three-year period,[8] (Table 1).

Figure 3 shows that these increases mostly occurred in all of Ethiopian's lowland areas, where pastoralists' and semi-pastoralists' livelihoods dominate.

Figure 3: Maps of forage adopter changes

3A) Forage Adoption by Region: Wave 4 Panel



The map shows the proportion of households adopting improved forage varieties in each region.

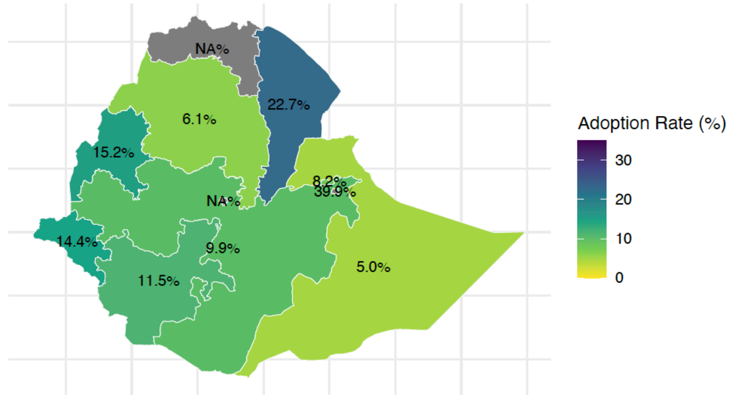
The improved forage varieties taken in Wave 4 Panel are: Elephant Grass, Sesbaniya, Alfaalfa, and Rhodes.

Adoption Rate is calculated as the proportion of adopting households to the total number of households in each region.

Areas in grey represent missing or unavailable data for adoption rates.

Using Panel Weights.

3B) Forage Adoption by Region: Wave 5 Panel



The map shows the proportion of households adopting improved forage varieties in each region.

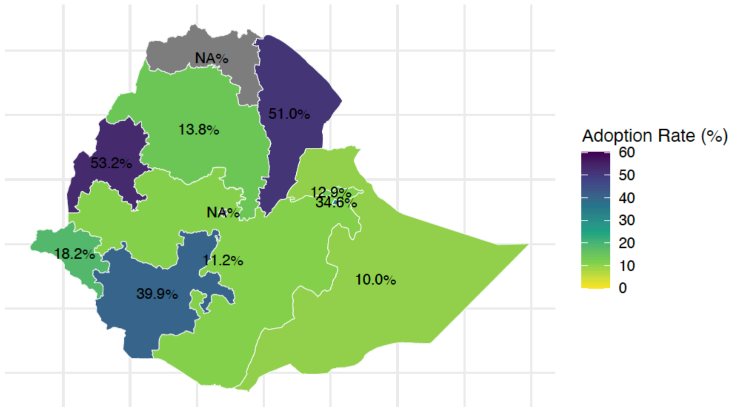
The improved forage varieties taken in Wave 5 Panel are: Elephant Grass, Sesbaniya, Alfaalfa, and Rhodes.

Adoption Rate is calculated as the proportion of adopting households to the total number of households in each region.

Areas in grey represent missing or unavailable data for adoption rates.

Using Panel weights

3C) Intensity of Forage Adoption by Region All Wave 5: 8 different varieties



The map shows the proportion of households adopting improved forage varieties in each region.

Adoption Rate is calculated as the proportion of adopting households to the total number of households in each region.

Areas in grey represent missing or unavailable data for adoption rates.

Using Static Wave 5 weights.

[8] Forage use had also been very low in the prior round of ESS (2015/2016) so recent changes seem to reflect a true increase and are not being driven by an anomaly in 2018/19.

Appendix D, Figure 8 shows that the (mostly) lowland regions with 0 adoption rates in 2018/19 all moved to positive numbers in 2021/22. There is a particularly large adoption in in Afar and Benishangul Gumuz, where by 2021/2022 more than 50% of animal-owning households relied on forages. At the same time, there are no large changes in either artificial insemination or in the use of crossbred large ruminants, indicating that this does not capture an overall intensification of the large ruminant sector, but rather a forage-specific development.

It also shows shares for each of the forages separately, by region. While Desho Grass is the most commonly used (10%), Elephant Grass, Alfalfa and Rhodes are all used by 4% of animal-owning households nationally. We also note some regional differences with Afar, for instance, showing shares above 17% of Desho Grass, Sesbania, and Elephant Grass in Afar, while Alfala and Rhodes Grass are relatively common in Harar. In addition, it shows that feed and forages are complemented in 8% of households with products from agro-industry.

ILRI's genebank has been a provider of high-quality forage germplasm in Ethiopia since 1983, distributing samples of improved forage species to private sector seed companies, NGOs and governmental research stations. The types of forage grasses included in the ESPS data were informed by the genebank's top distributed species. Improved feeds and feeding practices are promoted through NGOs, and regional governments, and several CGIAR projects have made efforts to kick-start investment by the private sector, leading to the establishment of Eden Field Agri-seed and the Ethiopian Seed Enterprise. While this was already discussed in *SPIA's Country Study 2020*, the data suggest that there has been a substantial scale-up of how such investments translate into access on the ground. By way of example, one of ILRI's partners, the Anatoli Animal Forge and Plant Seed Supply Enterprise, had 30 farmers doing seed multiplication in 2018/19. This had scaled to multiplication by 250 farmers by 2023.

Interviews with several key actors in the sector (both in Addis Ababa and in Afar), and qualitative fieldwork in Afar in July 2023, helped to further understand this pattern. Notably, there has been an increase in requests for seeds received at the Herbage Seeds Unit of ILRI. The highest peak of seed requirements occurred in 2020, with more than 3,500 kg of seeds distributed. NGOs, the government of Ethiopia, and the Food and Agriculture Organization of the United Nations (FAO) were the main recipients (Habte, 2023). Households do not seem to buy seeds directly, but instead gain access to fodder through distribution by NGOs and governmental actors. The process of seed multiplication involves several actors. After the seeds are distributed by ILRI, both research stations and private companies engage in multiplication. ILRI has been assisting forage and seed associations in gaining national recognition and ensuring seed quality.

In Afar, in particular, the region with the highest increase, the Ethiopian government has actively invested in irrigation and opened opportunities for private sector actors to produce in irrigated areas close to the Awash River. Fodder is produced alongside other cash crops. Fodder produced in this area is purchased by local governments and NGOs for subsequent distribution in the pastoralist and semi-pastoralist areas for emergency response during droughts. In areas away from the river, fodder production is very limited due to water limitations and *Prosopis* infestations (requiring large investments in uprooting and subsequent enclosures). Fodder production away from the river is mostly done by large private investors or NGOs who obtain land use permits from the regional government. Fodder prices have increased, driven by increased demand from NGOs and the regional government.

In summary, the increased fodder use observed in the ESPS 5 data therefore appears not to be driven by increased demand by rural households themselves, but rather is the result of government investments and emergency responses (by governmental, multilateral, and nongovernmental actors).[9]

[9] Dey et al (2022) confirm that the majority of the formal seed exchanges is through large institutional buyers such as NGOs and government offices.

4.5 Improved Chickpea Varieties

Table 1 shows the reduction in improved (Kabuli-type) chickpea, from 4.7% of crop-growing households in 2015/16 to 1.3% in 2021/22. This result goes against a narrative of a chickpea revolution in Ethiopia (as discussed, for instance, in Verkaart et al, 2017; 2019). For interpretation of the observed decline, first, note that there are two types of chickpea in Ethiopia, Kabuli varieties (which all have been introduced by both ICRISAT and ICARDA) and Desi varieties (some of which are local varieties, and others stem from research by ICRISAT). The Kabuli and Desi are visually distinct, both in the color of the flower and the color of the bean (Purushothaman et al., 2014), which serves as an observable feature because all released Kabuli chickpeas in Ethiopia are derived from CGIAR germplasm.[10] Measuring the adoption of Kabuli chickpea therefore gives a lower bound of CGIAR-introduced germplasm. Second, recall that the chickpea dynamics capture the evolution between 2015/16 and 2021/22, as improved chickpea was not measured in the 2018/2019 ESPS 4. Third, Ascochyta blight disease caused by *Ascochyta rabiei* and Fusarium wilt caused by *Fusarium oxysporum* have been identified as major problems for chickpea in multiple regions of the country, with yield losses that can go as high as 90 to 100% (Tessema et al, 2023; Negash et al, 2023; Bekele et al, 2021). Fourth, Ethiopia has exported chickpea for several years, particularly of Kabuli type. Trade disruptions related to COVID-19 and/or violent conflict within Ethiopia may have disincentivized farmers from cultivating Kabuli types. Finally, as chickpea in Ethiopia is mainly grown on residual moisture following the end of the main rainy season (mid-June to mid-September), weather conditions resulting in less residual moisture can also affect chickpea cultivation. Farmers switching away from the crop could be the natural consequence of these combined diseases, weather and trade stresses.

Data from the Agriculture Sample Survey (AgSS - CSA 2016; 2019; ESS, 2022) confirm there has been a 22% decline in the area under chickpea (all varieties) between 2015/16 and 2021/22. While CSA data from 2015 does not distinguish between Desi and Kabuli varieties, this distinction is made as of 2018/19 and shows that the decline from 2018/19 to 2021/22 was particularly large for Kabuli with a 40% reduction in area. As chickpea is grown on residual moisture following the end of the main rainy season (mid-June to mid-September), and as the ESPS survey visits for rural households fell between September to December 2021, and capture crops planted up to that point, it is also possible that some late planting of chickpea in 21/22 was not captured in the survey. This would only affect results for the highlands, however, as planning in the lowland (low moisture) area occurs earlier. More importantly, the pattern in ESPS broadly reflects the changes captured in AgSS with the share of households growing chickpea gradually falling from 2015/16 to 2018/19 to 2021/22, and the share of households with Kabuli types showing a much larger decline.

[10] While there are Kabuli landraces (one of which was released as a selected landrace in 1974), the seeds are much smaller than the released varieties and have much lower yields and are therefore considered to have been abandoned.

