DEGREE OF ADAPTATION OF PROCESS INNOVATION IN 39 SUSTAINABLE PRODUCTION UNITS IN THE MUNICIPALITY OF PASTO, COLOMBIA.

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LATIN AMERICAN TECHNOLOGICAL UNIVERSITY ONLINE

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Reception Date: October 4, 2023
Acceptance Date: August 12, 2024

Abstract

As we know, productive and entrepreneurial systems of any kind have been facing the great challenge of innovating to increase their competitiveness, quality and globalization. This interaction allows for the holistic development of productive systems, applying the support of institutional and community networks, with the aim of strengthening the social fabric and integral development in the territories. The present research work reflects the analysis of the processes of characterization of innovation, acquired in the framework of the project called "Transformation, territorial, resilience and sustainability 2020-2022" in its first phase, executed by FAO in conjunction with the Municipal Mayor's Office of Pasto-Nariño. Thirty-nine sustainable productive nodes were implemented, which only produced potatoes and milk as primary activities; the project was subjected to a comparative statistical analysis of means through the INFOSTAT 2020 statistical package, to characterize the degree of adoption of innovation in the beneficiary communities of the project. The results showed that in phase one, the average number of technologies used by the farming community was 23.8%, corresponding to 14 practices on average, and in the second phase the increase in technologies implemented was 22.48%, corresponding to 13 new practices, respectively.

It was also observed that the most used technologies were: adaptation of silvopastoral systems, soil conservation practices, soil cover, use of organic fertilizers and management of biopreparations. It is concluded that the course of this research, the communities have generated a significant impact, doubling the number of new practices used in the sustainable production nodes. Likewise, it can be seen that the standard of living perceived by the community does not present significant changes, but the trend of the standard of living in the communities increases due to the process of technology transfer and development in the territories.

Key words: Innovation, productive nodes, sustainability, silvopastoral.

CARACTERIZACIÓN DE LA INNOVACIÓN DE PROCESOS EN 39 NODOS PRODUCTIVOS SOSTENIBLES EN EL MUNICIPIO DE PASTO, COLOMBIA.

Resumen

Los sistemas productivos y empresariales, se han enfrentado al gran reto de innovar para incrementar su competitividad, calidad y globalización. Esta interacción permite el desarrollo holístico de los sistemas productivos, aplicando el apoyo en redes institucionales y comunitarias, con el ánimo de fortalecer el tejido social y desarrollo integral territorial. El presente trabajo de investigación plasma el análisis de los procesos de caracterización de la innovación, adquiridos en el marco del proyecto denominado "Transformación, territorial, resiliencia y sostenibilidad 2020-2022" en su primera fase, ejecutado por FAO en conjunto con la Alcaldía municipal de Pasto-Nariño. Se implementaron 39 nodos productivos sostenibles, los cuales solo producían papa y leche como actividad primaria; el proyecto se sometió a un análisis estadístico comparativo de medias a través del paquete estadístico INFOSTAT 2020, para caracterizar el grado de adopción de la innovación en las comunidades beneficiarias del proyecto. Los resultados mostraron que en la fase uno, el promedio de tecnologías usadas por la comunidad campesina era del 23,8% correspondiente a 14 prácticas en promedio y en la segunda fase el incremento de tecnologías implementadas fue del 22,48% que corresponde a 13 nuevas prácticas respectivamente; igualmente, se pudo observar que las tecnologías más empleadas fueron: adecuación de sistemas silvopastoriles, prácticas de conservación de suelos, coberturas de suelos, uso de abonos orgánicos y manejo de biopreparados. Se concluye que el trasegar de esta investigación, las comunidades han generado un impacto significativo, duplicando el número de nuevas prácticas usadas en los nodos productivos sostenibles. Igualmente, se puede apreciar que el nivel de vida percibido por la comunidad no presenta cambios significativos, pero la tendencia del nivel de vida en las comunidades aumenta debido al proceso de transferencia de tecnología y desarrollo en los

territorios.

Palabras Clave - Innovación, Nodos productivos, Sostenibilidad, silvopastoril.

