What and Who Has Determined Adoption? A Study on Improved Forage Technologies in Colombia from an Agricultural Innovation System (AIS) Perspective

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The XXIV International Grassland Congress / XI International Rangeland Congress (Sustainable Use of Grassland and Rangeland Resources for Improved Livelihoods) takes place virtually from October 25 through October 29, 2021.

Proceedings edited by the National Organizing Committee of 2021 IGC/IRC Congress

Published by the Kenya Agricultural and Livestock Research Organization

What and who has determined adoption? A study on improved forage technologies in Colombia from an Agricultural Innovation System (AIS) perspective

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Key words: Innovation system, improved forages, livestock, adoption factors

Abstract
The complex process behind the adoption of improved forages in Colombia remains largely unexplored. Despite governmental and scientific efforts to promote and disseminate the implementation of improved forages for the sake of sustainable livestock production, local livestock producers continue to extensively use native species and adoption rates of more efficient forages remain low. This study explores the dynamics behind the development and diffusion of improved forage technologies in Colombia, from the 1960's to the present through an Agricultural Innovation Systems (AIS) perspective. Here we map the agents involved, classify the roles they exerted over time and reconstruct the historical context in which the creation and dissemination of forage technologies in the country took form. Through the use of qualitative research tools such as in-depth interviews, and extensive archival work, we were able to identify various factors determining the course of improved forage adoption processes. First, a gradual decline on public and private investment destined to agricultural research hindered national scientific agendas and affected the continuity of ongoing projects. Second, the primacy of interpersonal relationships further complicates this panorama as it can either interfere with or promote the use of improved forages, subjecting technology dissemination to a non-institutional realm. Thirdly, released technological packages remain incomplete and impede rising adoption rates, mainly due to both Colombia's low-latitude (and its restrictions for national seed production) and ineffective processes of training and support aimed at local livestock producers. Aside from the identification of key actors and historical trends, the study concludes by suggesting the implementation of a systematic (AIS) approach that gives account of the complex and ever-changing process of forage adoption, its agents, roles, strengths and limitations so that a comprehensive diagnosis can serve as a guideline for future adoption policies in the subject.

Introduction

Improving both quality and availability of livestock feed in the tropics has been one of the main strategies to increase productivity and reduce the sector's environmental impacts (Herrero et al., 2013; Peters et al., 2012). Significant research and development (R&D) resources have been allocated to improve forage germplasm and led to the release of different cultivars, such as *Brachiaria brizantha* cv. Toledo (CIAT 26110), *Brachiaria humidicola* cv. Humidicola (CIAT 679) and cv. Llanero (CIAT 6133), *Brachiaria ruziziensis* cv. Kennedy, and *Brachiaria* hybrids (cv. Mulato, Mulato II, Caimán, Cobra) (Peters et al., 2011; Pizarro et al., 2013). According to studies conducted in several countries, those cultivars have shown superior characteristics in terms of forage quality and availability, better adaptation to different soil and climatic conditions, as well as multiple environmental benefits (Peters et al., 2012; Rao et al., 2015).

However, the final success of such R&D processes only takes place when livestock producers make effective use of the developed technologies. So far, only few studies have been documenting adoption and impacts of improved forage technologies, and the scarce available literature reports persistently low adoption levels (White et al., 2013; Labarta et al., 2017). In Colombia for example, planted forages are being used on around 62% of the total area under pastures in the lower tropics, and *B. humidicola* and *B. decumbens* (introduced in the 1970s) are the most common varieties (Labarta et al., 2017) – a figure that seems high at a first glance. However, many of these areas are in some state of degradation (IDEAM & U.D.C.A., 2015), which shows the lack of adoption of new cultivars. For *Brachiaria* hybrids, for example, the adoption rate is less than 1% (Labarta et al., 2017). In addition, there is a lack of studies that go beyond documenting adoption and impacts of improved forages. Although important advances have been made in understanding the causal relationship between livestock producers and their adoption behavior, there are no explanatory studies to date that offer a macro perspective for understanding the barriers to technology access and the mechanisms of dissemination. Available literature is explaining some of the factors that limit or promote forage technology adoption from a primary producer perspective, delving into sociodemographic and farm characteristics and enabling conditions such as access to credit and technical assistance, among others (e.g. Lapar & Ehui, 2004; Jera & Ajayi, 2008;

Dill et al., 2015). Although vital, we consider that these studies lack deeper perspectives that allow contextualizing decision-making from a historical perspective, evidencing the complex relationships between agents and institutions that participate in technology development, dissemination and adoption processes.