4.6 Other Innovations with Positive Trends

While we reviewed the most notable changes above, Table 1 also shows more modest increases in the reach of various other innovations, including conservation agriculture with minimum tillage (from 4.3 to 6.7%), though more similar increases were found for conservation agriculture with zero tillage. A more consistent pattern is observed for tree-related innovations with a reported increase of both afforestation (from 10.1 to 13.6%), and avocado trees on farmers' fields (12.5 to 16.5%), possibly reflecting the large emphasis on tree planting by the Ethiopian government in recent years.

4.7 Innovations Newly Measured in ESPS 5

As discussed in Section 2, the ESPS 5 data collection allowed us to incorporate measures of a number of new innovations: two-wheeled tractors, digital extension, and Rural Resource Centers. Following the logic of the country-level stocktake, these were incorporated because of expectations of them having scaled. Given the nature of the innovations, data were collected about them at the EA level in the community survey instrument. Table 1 shows that evidence of scale on two-wheel tractors, video-mediated extension services, or Tree Seed Centers that can be linked to CGIAR activities, all remains very limited.

4.7.1 Two-Wheel Tractors (2WTs)

Table 1 shows that 2WT use was only found in 4% of EAs. This is an order of magnitude smaller than expectations during key informant interview that motivated the inclusion of a measurement of 2WT use. While it is possible that some of the 2WT are used in the North and therefore in EAs that could not be covered due to the conflict, the data show that that at least outside of Tigray, the use of 2WTs is very limited. The data also shows that the share of EAs that have 2WT owners is similar to the share of EAs with 2WT users. *A priori* this also suggests that the model of dissemination, based on the idea that a market for services at the woreda level to be accessed by farmers in different communities, did not find widespread adoption. If that model were working, we should observe a larger share of farmers using 2WTs than actually owning them. Interestingly, this is indeed the pattern we see for 4WTs.

4.7.2 Digital Extension

Table 1 similarly shows that only 4% of communities report having benefited from video-based extension by 2021/22. While the Ministry of Agriculture had targeted a relatively large scale-up (according to some estimates 178 out of the 690 woredas), the ESPS data does not provide any evidence of large-scale exposure of farmers and communities. Data in the coming years could help distinguish whether this is just due to a delay in the scaling of the activities, or due to an inability of the program to reach the rural communities or other possible constraints.

4.7.3 Rural Resource Centers (RRC)

The ESPS 5 data show a low share of farmers reporting having planted trees that plausibly have their origin in a RRC. Hence while other evidence indeed points to significant activities in tree planting, in line with the strong government emphasis in this domain, the data suggests the RRCs may only have played a limited role on a national scale.

4.8 Innovations Measured In Other Studies

The results presented to date were all derived from the data collected as part of the collaboration with ESS and the WB-LSMS, which builds on a clear nationally representative sampling frame that allows to make inferences about the number of households reached. With the data and lab analysis being done by independent experts the results provide an objective estimate of that reach. As incorporating sampling for DNA fingerprinting into nationally representative surveys comes with a cost, the data collection (on purpose, and to avoid duplication) did not include sampling for DNA fingerprinting of crops for which other national-level crop varietal identification based on DNA was done in recent years. For completeness, this section therefore reports on the results of these other key studies, while pointing out that both the selection of the samples and the analysis of lab results and data followed a different process for these studies. This implies that direct comparisons with the innovations covered in the previous sections are challenging. Sampling frames notably do not allow the calculation of comparable numbers of the numbers of households reached with those additional innovations.

4.8.1 Wheat Varieties

Hodson et al (2020) provide a detailed account of varietal adoption in a nationally representative survey of wheat area in Ethiopia[11] by integrating DNA fingerprinting for wheat in the AgSS 2016/17. We summarize the main findings here as the results echo the relatively rapid take-up of the new technologies described in Sections 4.2 - 4.4 above.

Ethiopian wheat area is now dominated by bread wheat, with durum wheat representing only 4% of the sampled area. Ethiopia is the largest single producer of wheat on the continent and yet is still a net importer. Older bread wheat varieties are highly susceptible to stem and/or stripe rusts, and Ethiopia experienced epidemics of both, in 2010 and 2013 respectively. Breeding for resistance to these potentially devastating diseases has been the main focus of wheat improvement efforts in recent years. The findings from Hodson et al (2020) suggest that these relatively new rust-resistant varieties are finding their way into farmers' fields at a significant scale.

Initial work on wheat DNA fingerprinting was carried out at kebele level in 2014/15 in 239 kebeles, and this engagement was deepened to the household level and broadened to 432 kebeles in 2016/17. Thus, the data presented in Hodson et al (2020) present some evidence of dynamic change in the 239 kebeles observed in both waves of data collection. As we can see

[11] At the time of writing *SPIA's Country Study 2020*, we only had partial information from the related paper by Jaleta et al (2020) so we provide more details here.

in Table 3, and in Appendix E, new (post-2010) rust-resistant varieties are diffusing through the wheat-growing area. These new rust-resistant varieties were estimated to be cultivated on 43.8 % of the wheat area in 2016/17 (Hodson et al, 2020). Recent anecdotal evidence (Dave Hodson, personal communication) suggests that this trend has continued, alongside an expansion in the cultivated area of wheat.

Table 3: Data on dynamic change in bread wheat varieties (adapted from data reported in Hodson et al, 2020)

Variety	Year released	# Kebeles growing		Change	Comment
		2014/15	2016/17		
Kubsa	1994	137	104	-33	Stripe rust susceptible
Kakaba	2010	75	144	+69	Stem rust resistant
Danda'a	2010	22	68	+46	Stem rust resistant
Hidasie	2012	0	27	+27	Stem rust resistant
Ogolcho	2012	2	13	+11	Stem rust resistant

The area-weighted average varietal age suggests a stark divergence between durum wheat (39.1 years) and the figures estimated for bread wheat (12.8 years). In terms of the contribution to overall wheat area in 2016/17, varieties developed and released by Ethiopian Institute of Agricultural Research (EIAR) using germplasm received from ICARDA (durum) and CIMMYT (bread) represents 3% and 87% respectively. Relative proportions were found to be similar in the ESPS 5 data from 2021/22, with 4.3% of wheat-growing households reporting durum wheat, and the rest bread wheat.

4.8.2 Common Bean Varieties

Habte et al (2021) provide a detailed account of a varietal adoption study of the common bean area in Ethiopia, implemented by EIAR and CIAT in 2017. Data were collected from 1,122 bean-growing households across the main growing area for beans using a stratified sample that was drawn to be nationally representative of the growing area of beans. The final set of bean samples subjected to DNA fingerprinting is, however, no longer nationally representative because samples from 521 plots could either not be taken (as seed had already been harvested and sold/consumed at the time of the visit) or the seed samples from those plots were lost in transit from the field to the research station. Furthermore, of 1,046 seed samples that were taken, only 829 samples were successfully subjected to DNA fingerprinting. Thus, we report here the results from this selected sub-sample of 829 plot samples only.

While landraces and old improved varieties (Mexican142 and GLP585, the latter of which is not even released in Ethiopia) dominate the plots sampled by Habte et al (2021), Appendix F shows that nine improved varieties promoted under the tropical legumes projects (TL2 or TL3) had non-zero adoption in 2017, namely: Lehode, Awash_1, Anger, Hawassa_Dume, Cranscope, Nasir, Nazareth, Awash Melka and Argene. Among the subsample of plots with successful DNA fingerprinting, the share with positive identification of improved varieties in this study is 66.7%.

4.8.3 Chickpea Varieties

Melesse (2019) briefly reports on a DNA fingerprinting exercise carried out in Ethiopia by ICRISAT. Of 322 chickpea leaf samples collected from farmers and genotyped, 29% were matched to imported improved varieties with the remaining 71% matching to local chickpea varieties. While their data does not allow matching the genotyping results to the concurrently collected micro-level survey data, aggregate results suggest that 41% of farmers report cultivating an imported, improved variety, implying a significant degree of overestimation in this self-reported data.

5. Who Are The Adopters?

SPIA's Country Study 2020 documented that different CGIAR-related innovations were being adopted by different types of households. Indeed, while some innovations were shown to be more likely to be adopted by richer, younger, less remote, or more likely to be male household heads, the opposite was found for other innovations. Considering all innovations together showed an innovation system that is ultimately quite inclusive and caters to different types of households with different types of innovations (Alemu et al, 2024).

Table 4 shows that, broadly speaking, this pattern still holds in 2021/22. Most covariates are positively correlated with some innovations, while they are negatively correlated with others, confirming the idea of an innovation system in which different types of households adopt different innovations that may fit their preferences and circumstances better. Even so, Table 4 also shows that the variables that proxy for socioeconomic status or poverty (i.e. per-capita expenditures; ownership of productive assets; having off-farm income) do generally point to the poorer households now having lower adoption of some innovations, while this was not the case in 2018/19.

First, when focusing on specific covariates, we note that the correlation between the distance to markets and adoption of various innovations flips between 2018/19 and 2021/22. Conservation agriculture was previously positively correlated with distance to markets in ESPS 4 (i.e. more common in remote areas) while this now becomes positive in ESPS 5. For river dispersion, the change goes in the opposite direction, as it used to be more common in less remote areas in 2018/19 while the opposite holds in 2021/22. *A priori* this seems to indicate that proximity to markets may have become less of a driver for accessing innovations for some innovations but not others. Results on having asphalt road access further support this conclusion. Note that such shifts can be due both to the fact that road/access conditions may have changed over the period of the panel (due to road interruptions, investments, etc.), and to the innovations' adoption being differently affected by this access. Both seem to be at play. On the one hand, Appendix G confirms that for some EAs in the panel distances to markets indeed increased (with both the mean and the standard error of the distance being higher in 2021/22). As such, it is possible that changes in the correlations with distance to markets capture market displacement, potentially because of the conflict. On the other hand, analysis keeping the covariates constant at their baseline level (not shown) still shows different correlations for ESPS 4 and ESPS 5 indicating that the underlying relationship also shifted.