I. INTRODUCTION

Innovation measurement is essential in knowledge management, playing a fundamental role in the integral development of communities by generating significant benefits. Several analytical models, such as the Oslo Manual (MO) in 2018, recognize the types of innovation and serve as a reference for surveys as tools for innovation measurement (Gault, F. 2023). In Latin America, the Ibero-American Network on Science and Technology Indicators (RICYT) introduced the Bogota Manual (MB), standardizing indicators of technological innovation (Hidalgo Delgado, A. Y. 2019).

In Colombia, Technological Development and Innovation Surveys (EDIT) were conducted in manufacturing and services, supported by entities such as COLCIENCIAS, DNP and DANE (Aguilar Gallegos, N., & Altamirano Cárdenas, J. R. 2020). The Agricultural Innovation Survey ENIAGRO in 2013 marked the measurement of innovation in the Colombian agricultural sector (Omar, C. et al. 2013). In addition, technology transfer in the agricultural sector was strengthened with the creation of the National Agricultural Innovation System (SNIA) in 2017 (Contreras Pedraza & Uribe Galvis, 2021).

In this context, the motivation to investigate innovation arises from the need to observe the erratic behavior of the agricultural sector, focusing on modern agriculture beyond agri-food, including market competition, quality and its positive impact on rural communities (Parra Real, J. L. 2023). Additionally, FAO aims to transform agri-food systems to ensure food security and sustainable development. The Secretariat of Agriculture of Pasto joins this proposal with the project "Territorial transformation, Resilience and Sustainability", implementing "sustainable productive nodes (NPS)" in San Juan de Pasto.

These nodes are systems that interact in the rural community to protect food security and strengthen various aspects. Sustainable production based on agroecology is fundamental. For this reason, the study of technological dynamics in production systems provides guidelines for innovation strategies and holistic development in global communities, impacting technological, business, social and environmental aspects (Melgoza Arteaga, M. 2022).
This study focuses on characterizing innovation in 39 sustainable productive nodes in San Juan de Pasto, under the project "Resilience, productivity and sustainability" in collaboration with FAO and the Municipality of Pasto.

II. METODOLOGY

The innovation exploration was carried out in 6 villages of Santa Barbara, municipality of Pasto, department of Nariño, Colombia. The area is characterized by a steep slope with an average altitude of 2800 meters above sea level

Image 1. NPS Women Entrepreneurs of Peace. Source: Own.

Fuente: Esta Investigación

The study area corresponds to 39 units called "sustainable production nodes (SPN)" of ¼ Ha, distributed in the study area. An indicator is identified, which describes a set of observable practices in each NPS.

Each NPS was provided with seeds and tillage tools, as well as a comprehensive training package provided by FAO in conjunction with the Pasto municipal government.

As for the collection of information, primary sources obtained through the technical assistance process in the area with the producers were used; we also relied on secondary sources such as a characterization study of the area, to capture the perception of the technologies used at the beginning of the project and the impact generated by it in a sample of 39 Nodes, at the beginning and end of the implementation of the NPS in its first phase.

Table 1 shows the NPS under study and their main characteristics before project implementation.

Vereda	NPS	Producción base	Hombres	Mujeres
Los Àngeles	10	Papa y leche	32	43
Jurado	6	Papa y leche	13	35
Cerotal	6	Papa y leche	4	28
Las Encinas	6	Papa y leche	12	35
La Esperanza	6	Papa y leche	10	29
Las Iglesias	5	Papa y leche	15	32

Fuente: Propia

The selected innovation indicator can be identified in Table 2, mainly characterizing sustainability and agro ecological reconversion processes.

Table 2. INDICATOR SELECTED IN THE PROCESS OF INNOVATION IN AGROECOLOGY.

Indicador	Medición
Procesos nuevos o mejorados	Número o porcentaje de labores incorporadas

Fuente: Propia

The analysis considered the selection of indicators that were easy to understand and measure, whose information was feasible to obtain, with the greatest possible reliability, and took into account previous studies by Funes-Monzote et al. (2009), Vera-Pérez (2011) and (Blanco-Lobaina et al., 2013).