In this sense, the objective of this study is to identify limitations and opportunities in the development, adoption and diffusion of improved forage technologies in Colombia from an AIS perspective. Through a qualitative approach we provide a detailed analysis that addresses the nature of inter-actor relationships and the contingencies that determine their development over time. To do so, we rethink adoption and diffusion from a historical perspective, highlighting the many variables and actors that participate in the process, in order to (i) identify main events that have influenced the course of R&D and dissemination of forage technologies in the country; and (ii) map the actors that are part of the innovation system, describing their roles, links and attitudes.

Methods and Study Site

Information was collected applying a qualitative methodology through in-depth interviews and a detailed literature review. A total of twelve interviews were conducted, six with research institutions, five with private sector actors and one with a public sector actor. The interviews followed an open-ended question format, lasting approximately one hour. For each interviewee, between 5-7 questions were selected from a guiding document developed around the following categories: (i) roles, attitudes and practices of the institution within the AIS; (ii) historical moments, determining institutional or contextual changes and their impact on AIS processes; (iii) patterns of interaction, relationships and roles between AIS actors; and (iv) facilitating environment, the role of the government, political and institutional context. The selection of the questions was made prior to the interview and according to the profile of the interviewee. Data analysis was done by (i) transcription of information; (ii) coding/categorization of key aspects; and (iii) interpretation of information.

Results

Mapping of actors

The Colombian AIS for improved forages comprises multiple actors, both from the public and private sectors. Six main components were identified in this study: (i) Policy; (ii) R&D; (iii) Extension, training and information; (iv) Seed supply; (v) Financing, and (vi) Primary producer. According to the scheme proposed by Arnold and Bell (2001), Figure 1 shows the main agents of the AIS for improved forages in Colombia.

Relationships between R&D institutions mainly occur for collaborative research as part of specific projects. The links are strong between some institutions (e.g. Agrosavia and CIAT and their Forages Network), however, in most cases, we observe weak links that generate duplication of research efforts and competition for resources. There are not many strong links between R&D institutions and intermediary agents such as seed supply companies. CIAT, as exemption, has a strong link with Papalotla regarding the financing, co-development, and exchange of information on forage hybrids. Seed companies play a key role in providing technical assistance and training to primary producers, although mainly at the regional level. National universities have a high level of influence regarding the application of technologies. However, this is done through specific scaling projects and requiring allies. In the interviews, it was pointed out that the impacts of dissemination processes depend on the collaboration among institutions, and that the competitive nature of funds increases the participation of universities in R&D processes. The MADR is identified as an actor with strong influence on R&D and diffusion processes of improved forages. This influence is associated with the power the MADR possesses in the sustainable livestock policy agenda at the national level, the financing of research programs and projects in forage technology development, and its contribution to establishing and maintaining the MGS. In recent years, the MADR and the Ministry of the Environment and Sustainable Development (MADS) have more and more aligned their agendas supporting sustainability more strongly. The existence of mentioned gaps and weak links between most innovation actors and support structures has resulted in a generally weak innovation system. However, important outreach initiatives are highlighted to strengthen institutional links and communication between actors, such as the participation of the sector's main actors in platforms (e.g. MGS), and approaches from the private sector and research institutions.