Table 4: Variables associated with the adoption of agricultural innovations in full sample of ESPS 5

Variable	"Total size of parcels"	"Distance to market (km)"	"Asphalt as a main access road"	"Livestock manager is female"	"Female share of family labor is > 50%"	"Annual consumption per capita (ETB)"	"Bottom 40% annual consumption"	"Productive asset index"	"Annual off farm income (ETB)"	"Age of household head"
Animal Agriculture										
Large ruminant crossbreed	1.46***	-3.23***	n.s.	n.s.	-0.05***	n.s.	n.s.	0.36***	4,189.81**	6.65**
Poultry crossbreed	0.65***	n.s.	n.s.	n.s.	n.s.	2,563.65**	n.s.	0.39***	n.s.	n.s.
Forage grasses	n.s.	-2.72***	n.s.	0.21***	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Forage gras (Elephant, Sesbaniya, Alfalfa & Rhodes)	n.s.	-2.10***	0.13**	n.s.	-0.04**	n.s.	n.s.	n.s.	n.s.	n.s.
Crop germplasm improvements										
Chickpea kabuli varieties	1.36***	n.s.	n s.	n.s.	-0.07***	n.s.	n.s.	n.s.	n.s.	n.s.
Maize varieties	n.s.	3.83***	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	-2,523.26**	n.s.
Drought-tolerant maize varieties	n.s.	5.57***	n.s.	n.s.	n.s.	n.s.	-0.14**	n.s.	-1,616.17***	n.s.
Natural resource management										
River diversion	-0.44***	5.58***	-0.10***	n.s.	n.s.	4,261.01**	n.s.	n.s.	-1,520.95***	n.s.
SWC practices	0.34***	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	0.31***	n.s.	n.s.
Minimum tillage CA	0.57**	-1.81**	0.11**	n.s.	-0.04**	n.s.	-0.18**	n.s.	n.s.	n.s.
Fruit trees (Mango, Papaya, Avocado)	-0.22**	-2.04***	0.06**	n.s.	0.06**	n.s.	n.s.	n.s.	n.s.	n.s.

Note: Note: Each cell is a coefficient estimate from a separate regression of the row variable on the column variable. For statistically significant relationships, the magnitude of the difference is indicated. Green shows a positive relationship while red demonstrates a negative relationship. All estimates are based on the full sample of households in ESPS 5. Data for distance to market and type of access road measured at EA level, with reported coefficient coming from household level regressions. The analysis excludes innovations adopted by fewer than 4% of households. Cross-sectional weights applied.

*** $p < 0.01$. ** $p < 0.05$. n.s = non-significant.

CA = conservation agriculture, ETB = Ethiopian birr (inflation adjusted), SWC = soil and water conservation.

Beyond this general trend, there have also been some other notable shifts in the three-year window, with the changes being illustrated in Table 5.

Table 5: Comparing association of variables with the adoption of agricultural innovations across waves in the ESPS (only for panel households)

	Total size of parcels		Distance to market (km)		Asphalt as a main access road		Livestock manager is female		Female share of family labor is > 50%	
	Wave 4	Wave 5	Wave 4	Wave 5	Wave 4	Wave 5	Wave 4	Wave 5	Wave 4	Wave 5
Animal Agriculture										
Large ruminant crossbreed	0.55***	1.08***	-3.90***	-2.39***	0.16***	n.s.	n.s.	n.s.	-0.04**	-0.06***
Poultry crossbreed	n.s.	0.50***	-1.84***	n.s.	0.10***	n.s.	0.06**	n.s.	n.s.	n.s.
Forage gras (Elephant, Sesbaniya, Alfalfa & Rhodes)	-0.48***	n.s.	-3.28***	-2.24***	-0.08***	0.12**	0.11***	0.18**	-0.05***	n.s.
Crop germplasm improvements										
Chickpea kabuli varieties	1.18***	1.43***	n.s	n.s	-0.14**	n.s	n.s	n.s	n.s	-0.08***
Maize varieties	n.s.	n.s.	2.40***	3.84***	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Drought-tolerant maize varieties	n.s.	n.s.	n.s.	5.30***	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Natural resource management										
River diversion	n.s.	-0.37***	-2.32***	7.03***	n.s.	-0.12***	n.s.	n.s.	n.s.	n.s.
SWC practices	0.65***	0.39***	6.40***	n.s.	n.s.	n.s.	0.06**	n.s.	-0.05***	n.s.
Minimum tillage CA	1.02**	0.64***	4.26**	-1.81***	n.s.	0.11**	n.s.	n.s.	-0.06***	-0.04**
Fruit trees (Mango, Papaya, Avocado)	n.s.	n.s.	n.s.	-1.79***	0.15***	0.06**	n.s.	n.s.	n.s.	0.05***

Note: Each cell is a coefficient estimate from a separate regression of the row variable on the column variable. For statistically significant relationships, the magnitude of the difference is indicated. Green shows a positive relationship while red demonstrates a negative relationship. All estimates are based on the panel households of ESPS 4 and ESPS 5 (with covariates and adoption rates measured in each wave), except for estimates for chickpea, which use data from ESPS 3 and ESPS 5. Data for distance to market and type of access road measured at EA level, with reported coefficient coming from household level regressions. The analysis excludes innovations adopted by fewer than 4% of households in ESPS 4 (with the exception of forages, given their large increase in ESPS 5) and innovations that are not measured in the same way in ESPS 4 and ESPS 5. Panel weights applied.

*** $p < 0.01$. ** $p < 0.05$. n.s = non-significant.

CA = conservation agriculture, ETB = Ethiopian birr (inflation adjusted), SWC = soil and water conservation.

	Annual consumption per capita (ETB)		Bottom 40% annual consumption		Productive asset index		Annual off farm income (ETB)		Age of household head	
	Wave 4	Wave 5	Wave 4	Wave 5	Wave 4	Wave 5	Wave 4	Wave 5	Wave 4	Wave 5
	n.s.	3,041.22**	n.s.	-0.16***	n.s.	0.34***	2,293.34**	3,370.51**	n.s.	5.84**
	n.s.	n.s.	n.s.	n.s.	n.s.	0.27***	-959.04***	n.s.	n.s.	n.s.
	n.s.	n.s.	n.s.	n.s.	0.75***	n.s.	-1,206.19***	n.s.	-6.29***	n.s.
	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s	n.s	n.s	n.s
	n.s.	n.s.	n.s.	n.s.	0.51***	n.s.	n.s	n.s	n.s	n.s
	n.s.	n.s.	-0.17**	n.s.	n.s.	n.s.	n.s	n.s	n.s	n.s
	n.s.	4,193.68**	n.s.	n.s.	n.s.	n.s.	n.s.	-1,236.67**	n.s.	-4.49**
	n.s.	n.s.	n.s.	n.s.	0.42**	0.33***	n.s.	n.s.	n.s.	2.81***
	-3,281.10**	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	3.31**
	-2,198.41***	n.s.	0.14***	n.s.	0.32***	0.17**	-760.49**	n.s.	4.51***	2.25**

Second, when focusing on individual innovations, we see remarkable shifts in the types of households adopting poultry crossbreeds, an innovation for which there is a relatively large increase in adoption rates. First, while poultry crossbreeds seemed to have been accessible for all kinds of households, with notably higher adoption for households with female household managers and lower off-farm income, some of the covariates in ESPS 5 show a less inclusive adoption pattern. Adoption of poultry crossbreeds is no longer more likely among female managers, and instead, we note higher adoption rates among households with larger land holdings and more productive assets (with the change compared to 2018/19 being statistically significant for all three of these covariates). While analyzing the underlying reasons for this shift is beyond the scope of this report, we flag that future research may want to investigate whether this pattern is resulting from market forces within the private-public partnership for improved poultry, from market imperfections that could be addressed with complementary interventions, or result from the particularly difficult combination of shocks affecting rural households during the period of the panel. Independent of the underlying reason(s), the pattern suggests that once adoption rates of innovations increase, the population gaining access to them does not necessarily include more of the marginalized or vulnerable populations.

By contrast, note that adoption of drought-tolerant maize varieties (and broadly of CGIAR-related maize varieties) continues to be at similar levels for different types of households in the main growing areas. If anything, adoption of drought-tolerant maize varieties has become more inclusive as adoption rates increased, with more remote households being more likely to adopt, while the poorest 40% no longer have lower adoption rates. None of the other covariates significantly correlates with the use of drought-tolerant maize, neither in 2018/19 nor in 2021/22. This is a crucial finding as it suggests that the climate-resilient seeds were available to a large segment of the population and are independent of typically observed variables often considered to be correlated with adoption (i.e. wealth, education, location).

Finally, we complete the analysis with information on the types of households using fodder grasses. This analysis was not included in *SPIA's Country Study 2020* as adoption rates had been low at the time of our first report. Table 4 shows that overall, there are a limited number of covariates that help explain adoption of forage grasses. One notable pattern is that more remote households (both in terms of distance to market and access to asphalt roads) have less access. The significant correlations related to gender do not point in the same direction, so probably should not be over-interpreted. Considering the dynamics, for the four forages that are measured in similar fashion across the two survey rounds, results in Table 5 show that quite a few predictors of adoption in ESPS 4 are no longer predictive in ESPS 5. Some of the changes point to more inclusive adoption along some dimensions (gender, age, productive assets) but other changes go in the opposite direction (with larger farmers and those with access to asphalt roads and those with off-farm income no longer less likely to adopt). This is consistent with fodder crop access being driven through new supply side factors that were not active in 2018/19, as discussed above. Distribution by government and NGOs is indeed likely to lead to different adoption patterns than more demand-side (spontaneous) adoption.

5.1 Are there changes in farm-level synergies between innovations?

The evidence above confirms that, as in *SPIA's Country Study 2020*, different types of households tend to adopt different types of agricultural innovations. As context and households' internal and external constraints differ, this naturally translates into households making heterogeneous decisions on the type of innovations to adopt, even if ultimately many of them adopted at least one of the innovations we measured. This fundamental heterogeneity does mean that households may not be deriving additional gains from possible synergies that exist between different innovations. For example, if fodder crops have higher returns for cross-bred animals, or if the use of conservation agricultural practices is likely to result in bigger gains if co-adopted with improved maize varieties, then maximal gains will only materialize if it is the same households adopting these combinations of innovations. Evidence of such farm-level synergies occurring remains very mixed. When considering changes between 2018/19 and 2021/22, we note that co-adoption rates between different innovations are relatively stable (Appendix H). Where there are shifts, we find slight shifts away from expected synergies, as improved maize varieties are now less likely to be found among households using conservation agricultural practices (compared to those that do not), while there was a slight positive synergy before. Similarly, the slight positive synergy found between animal crossbreeds and the use of improved forages in 2018/19 is no longer there in 2021/22 (as expected, given that adoption of forages occurs in the lowland pastoralist systems where crossbreeds are very rare).