Work incorporated.

It was possible to observe 60 practices in the NPS under study based on the information shown in Table 3.

3. These practices were grouped by themes, such as: P1, Establishment of agroforestry systems; P2, Polyculture and spatial and temporal diversification; P3, Biological control; P4, Productive diversification; P5, Crop rotation; P6, Production and use of organic fertilizers; P7, Soil conservation and protection; P8, Other practices. (Contino-Esquijerosa et al., 2018).

Table 3. Sustainable agroecological practices

Practirce	Group membership considerations
P1 Establishment of agro-forestry systems	Planting of: posts and/or live fences, forest and/or fruit plantations, tree protein banks, scattered trees in pastures, hydro-regulating strips, trees intercropped with agricultural crops, trees intercropped with pasture and/or forage, biological corridors and trees in non-productive/cultivable soils.
P2 Polycultures. Spatial and temporal diversification	Intercropping of: annual crops, perennial crops or mosaics, annual crops intercropped with perennial crops, trees of different species, agricultural crops with forage crops, grasses associated with herbaceous legumes, agricultural and/or forage crops with flowers.
P3 Biological control of pests	Use of: bio pesticides or biological means, traps (colored, scented, among others). Planting of pest repellent and/or medicinal plants and natural preparations (repellent or medicinal).
P4 Diversification of production	Existence in the production system: agriculture, livestock, fruit trees, beekeeping, aquaculture, rabbits, poultry, swine, sheep and/or goats, timber, flowers and ornamental plants.
P5 Crop rotation	Crop rotation: annuals, perennials, annuals, with perennials. Rotation of agricultural areas with livestock and recovery of idle or invaded areas of thorny bushes..
P6 Production and use of organic fertilizers	Production of: animal manure (and its treatment), compost, worm humus, efficient microorganisms and bio fertilizers. Use of biodigester effluents. Soil application of: animal manure, compost, worm humus, efficient microorganisms, organic fertilizers, bio fertilizers and/or bio nutrients, chicken manure, cachaza, crop residues, bio digester effluents and organic fertilizers.

P7 Preservation and protection of the soil	Soil cover with: Mulch (dead cover) and crop residues, use of: legumes/ green manures, rehabilitation and/or renovation of pastures and barriers (dead or live) against soil erosion, terracing against soil slope. Use of: minimum tillage and animal traction.
P8 Other practices	Use of: Crop residues and by-products for animal feed and alternative energy sources.

Fuente: Contino-Esquijerosa et al., (2018).

When implementing the NPS, they quantified the work incorporated, analyzing the new practices in a time range of 4 months. Subsequently, an analysis of the processes incorporated in the 39 NPS was obtained.

Regarding the statistical analysis, a comparison of proportions was carried out with the INFOSTAT®

III. RESULTS AND RESEARCH DISCUSSION

The process of observation and information processing is shown in Table 4, detailing a process of adoption of new practices in the 39 NPS.

It can be inferred that the practices with significant differences are those that have a higher degree of adoption, because they are those that are easier to perform in the field, such as pest control work as a biological alternative using different types of preparations, chromatic traps, repellents, efficient microorganisms, etc. Many of these practices are recommended by Nicholls et al (2015).

Tabla 4. PRUEBA DE MEDIANAS PARA DOS MUESTRAS FASE X VARIABLE.

Variables	Total de Practicas	Desviación		Mediana		P(2 colas) estándar
		Fase		Fase		
		1	2	1	2	
P1	9	0,51	1,23	2	1	0,0873
P2	5	0,59	1,07	1	1	0,8173
P3	6	0,41	1,53	1	2	<0,0001
P4	11	1,02	1,44	2	1	0,0083
P5	5	0,55	1,47	1	2	0,0036
P6	9	1,27	1,86	2	4	<0,0001
P7	4	0	0,99	1	2	<0,0001
P8	10	1,12	1,3	3	2	<0,0001
Total	60			13	15	

Fuente: Propia

On the other hand, in some neighboring areas, as they are cattle-raising areas, they have agroforestry systems, and for this reason, some units have previously worked with arrangements concerning protein banks, live fences, etc.