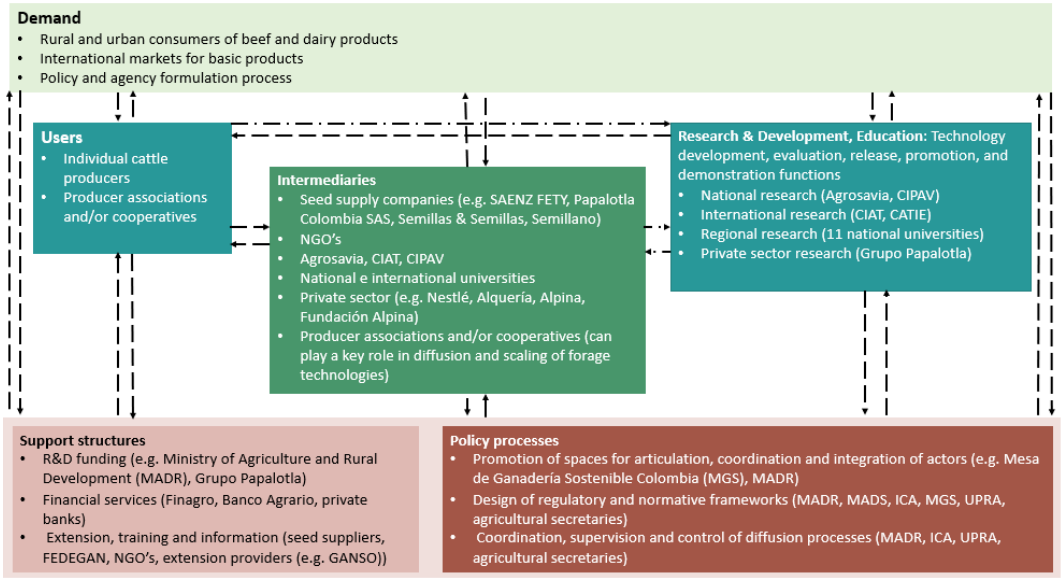

Figure 1. Main agents of the AIS for improved forages in Colombia

Gaps in R&D and dissemination processes

Reduction of research funds: Two historical moments stand out as decisive in agricultural research, the *green revolution* and the advent of neoliberal economic opening in Latin American developing countries. The first moment is recognized as a fundamental milestone for research where the flourishing and consolidation of programs and institutions such as CIAT's Tropical Forages Program and Agrosavia are highlighted. In the second moment, that took place in the 1990s in the framework of neoliberal transformations and economic flexibility, research institutions began a process of restructuring due to budget cuts. This limited researchers both in the formulation of new and in the follow-up and monitoring of existing projects. Researchers who before could only focus on doing research now had to perform additional tasks such as fund-raising, project management and other administrative tasks. This undermined the development of research agendas, fragmented personal and institutional relationships and weakened stronger research advances (e.g. programs such as the International Network for the Evaluation of Tropical Pastures (RIEPT), have ended). Since then, the focus of tropical forage research is rather set by the availability of resources than long-term research agendas. Apart from such negative developments, the restructuring in the 1990s also had positive impacts on research planning. Where researchers before often had the role of the *benevolent dictator*, the new focus was set more towards participatory research methods, allowing more contact with reality. However, there still exist perceived lags in the role of the researcher and also the extension worker.

Absence/weakness of social research support: Although in recent decades research has tried to integrate the perspectives of beneficiary populations and to reflect greater horizontality with the involved communities, the interviewees indicate that the average duration of research projects (3 years) as a decisive limitation in the diffusion and adoption of improved forages. This timeframe, they mention, makes it impossible to measure the impact and scope of introducing new species and is considered insufficient for evaluating the continuity of adopting new species. Consequently, a complete panorama on the adoption of improved forages at the national level is still far from reality. According to the interviewees, this is also a consequence from what is identified as one of the main bottlenecks: the disarticulation between different areas and research professionals, as well as between entities in charge of formulating and executing technological innovation projects.

Lack of cohesion between national R&D institutions and seed companies: Both components have not yet worked in a joint and interdependent manner. On the one hand, the research entities aim at evaluating and releasing new forage cultivars by collaborating with their donors. On the other hand, seed producers determine their portfolio by their own perspective of consumer demand and, above all, by seed profitability. This has led to failed releases despite promotional efforts, as basic and commercial seed supply were not granted.

Release of materials as part of incomplete technological packages: Political pressure to accelerate the release of materials, the pressure of executing research funds in a timely manner, and difficulties to understand unexpected events in the course of research projects end up triggering *accelerated* releases with low adoption.

High speculation, variation in seed production levels and prices by seed companies from Brazil: The seed market in Colombia depends on the market dynamics in Brazil. The varieties and quantities imported by the

trading companies are negotiated one year in advance, and depend on the speculation of companies in Brazil regarding the price behavior of forage varieties compared to other crops.

Cultural gaps and personal relationships: Personal relationships are key in the scaling of technologies, since they allow or hinder the interaction of various fronts and entities, the continuation of projects and their follow-up. They can prevent or facilitate access to information and resources and at the same time chain inter-institutional relations to the personal sphere. Expedited and transparent interpersonal relationships facilitate research, while rivalries, budgetary struggles, and fragile ties hinder or even torpedo the viability of a project.

Weakness of the extension processes in the promotion of forage technologies. The reforms of the 1990s weakened the key components of the national extension system, which led to its progressive exhaustion and disarticulation. The lack of permanent updating in knowledge, methodologies and technologies in the Municipal Entities for Technical Assistance (UMATAs), and later in the Provincial Centers for Agribusiness Management (CPGA) and Agricultural Technical Assistance Service Providers (EPSAGROs) stands out. This has generated a knowledge gap between technology development efforts and user demand. The creation of EPSAGRO aggravated this as a strategy to attract resources and to the detriment of service quality. Especially in terms of promotion and scaling of forage technologies, the role of Agrosavia, national universities, and entities such as CIPAV, FEDEGAN and CIAT stands out, since they carry out dissemination activities as part of their projects in different regions of the country. In terms of training, seed companies play a key role.