Overall, these results, while in line with the earlier findings, have important implications. They suggest that CGIAR researchers may want to assume that synergistic adoption is the exception rather than the rule, implying that estimations (simulations) of expected returns from certain innovations are more realistic when they do not assume the other innovations will also be in place. For example, researchers may want to calculate feed conversion assuming traditional breeds rather than crossbreeds or might model the economic returns to conservation agriculture adoption without assuming the latest released maize varieties will be used. These more conservative analyses might provide information that is more relevant for real-world decision-makers than calculations that assume the optimal combination of inputs and practices being used.

5.2 What characterizes the new adopters?

Given that we have a number of innovations for which there have been relatively large positive shifts in adoption, one can wonder which types of households shifted over the three-year period from being non-adopters to adopters. Exploiting the panel dimension of the data can help us understand to what extent the increase in reach is benefiting those that CGIAR-related research was targeting.

Table 6 shows a very mixed answer to this question. First, among the innovations considered, new adopters are not more likely to be households with either a female head, female managers, or female labor force. Indeed, results go significantly in the opposite direction for four out of the six innovations, including conservation agriculture and crossbred chicken. New adopters for these two innovations are also skewed towards those with more land. The results show a slightly more positive result for the different welfare-related indicators. New adopters of maize with CGIAR germplasm are likely to have lower levels of per capita expenditures, and new adopters of feed and forages are more likely to be among the poorest 10% in the country. New feed and forage adopters are also more likely to live in remote areas, while the opposite trends hold for new adopters of maize with CGIAR germplasm and improved chicken. Overall, the analysis of the new adopters does not provide strong evidence of a more inclusive reach, with a few exceptions.

Table 6: Who are the new adopters?

	Total parcels size in HA per hh	HH-head is female	At least 1 female hh-member listed as owner in parcel title	Share of female family labor >50%	Nominal annual consumption per adult equivalent (ETB)	Bottom 1 consumption quintile	Bottom 1-2 (<40%) consumption quintiles	Productive asset index	Annual Off-farm income (ETB)	HH Distance in (KMs) to Nearest Market
SWC practices	n.s.	n.s.	n.s.	n.s.	2,819.78**	n.s.	n.s.	n.s.	-995.79***	n.s.
CA - using Minimum tillage	0.26**	-0.12***	n.s.	-0.03**	n.s.	n.s.	n.s.	0.25*	n.s.	n.s.
Fruit Trees (Avocado, Mango, or Papaya)	n.s.	n.s.	-0.11*	n.s.	n.s.	n.s.	0.12**	0.29**	n.s.	n.s.
Crossbred poultry	0.34***	-0.07**	n.s.	n.s.	n.s.	n.s.	n.s.	0.40***	n.s.	-17.74***
Feed and forages	n.s.	n.s.	n.s.	n.s.	n.s.	0.09***	n.s.	n.s.	1,256.16***	22.55***
Maize CG-germplasm	n.s.	n.s.	-0.20**	n.s.	-2,538.52*	n.s.	n.s.	n.s.	n.s.	-20.34***

Note: Each cell is a coefficient estimate from a separate regression of the row variable on the column variable. For statistically significant relationships, the magnitude of the difference is indicated. Green indicates that new adoption is progressive (toward smallholders, female farmers, poorer or more remote farmers) while red indicates new adoptions are less likely among those groups. All estimates are based on the panel households of ESPS 5.

*** p < 0.01, ** p < 0.05. n.s = non-significant.

CA = conservation agriculture, ETB = Ethiopian birr, HH = household, SWC = soil and water conservation.

6. Where Are The Adopters?

The regional representativeness of the ESPS data makes them well-suited for analyzing the geographical patterns in the reach of CGIAR innovations. With the panel data between ESPS 4 and ESPS 5, we can analyze whether the dynamic changes are concentrated in certain regions of the country, or areas with differential geospatial characteristics, which can help us understand their scaling pathways. In that light, we already discussed the most striking regional patterns for the innovations with the largest dynamic changes in Section 4. The new data also allow for region-specific analysis for other innovations, which can help identify the extent to which the average stability hides diverging dynamics across regions.

Furthermore, we can revisit the relationship between the location of the CGIAR research activities and the geospatial diffusion of the innovations. *SPIA's Country Report 2020* demonstrated that there was very little relationship between the location of the CGIAR research activities and the geographical spread of the innovations in 2018/19. With the new wave of data and given that adoption patterns and scaling can evolve over time and space, we revisit this question.

We updated the information on the location of CGIAR research activities to account for new activities that took place before the 2021/22 round. Appendix I shows that CGIAR research activities have expanded to a larger number of woredas. As a result, there is meaningful variation across the territory in terms of distance to these CGIAR research activities (Appendix J) which we exploit to analyze geographical diffusion.

With this information, we can revisit the correlation between distance to CGIAR projects and adoption of innovations in Table 7. Doing so reveals a pattern that is slightly different than in the first report. Notably, being only a short distance from a CGIAR research activity (less than 25km) does seem to positively correlate to adoption for large ruminant crossbreeds, forages, and improved chicken breeds, which is suggestive of some geographical diffusion, though it remains limited to those short distances. We do not find a similar pattern for small ruminants, orange-fleshed sweetpotato (OFSP), conservation agriculture, or avocado tree research activities, for which we broadly confirm earlier findings.

Table 7: Correlation between distance to CGIAR projects and adoption of innovations

	Woredads-Projects (N)	<25 km	25-49km	50-74km	75-99km	100-124km	125-149km
Animal agriculture							
Large Ruminants Crossbreeds	212	0.061*	0.024	-0.009	-0.109	0.143	-0.026
Small Ruminants Crossbreeds	49	0.007	0.0002	-0.007	0.009	-0.001	-0.007
Poultry Crossbreeds	21	0.119***	0.006	-0.051	-0.013	-0.04	0.012
Improved Forage Varieties	29	0.212*	-0.01	0.049	-0.079	0.126	-0.106
Improved Forage + PRM	67	0.101	0.057	0.08	-0.16	0.098	0.023
Crop agriculture							
Orange Fleshed Sweet Potatoes	82	-0.011	0.003	-0.0005	0.008	0.003	-0.005
Natural Resource Management							
CA (Minimum Tillage)	41	0.0002	-0.017	0.027	-0.002	0.033	-0.021
Avocado Trees	11	-0.012	0.104	0.143	-0.292*	0.189	0.245***

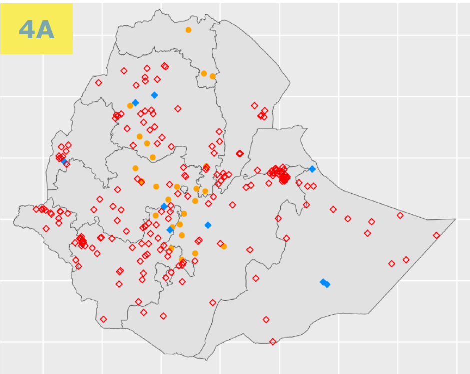
Note: Table shows correlation of adoption of innovations (rows) against distance to georeferenced locations at different cutoffs (columns). Coefficient estimates for each tested distance are provided and highlighted when statistically significant (*** p < 0.01, ** p < 0.05). Excluding innovations with less than 1% adoption rates, or less than 5 woredas with project data. CA = conservation agriculture, PRM = participatory rangeland management.

We investigate the spatial distribution for some of the innovations in more detail through a series of maps showing the location of CGIAR activities for a specific innovation, and indicators of adoption at the EA level. Appendix K, Figure 10 shows that while large ruminants can be found in all parts of the country, both the research and the adoption of crossbreeds occur predominantly in the highlands. Within the highlands, there does not seem to be any obvious higher concentration of adoption closer to research activities. Similarly crossbreed small ruminants (Appendix K, Figure 11) which are overall rare, or crossbred chickens (Appendix K, Figure 12), improved forages (Appendix K, Figure 13), and conservation agriculture (Appendix K, Figure 14) all do not seem to be much more likely to be found in proximity to research activities. Hence, while the correlation table above did suggest that very close proximity may aid diffusion, the overall location of adoption and research activity does not seem to be strongly correlated.

This pattern is confirmed most strikingly for two-wheel tractors. Figure 4, Map 4a, shows that the few EAs for which the ESPS data do show the presence of 2WTs are typically very far away from the related CIMMYT activities. Figure 4, Map 4b, shows that the adoption of four-wheel tractors (4WTs) is slightly closer to the location of CIMMYT activities, which possibly suggests that in places where farmers are ready to shift to mechanization, they have shifted immediately to 4WTs that are seemingly being supplied well by private markets. Together these figures raise questions about the effectiveness of action research on small mechanization, and it seems likely that adoption of different mechanization options is driven by other factors, including competitive market forces.

Figure 4: Spatial distribution of research activities promoting 2WTs and adoption data in ESPS 5

Two Wheel Tractors



The dots (orange) represent the Intervention Areas pertaining to Two Wheel Tractors Intervention (Wave 5).

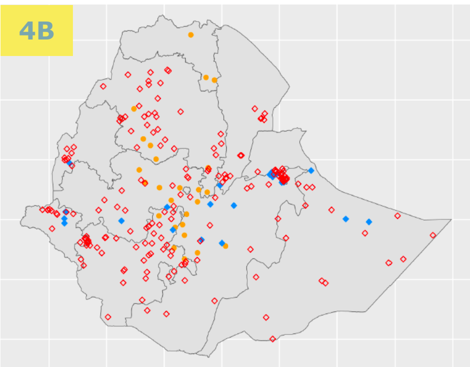
The diamonds (blue) represent the EAs with at least 1 HH adopting the Innovation.

The diamonds (red) not filled represent the EAs without the Innovation.

25 CGIAR Areas in Wave 5.

Note: 5a) Spatial distribution of research activities promoting 2WTs and data on their adoption in ESPS 5

Four Wheel Tractors



The dots (orange) represent the Intervention Areas pertaining to Two Wheel Tractors Intervention (Wave 5).