Likewise, there is a wide variety of untapped forage sources that were identified in the adoption processes for their use.

Regarding soil resource management P6, in Table 5 we can appreciate a degree of apprehension of knowledge and application of new practices in a percentage of 44.74% for the efficient management of waste for soil improvement, allowing an improvement in the overall quality of the soil as named by (Olivares-Perez et al, 2018).

Similarly, regarding crop rotation and polyculture, the trends indicate that the community has an average adoption rate of 9.33% and 33.16% respectively in terms of maintaining these systems as part of a biodiverse approach.

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In Table 5, we can see that the practices implemented in phase one were 23.8% corresponding to 13 practices on average and in the second phase the increase of technologies used was 22.48% corresponding to 15 new practices respectively.

It was observed that the most commonly used technologies were: adaptation of silvopastoral systems, soil conservation practices, soil cover, and use of organic fertilizers and management of biopreparations.

Tabla 5. Evolución de labores en el proceso fase 1 2020, fase 2, septiembre 2022.

Variables	Total de Practicas	Numero de Practicas		Practicas promedias %		Total, de labores aplicadas %
		Fase		Fase		
		1	2	1	2	
P1	9	2,28	1,03	25,36	11,40	36,76
P2	5	1,41	1,05	28,21	21,05	49,26
P3	6	1,13	1,68	18,80	28,07	46,87
P4	11	2,44	1,03	22,14	9,33	31,47
P5	5	1,44	1,66	28,72	33,16	61,88
P6	9	2,10	4,03	23,36	44,74	68,10
P7	4	1,00	1,37	25,00	34,21	59,21
P8	10	2,49	1,50	24,87	15,00	39,87
Total	60					

Fuente: Propia

This ultimately generates welfare in the agroecosystem, such as greater biological, productive, economic, energetic and environmental efficiency (Funes-Monzote, 2009), all of which translates into higher income in a sustainable and environmentally friendly way.

In this regard, Velásquez Alcántara, H. D. (2023). Refers that these applied processes are effective methodological elements to establish a dialogue between experts and farmers, and that they also facilitate the collective construction of knowledge and guarantee the inclusion of agroecological principles in the technological activity of reconversion.

Likewise, Solis, C. R. R., Ramírez, E. E. G., & Angulo, J. P.C. (2017). They pointed out that the training and renewal of thinking, to the improvement of the management of managers, is vital for the integral development of the territories.

Thus, we can infer that agricultural extension is key in the processes of knowledge acquisition and acceptance of new technologies through change management.

For this reason, an analysis of the adoption of new technologies provides guidelines to strengthen the development links in the different communities, generating input for the reconversion of technologies.

We can also affirm that the diversity of agroecological practices and ancestral knowledge, as a factor of innovation and development in the communities, is key to economic, productive, social, and environmental sustainability and viability in the study area.

As for diversification as a source of social development, it gives us the perspective of an agroecological system, encouraging the community to opt for the use of these new technologies.

In general terms, we can observe in Table 4, that the average of total practices fluctuates between 31.47%, 68.10% and represents 49.8% of average labor applied, which corresponds to a medium to low technological level.

IV. CONCLUSIONS

It is concluded that the support networks for innovation, headed by the agricultural extension service, induce process innovation and adoptability, technology transfer, innovation and development in the territories. Similarly, the level of innovation tends to increase over time due to the need to produce food efficiently, breaking paradigms. In addition, they are an important pillar in the territorial development process, establishing new challenges to strengthen food security.

We can also infer from the data obtained, that it is necessary to carry out a deep analysis of the technologies and their respective instruments because the practices in the field must ensure their versatility and adaptation to the reality of the field in each territory. Thinking about the efficiency of the processes, to ensure a more efficient generational replacement and that our future generations do not abandon the field due to the lack of tools, strategies, and opportunities for a decent and satisfactory income generation.

AKNOWLEDMENTS

The author expresses sincere gratitude firstly to the Eternal YHWH, family and loved ones. I also thank the Mayor's Office of San Juan de Pasto and the FAO project team for "Resilience, productivity and sustainability".

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