Traditionally, credit has not promoted investment in sustainable intensification: Despite the fact that the Fund for the Financing of the Agricultural Sector (Finagro) has established Special Credit Lines (LEC) for the promotion and renovation of improved forages, as well as productive intensification through silvo-pastoral systems, a pronounced demand has not been observed yet. Instead, credits have been oriented mainly to the purchase of animals. This orientation is more pronounced among small and medium producers with participation percentages of 96.5% and 75.75%, respectively. For its part, the investment dedicated to sowing improved forages does not exceed 2%. This situation constitutes a limitation for adoption. This has been accentuated as a consequence of important credit dynamics leading to inequalities in the rural sector: A growth in the substitute portfolio, where resources have been directed towards value chain links with lower risk. However, it is important to note that, in recent years, credit institutions have established mechanisms for adoption, such as the Rural Capitalization Incentive (ICR), whose objective it is to help subsidize up to 40% of the debt of smallholder producers that request credits for the establishment of silvo-pastoral systems.

Discussion [Conclusions/Implications]

The analysis of the R&D and diffusion and adoption processes of forage technologies under an AIS approach demonstrates the existence of gaps and weak links, as well as the interdependence and divergence of the institutions in their goals and perspectives. This has resulted in a generally weak system. However, the actors recognize the importance of strengthening collaborative ties at the institutional level and, therefore, important initiatives have been developed. The results also illustrate the complex dynamics behind the development and dissemination processes of improved forages, marked by important moments and decisions at a historical level that have encouraged or restricted them. The impact of the budget restructuring of the 1990s on research work and rural technical assistance services is highlighted, as well as the lack of cohesion between R&D institutions and seed companies, which have caused the release of incomplete technologies and, therefore, resulted in low adoption levels and little impact. Dynamics such as changes in agricultural credit have accentuated inequalities in the rural sector, and limited the adoption of forage technologies. The primacy of personal relationships that can interfere with or promote the use of improved forages is also highlighted, subjecting the diffusion of technology to a non-institutional environment.

Acknowledgements

This work was carried out as part of the CGIAR Research Program on Livestock. We thank all donors who globally support our work through their contributions to the CGIAR System.

References

Arnold, E., Bell, M. 2001. Some New Ideas about Research for Development. In Partnerships at the Leading Edge: A Danish Vision for Knowledge, Research and Development. Report of the Commission on Development-Related Research Funded by Danida, 279-319. Copenhagen: Ministry of Foreign Affairs/Danida

Herrero, M., Havlík, P., Valin, H., Notenbaert, A., Rufino, M.C., Thornton, P., Blümmel, M., Weiss, F., Grace, D., Obersteiner, M. 2013. Biomass use, production, feed efficiencies, and greenhouse gas emissions from global livestock systems. *PNAS*, 110(52): 20888-20893. doi:10.1073/pnas.1308149110

IDEAM., U.D.C.A. 2015. Síntesis del estudio nacional de la degradación de suelos por erosión en Colombia - 2015. IDEAM - MADS. Bogotá D.C., Colombia.

Labarta, R., Martinez, J. M., Yaccelga, A., Reyes, B., Gomez, L., Maredia, M., … Toro, M. 2017. Assessing the adoption and economic & environmental impacts of Brachiaria grass forage cultivars in Latin America focusing in the experience of Colombia (Unpublished report)

Peters, M., Franco, L.F., Schmidt, A., Hincapié, B. 2011. Especies forrajeras multipropósito: Opciones para productores del Trópico Americano. Centro Internacional de Agricultura Tropical (CIAT); Bundesministerium für Wirtschaftliche Zusammenarbeit und Entwicklung (BMZ); Deutsche Gesellschaft für Technische Zusammenarbeit (GIZ), Cali, Colombia.

Peters, M; Rao, I; Fisher, M; Subbarao, G; Martens, S; Herrero, M; … Hyman, G. 2012. Tropical forage-based systems to mitigate greenhouse gas emissions. In Eco-efficiency: From vision to reality. International Center for Tropical Agriculture (CIAT), Cali, Colombia. 171–190 p

Pizarro, E.A., Hare, M.D., Mutimura, M., Changjun, B. 2013. Brachiaria hybrids: potential, forage use and seed yield. *Tropical Grasslands- Forrajes Tropicales* 1(1): 31–35. doi:10.17138/TGFT(1)31-3

Rao, I., Peters, M., Castro, A., Schultze-Kraft, R., White, D., Fisher, M; … Rudel, T. 2015. LivestockPlus – The sustainable intensification of forage-based agricultural systems to improve livelihoods and ecosystem services in the tropics. *Tropical Grasslands - Forrajes Tropicales* 3(2): 59-82. doi:10.17138/TGFT (3)59-82

White, D.S., Peters, M., Hornes P. 2013. Global impacts from improved tropical forages: A meta-analysis revealing overlooked benefits and costs, evolving values and new priorities. *Tropical Grasslands– Forrajes Tropicales,* 1, 12−24