The diamonds (blue) represent the EAs with at least 1 HH with four wheel tractors.

The diamonds (red) represent the EAs without the four wheel tractors.

Note: 5b) Spatial distribution of research activities promoting 2WTs and data on adoption of 4WTs in ESPS 5

7. Estimating Overall Reach of CGIAR-related Innovations in Ethiopia

By collecting data on many innovations from the same nationally representative sample of households, we can also provide an estimate of the reach of the CGIAR at the system level. *SPIA's Country Study 2020* developed a methodology to do so, by calculating an upper and lower bound estimate. The upper bound is an estimate of the number of households reporting technologies or practices that have been subject to CGIAR research efforts, even if it does not imply that all these households *de facto* have benefited from a specific innovation that can be clearly attributed to CGIAR. The upper bound hence captures the number of households that in theory could benefit from CGIAR research efforts (a notable example being soil and water conservation methods). The lower bound estimate is calculated by restricting the calculation to those innovations that exhibit distinguishable markers of CGIAR's contribution based either on DNA fingerprinting or some clearly distinct visible features that allow us to use farmer self-reported data with confidence. For the ESPS panel, this includes CGIAR-related maize varieties (measured through DNA), Awassa 82 and orange-fleshed sweetpotato cultivars (measured through visual aids), and Kabuli chickpea (measured through visual aid). This is a lower bound given that the ESPS could not possibly include such features for all CGIAR innovations.

Following the same methodology, and using the panel dimension of the survey, we show that by 2020/21 the lower bound estimate had increased to 5.8 million rural households, and the upper bound had increased to 11.5 million. The latter represents 87% of rural households potentially reached by CGIAR research efforts. The lower bound is also a remarkable increase (up from 3.8 million for the population represented by the panel in 2018/19), driven largely by the increase in the adoption of maize varieties with CGIAR germplasm. An important consideration when interpreting these calculations is that the 2020/21 survey did not include Tigray because of the ongoing conflict so these calculations exclude households using CGIAR-related innovations in that region.

8. Conclusion

This report highlights the value of having panel data collection sustained over time, to build a rich picture of the role of innovations at a country level. This report draws on data that reveals continued progress on the scaling of agricultural innovations throughout a period of immense instability in the country and compound shocks. Between the 2018/19 and 2021/22 survey waves Ethiopia lived through disruptions caused by the COVID-19 pandemic, drought, and an extended civil conflict. For the estimated reach of agricultural innovations to have increased during this three-year period is a remarkable and unexpected result.

Looking across the universe of CGIAR-related agricultural innovations in Ethiopia, we can see that the growth is in part driven by fast scaling of drought-tolerant maize in particular, the adoption of which almost doubled in a three-year period. Other innovations with remarkable growth were fodder crops and (to a somewhat lesser extent) improved chicken breeds and fruit trees. While rigorously parsing out the reasons for each of these jumps goes beyond the scope of this report, we point in each of these cases to clear supply-side factors that likely were influential to different extents. This includes government and NGO distribution of seeds and forages, in addition to further implementation of policies conducive to scaling, as we first discussed in *SPIA's Country Study 2020*.

The dynamic analysis in this report allowed the revelation of key stylized facts on the scaling of agricultural innovations. As such the report and the underlying data provide a window on the possible learning from even longer-term dynamic panels. The positive trends observed in the scaling of agricultural innovations suggest that they may still have a major role to play in years to come to enhance rural household resilience and help them adapt to the ever-changing environment. Combining future panel data collection with information on resilience-building policies and programs could have a particularly large potential to disentangle the supply and demand side factors driving the diffusion of agricultural innovations at scale.

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Farmer Matebe Marisa prepares maize porridge with her baby Yaned Matiwas in her kitchen. Yubo village, Wondo Genet, Ethiopia, 2015.
Credit: CIMMYT/ Peter Lowe

Appendices

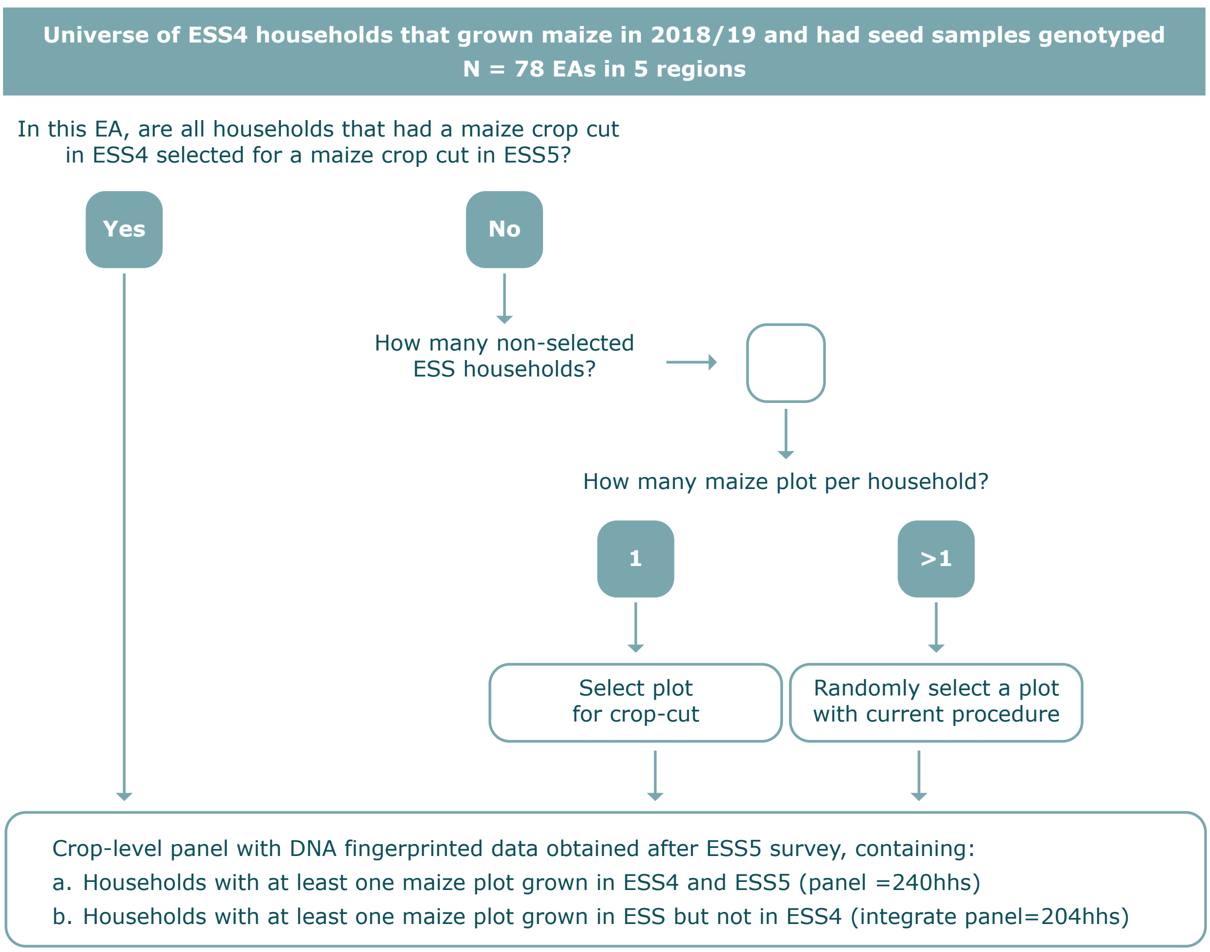
Appendix A. Maize Varietal Identification Using DNA Fingerprinting

A1. Sampling details

For the ESPS 5 (2021/22), SPIA in partnership with ESS and WB LSMS team implemented:

1. Maize DNA fingerprinting by collecting samples on a maize plot of ESS households that were sampled for DNA fingerprinting in ESPS 4 (i.e., households with maize crop cuts in ESPS 4), performing additional crop-cuts in case all their maize plots are left out by the random selection in the ESPS 5.
2. Collecting maize DNA fingerprinting on ESPS 5 households growing maize in ESPS 5 but not growing maize in ESPS 4, allowing to obtain varietal identification for new maize growers. Vice versa, some households growing maize in ESS 4 will have stopped growing, and hence will not be sampled. See Figure 5 for more clarification.

Figure 5: Decision tree to guide enumerators selecting maize crop samples in the ESPS 5



Hence, as summarized in Table 8, SPIA managed to collect 488 samples from 78 EAs in five regions where maize samples were collected in the ESPS 4 (n = 97). The data collection resulted in a total of 292 samples taken from the 230 panel households, for DNA fingerprinting.

Table 8: Summary of the sampling for maize DNA fingerprinting in ESPS 4, ESPS 5 and panel component (ESPS 4 and ESPS 5)

Region	ESPS 4			ESPS 5			ESPS 4 + ESPS 5			
	#EA w/ Maize DNA	#HH w/ Maize DNA	#Plot w/ Maize DNA	#EA w/ Maize DNA	#HH w/ Maize DNA	#Plot w/ Maize DNA	#EA w/ Maize DNA	# Panel HH w/ Maize DNA	#Plot w/ Maize DNA	#HH w/ Maize DNA-missing from the panel HHs
Tigray	26	90	97							90
Amhara	33	125	134	22	110	111	21	60	63	65
Oromia	28	100	107	20	108	123	20	61	74	39
SNNP	21	83	103	21	136	146	20	72	96	11
Harar*	12	47	63	13	74	91	11	35	56	12
Dire Dawa	2	2	2	2	16	17	2	2	3	
Total	**122**	**447**	**506**	**78**	**444**	**488**	**74**	**230**	**292**	**217**

Note: Maize DNA sample implemented in 78 EAs out of 97 EAs planned. Due to security problems, the number of maize samples collected has been reduced. This reduction is explained by the inability to collect data from 44 EAs in the three regions: Tigray (26 EAs), Amhara (11 EAs), Oromia (8 EAs).

EA = enumeration area, HH = household.

A2. Laboratory analysis (genotyping details)

Laboratory analysis of the ground samples of maize flour followed the methods used in *SPIA's Country Study 2020* as closely as possible. The reference library used in the analysis was the same set of varieties as used on the earlier survey round, and the same protocols for sample handling and genotyping were used as described in that report, as follows:

"The barcoded, dried field samples were transported to the ILRI campus in Addis Ababa, where they were dried further and then ground to obtain 50 grams of flour. DNA from this material was extracted in Addis Ababa using Qiagen DNeasy plant mini kits. Plates containing the DNA samples were then shipped to the Diversity Arrays laboratory in Canberra, Australia, for genotyping by sequencing using the DarTSeq platform. The DarTSeq platform uses a combination of a proprietary complexity reduction method and next-generation sequencing platforms, described in Kilian et al. (2012). N For each sample approximately 200,000 fragments of DNA are sequenced, while matching relies on 20,000 polymorphic markers represented as counts of either of two nucleotide states. The counts for field samples are compared with allele counts of the references and the proportion of alleles present in the field samples that are absent from the reference are regarded as impurities. The purity score is determined by taking the difference between one and the proportion of impurity. For each sample, the reference with the highest purity score is assigned as the crop variety name. Additional outputs for analysis include the genetic separation between reference library samples as well as the sequenced genomic data." (SPIA's Country Study 2020, p. 19).

Appendix B. Overview of Measurement of CGIAR-related Innovations in the Ethiopian Socioeconomic Survey

Table 9: Overview of measurement of CGIAR-related innovations in the Ethiopia Socioeconomic Survey

#	Innovation	ESPS 3 (2015/16)	ESPS 4 (2018/19)	ESPS 5 (2021/22)	ESPS 5 Variables
Crop germplasm improvement					
1	Improved maize Variety		DNA_data$subbinReferences & S4$s4q01b == 2	DNA_data$subbinReferences & S4$s4q01b == 2	Maize crop-level panel DNA data has collected Maize crop samples: 488 samples Implemented EAs: 80 EAs out of 93 EAs planned 12 EAs suspended due to security; 1EA due to drought
2	Chickpea kabuli varieties	w3S4$Chickpea_type			What does the chickpea flowers look like?
3	Direct Seed Marketing (DSM)* / **			PP. S4 q14b	Added private dealer/companies to categories at the household levels. SEEDS ROSTER, Who/Which firms/institutions were the sources of the [SEED] that you purchased or purchased on credit during the [CURRENT AGRICULTURE SEASON]?
4	Orange-fleshed sweetpotato	w3S4$SP_OFSP	w4S4$SP_OFSP	PP. S5. q3	What does the sweetpotato flesh look like? (show visual aid)
5	Hawassa 83 sweetpotato	w3S4$ SP_Awassa83	w4S4$SP_Awassa83	PP. S4. Q25	What does the sweetpotato skin look like? (show visual aid)
6	Durum and Bread wheat**			PP. S4. Q26	ASK ONLY FOR WHEAT: (CROP CODE=08) Is this wheat planted in this [FIELD] a Durum wheat type/ variety? 1. Yes 2. No 3. Don’t know
7	Food and malt barley**			PP. S4 q14b	ASK ONLY FOR BARLEY: (CROP CODE=01) Is this barley planted in this [FIELD] a Malt barely type/ variety? 1. Yes 2. No 3. Don't know
Animal agriculture				PP. S4 q14c	
8	Large ruminant crossbred	w3ls_sec_8_1q02	w4S8$ls_s8_1q03	S8$ls_s8_1q03 and PP. S8.3. q2b	Strengthen attribution by adding a) a question on ear-tagged animals - PP. S8.3. q2b
9	Large ruminant crossbred	w3ls_sec_8_3q02	w4S8$s8_3q02	PP.S.8.3 q2	Strengthen attribution by adding whether public/private farm artificial insemination (AI) service was used.

Appendix C. Visual Aid to Identify Adoption of Two-Wheel Tractors

Figure 6: Farmers with two-wheel tractors

Code one: Two-wheel tractor attached with seeder/for direct planting
ባለ 2 ጎማ ትራክተር ለእቀባ/እርሻ ሳይታረስ/ ዘር ለመዝራት የሚያገለገል መዝሪያ ማሽን
Tiraaktera abbaa gommaa- 2 kan osoo qonna hin qotin sanyii faccaasuf kan fayyadu

Appendix D. Changes in Adoption Rates of Selected Innovations, by Region

Figure 7: Drought-tolerant maize

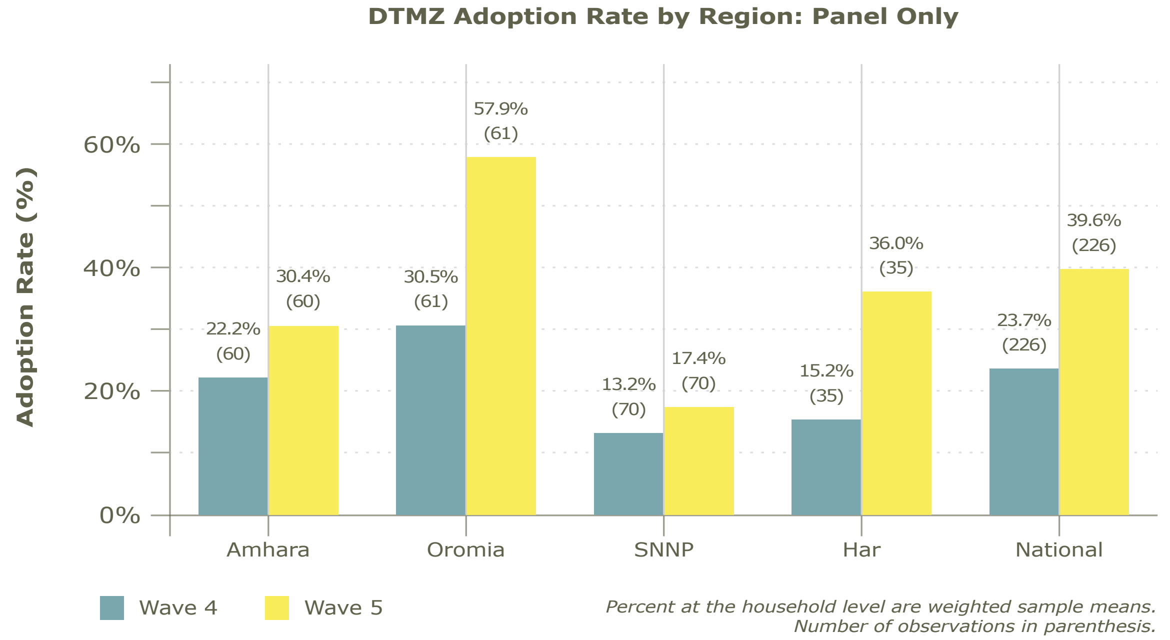


Figure 8: Improved forages

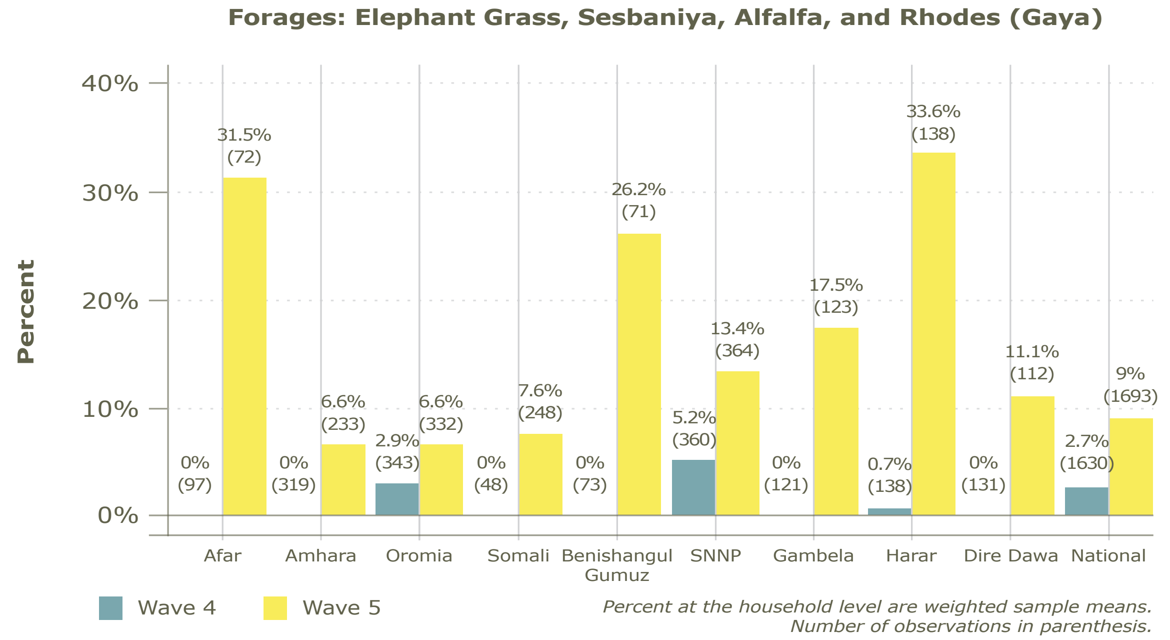
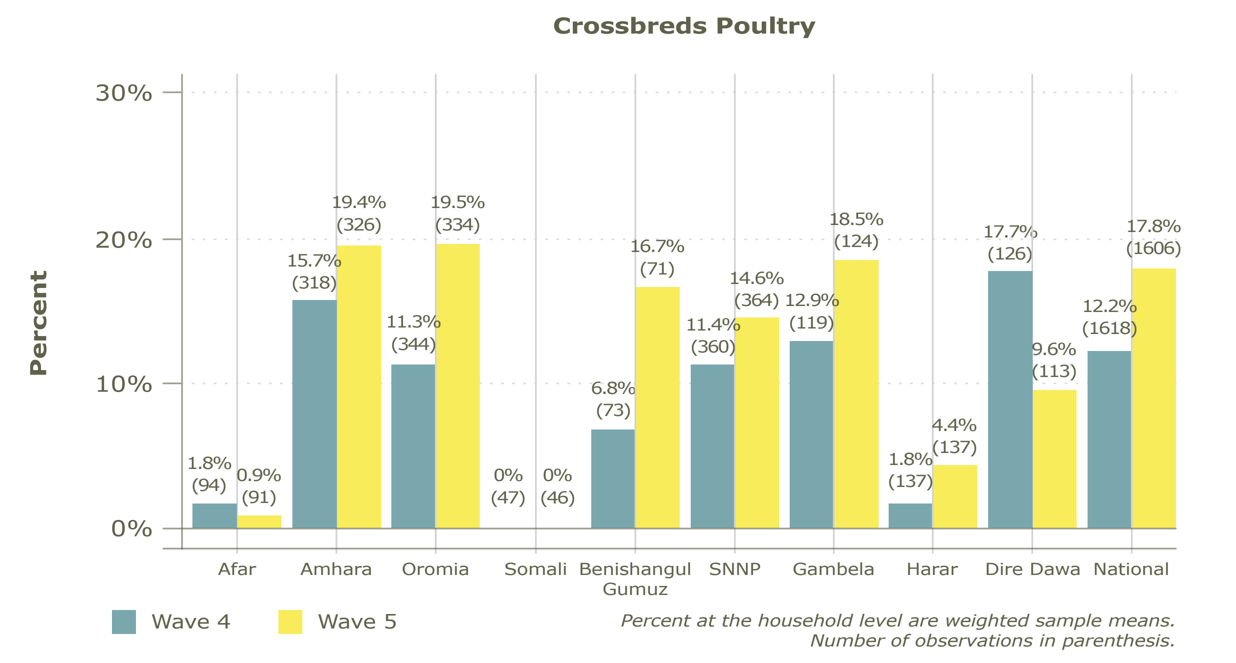


Figure 9: Crossbred poultry



Appendix E. Estimated Share of Ethiopian Wheat Area in 2016/17, by Variety

Table 10: Estimated share of Ethiopian wheat area in 2016/17, by variety, with new (post-2010 releases) rust-resistant varieties highlighted (adapted from Hodson et al, 2020)

		Wheat area		
Variety	**Year released**	**Area (‘000 ha)**	**Individual (%)**	**Cumulative (%)**
Kakaba	2010	183.1	27.1	27.1
Kubsa	1995	86.6	12.8	39.9
Digalu	2005	69.7	10.3	50.3
Danda’a	2010	65.7	9.7	60.0
Galema	1995	39.2	5.8	65.8
(Bobicho / Senkegna)	2002	35.0	5.2	71.0
Pavon-76	1982	24.2	3.6	74.6
Hidasie	2012	20.1	3.0	77.5
Ogolcho	2012	18.8	2.8	80.3
Arendato (durum)	1967	15.0	2.2	82.5
Hawi	1999	13.6	2.0	84.6
Simba	1999	13.1	1.9	86.5
Tussie	1997	11.3	1.7	88.2
Huluka	2012	7.8	1.2	89.3
Sirbo	2001	7.4	1.1	90.4
Mada Walabu	1999	6.9	1.0	91.5
Lasta (durum)	2002	5.8	0.9	92.3
Bolo	2009	5.6	0.8	93.2
Others	1967 – 2016	46.2	6.8	100.0
Total		**674.9**		

Appendix F. Bean Adoption Study Results Using DNA Fingerprinting in 2017

(Adapted from Habte et al, 2021)

Table 11: DNA fingerprinting results for common bean from Habte et al (2021)

Variety	Traits	Year of release	Share of plots (%)	
			Individual	Cumulative
Landraces	-	N/A	33.3	33.3
Mexican142	Small seeded; white; for canning / export; often considered a landrace now	1973	26.7	60.0
Lehode	For canning / export	2010	9.9	69.9
GLP585	-	1982	9.8	79.7
Awash_1	Small seeded; white; for canning / export; high yielding; resistant to common bacterial blight and halo blight diseases	1990	8.9	88.6
Anger	Small seeded; dark red; for consumption / domestic market; high yielding; moderately resistant to anthracnose, angular leaf spot and common bacterial blight diseases	2005	3.4	92.0
Hawasa_Dume	Small seeded; red; for consumption / domestic market; high yielding; resistant to common bacterial blight and angular leaf spot diseases	2008	2.2	94.2
Roba_1	Small seeded; creamy; for consumption / domestic market; fast cooking; high yielding; moderately resistant to leaf blight diseases	1990	2.1	96.3
Cranscope	Large seeded; speckled; for canning / export; early maturing; high yielding; moderately resistant to common bacterial blight and halo blight diseases	2007	1	97.3
Nasir	Small seeded; red; for consumption / domestic market; high yielding; resistant to common bacterial and halo blight diseases	2003	0.8	98.1
Lyamungu_85	-	1985	0.7	98.8
KWP9	-	2014	0.4	99.2
Nazareth	Small seeded; white; for canning / export; high yielding; resistant to common bacterial blight and halo blight diseases	2005	0.4	99.6
Awash Melka	Small seeded; white; for canning / export; high yielding; resistant to common bacterial blight and halo blight diseases	1999	0.2	99.8
ADP40_ KATWELA	-	N/A	0.2	100
Argene	Small seeded; white; for canning / export; high yielding; resistant to common bacterial blight and halo blight diseases	2005	0.1	100

Note: Varieties promoted by the tropical legumes projects (TL2 or TL3) are highlighted. Varieties not formally released in Ethiopia are missing their trait information but are given year of release for other countries where relevant

Appendix G. Descriptive Statistics on Correlates

Table 12: Descriptive statistics on correlates

Variable	Wave 4			Wave 5		
	Observations	Mean	SE	Observations	Mean	SE
Smallholder context						
Total area per household (ha)	1,806	1.02	0.03	1,793	1.07	0.04
Main access road surface is tar/asphalt (%; EA-level)	172	12.8%	0.03	174	14.4%	0.03
Distance to nearest large weekly market (km; EA-level)	172	6.08	0.79	174	7.64	1.11
Distance to nearest informal savings and credit cooperative (SACCO) (km; EA-level)	172	17.44	2.60	174	12.96	1.41
Gender, social inclusion, and youth						
% of households with female head	1,811	21.2%	0.01	1,806	22.9%	0.01
% of households with at least one female member listed on a parcel title	1,189	69.1%	0.02	1,235	77.2%	0.01
% of households with a female livestock manager/keeper	1,527	89.3%	0.01	220	68.0%	0.04
% of households with female share of family labor > 50%	1,817	5.5%	0.01	1,793	7.1%	0.01
Age of household head (years)	1,811	44.23	0.49	1,806	46.64	0.48
Nominal annual consumption per adult equivalent (ETB)	1,811	13,424	320.13	1,806	14,562	330.3
% of households in bottom 20% of annual consumption	1,811	24.5%	0.01	1,806	27.0%	0.01
% of households in bottom 40% of annual consumption	1,811	48.2%	0.02	1,806	49.1%	0.02
Asset index	1,811	2.86	0.03	1,806	1.94	0.03
Productive asset index	1,811	1.57	0.04	1,806	1.42	0.04
Annual off-farm income (ETB)	1,811	1,812	156.95	1,806	2,195	377.4

Note: All estimates are based on the panel households of ESPS 4 and ESPS 5. Note that the gender of the livestock manager/keeper is missing for a large share of households in ESP S5, limiting comparability.

ETB = Ethiopia birr

Appendix H. Synergies Among Different Innovations

Table 13: Synergies among different innovations

	AWM & SWC practices		Conservation Agriculture (CA)		Agroforestry practices		Forages		Animal crossbreeds		Maize – CGIAR germplasm	
	Wave 4	Wave 5	Wave 4	Wave 5	Wave 4	Wave 5	Wave 4	Wave 5	Wave 4	Wave 5	Wave 4	Wave 5
AWM & SWC practices	-	-	3.5%	4.9%	11.7%	14.0%	5.0%	8.6%	10.8%	15.2%	53.2%	61.5%
Conservation Agriculture (CA)	3.5%	4.9%	-	-	1.4%	1.7%	0.2%	0.9%	0.4%	1.5%	3.4%	6.2%
Agroforestry practices	11.7%	14.0%	1.4%	1.7%	-	-	1.0%	1.3%	3.6%	4.5%	9.9%	16.6%
Forages	5.0%	8.6%	0.2%	0.9%		1.3%	-	-	1.3%	2.1%	3.0%	9.7%
Animal crossbreeds	10.8%	15.2%	0.4%	1.5%	3.6%	4.5%	1.3%	2.1%	-	-	10.9%	18.1%
Maize - CG germplasm	53.2%	61.5%	3.4%	6.2%	9.9%	16.6%	3.0%	9.7%	10.9%	18.1%	-	-

Row variable is >=10% more likely to be adopted given the column variable is adopted

Row variable is 1-10% more likely to be adopted given the column variable is adopted

Row variable is 1-10% less likely to be adopted given the column variable is adopted

Row variable is >=10% less likely to be adopted given the column variable is adopted

Note: AWM = agricultural water management, SWC = soil and water conservation

Appendix I. Georeferenced Location of CGIAR Activities

Table 14: Overview of georeferenced location collected and retrieved for CGIAR-related areas of activity

Innovation	N (Project level data)- SPIA report- 2018/19 Report	N (GPS retrieved)- 2018/19 Report	N (Project level data)- new/ additional locations-2022	N (Project level data)- (GPS retrieved-2022)
Animal Agriculture				
Large ruminants crossbred	144	134	101	78
Small ruminants crossbred	27	40	12	9
Poultry crossbred	23	21		
IBLI	-		17	11
National Livestock Market Information Systems (NLMIS)	-		47	26
Delivery of improved forage varieties			30	29
Participatory Rangeland Management (PRM)			41	38
Crop germplasm improvements				
Improved sorghum varieties	4	3		
OFSP	87	82		
Public Private Partnership for barley seed dissemination	62	58		
Crop variety recommendations with citizen science	-		24	23
Faba bean			15	15
Improved barley varieties			9	9
Potato			3	3
Rust resistant wheat varieties			53	49
Other improved wheat varieties			23	23
Soil and water conservation	21	6		
Two-Wheel Tractor (2WT)			35	25
Total	435	390	418	344
Soil and water conservation	21	6		
Two-Wheel Tractor (2WT)			35	25
Total	**435**	**390**	**418**	**344**

Note: Project-level data were obtained using project documents, communications and interviews with scientists. Project-level data include zones from which all woredas were retrieved. The gray highlight indicates innovations not included in *SPIA's Country Study 2020*, Appendix Table 31. We exclude maize-related locations as these are analyzed separately.

Appendix J. Summary Statistics on Distances to CGIAR Activities

Table 15: Variation across EAs in distance to CGIAR research activities

	Share of EAs in the sample located at ... km distance of a CGIAR research activity					
	25	**50**	**75**	**100**	**125**	**150**
Large Ruminants Crossbreeds	0.304	0.432	0.487	0.529	0.554	0.618
Small Ruminants Crossbreeds	0.215	0.447	0.561	0.635	0.684	0.732
Poultry Crossbreeds	0.178	0.369	0.447	0.574	0.641	0.713
Improved Forage Varieties	0.085	0.199	0.275	0.364	0.431	0.499
Improved Forage + Participatory Rangeland Management	0.163	0.411	0.561	0.669	0.724	0.778
Orange-Fleshed SweetPotatoes	0.121	0.274	0.415	0.479	0.516	0.549
CA (Minimum Tillage)	0.101	0.28	0.559	0.664	0.731	0.765
Avocado Trees	0.074	0.167	0.231	0.28	0.324	0.42

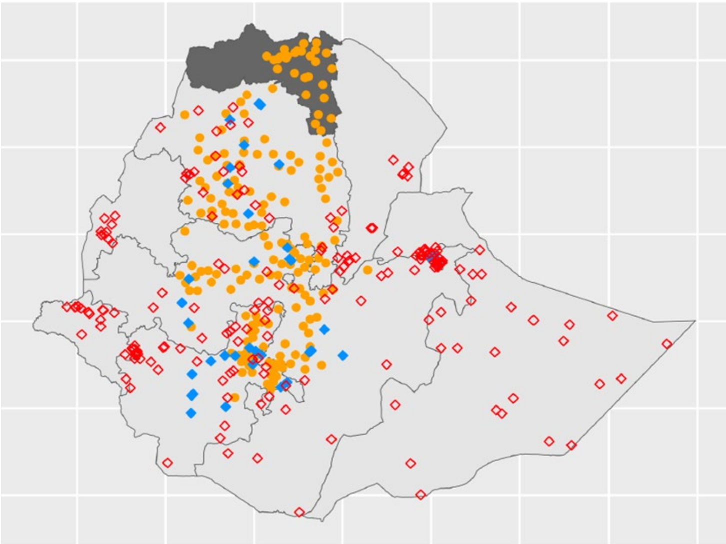
Note: Distance to CGIAR research activity is calculated based on the woreda-level data of the location of the research activity and the EA-level GPS coordinates

EA = enumeration area

Appendix K. Maps of Locations for CGIAR-related Projects and Adoption of Large Ruminants, Small Ruminants, Crossbred Chickens, Forage Varieties, and Conservation Agriculture

Figure 10: Adoption of large ruminants

Large Ruminants CrossBreeds



The dots (orange) represent the Intervention Areas pertaining to Large Ruminants Crossbreeding (Wave 4 & 5).

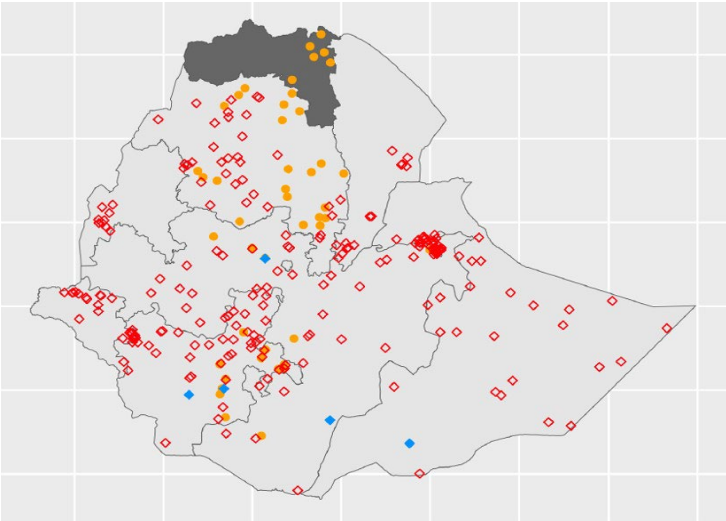
The diamonds (blue) represent the EAs with at least 1 HH adopting the Innovation.

The diamonds (red) represent the EAs without the Innovation.

78 CG Areas in Wave 5 & 134 in Wave 5.

Figure 11: Adoption of small ruminants

Small Ruminants CrossBreeds



The dots (orange) represent the Intervention Areas pertaining to Small Ruminants (Wave 5).

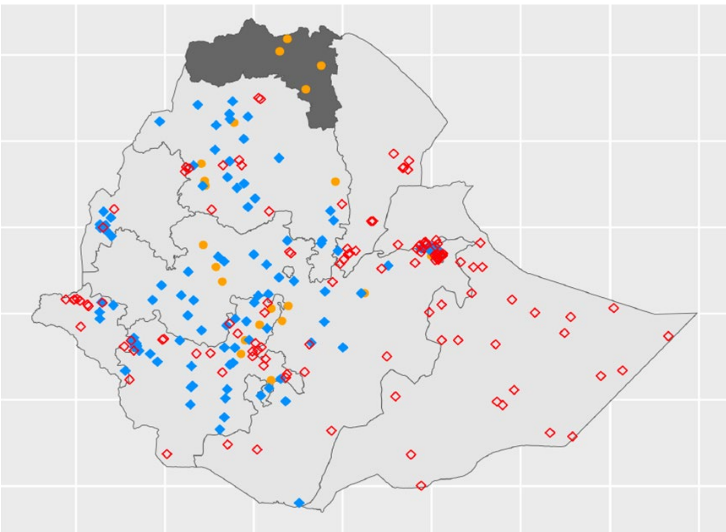
The diamonds (blue) represent the EAs with at Icast 1 HH adopting the Innovation.

The diamonds (red) represent the EAs without the Innovation.

Only 5 EAs.9 CG Areas in Wave 5 & 40 in Wave 4.

Figure 12: Adoption of chicken crossbreeds

Poultry CrossBreeds



The dots (orange) represent the Intervention Areas pertaining to Poultry Crossbreeding (Wave 4).

The diamonds (blue) represent the EAs with at least 1 HH adopting the Innovation.

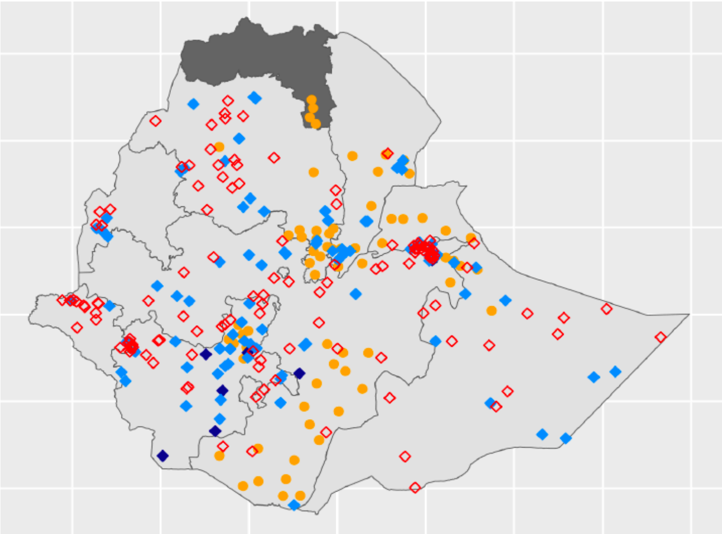
The diamonds (red) represent the EAs without the Innovation.

21 CG Areas in Wave 4.

Figure 13: Adoption of forage varieties

Improved Forage Varieties: All 8 Forage Varieties

CGIAR intervention areas: Improved Forage Varieties and PRM



The dots (orange) represent the Intervention Areas pertaining to Improved Forage Varieties and PRM.

The diamonds (dark blue) represent the EAs with all HHs adopting the Innovation.

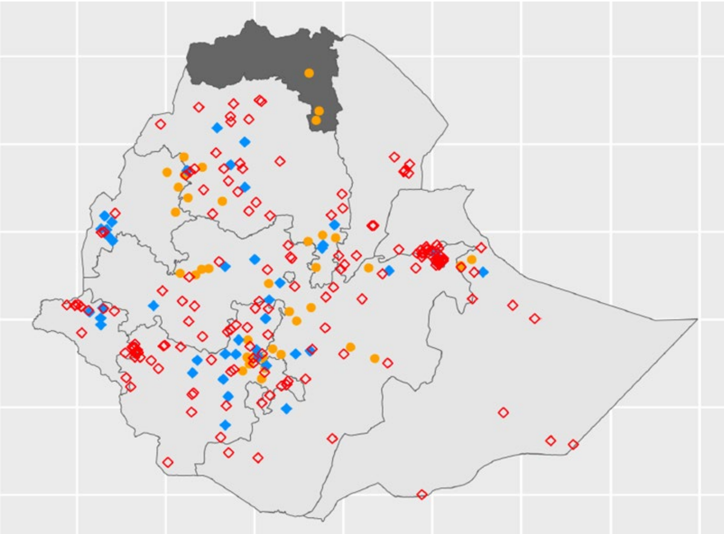
The diamonds (light blue) represent the EAs with at least 1 HH adopting the Innovation.

The diamonds (red) not filled represent the EAs without the Innovation.

67 CG Areas in Wave 5: including PRM.

Figure 14: Adoption of conservation agriculture

Minimum Tillage Conservation Practices



The dots (orange) represent the Intervention Areas pertaining to Conservation Agriculture (Wave 4).

The diamonds (blue) represent the EAs with at least 1 HH with minimum tillage conservation practice.

The diamonds (red) represent the EAs without the minimum tillage conservation practice.

41 CG Areas in Wave 4.

Ethiopia, upper Ghibe valley.
Credit: ILRI

Standing
Panel on
Impact
Assessment

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