KNOWLEDGE NETWORKS: DIAGNOSIS OF RESEARCH NETWORKS IN PERU FOR INNOVATION GENERATION IN DERIVATIVES OF ORIGINATING PRODUCTS, 2017

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ABSTRACT

In the 21st century, biological diversity is one of the comparative advantages of Peru in world trade and foreign policy because it is an opportunity to boost economic and social development. The National Council of Science, Technology and Technological Innovation (CONCYTEC) identified that two of the three main causes of the incipient value enhancement of the biodiversity components of the country are the lack of scientific knowledge and the limited capacity and institutional articulation (CONCYTEC, 2014).

The valorization of such biodiversity requires the generation of new knowledge about its resources. The construction of this knowledge becomes systematic and sustainable when it is made as a collaborative process between different stakeholders of the National Agrarian Research System (SNIA). This work specifically studies the scientific collaboration networks. In this framework, collaborations and social networks are considered as a type of social, interpersonal or relational capital, as long as they provide a competitive advantage to the individual and the group. This can be essential for the access to resources and information as well as for the generation and dissemination of scientific knowledge.

The main objective of this research is to diagnose in 2017 the connectivity level of the scientific collaboration networks between scientific Peruvian professionals whose research deals with four priorized chains of Peruvian Andean agrobiodiversity and amazonic biodiversity (maca - Lepidium meyenii, yacón - Smallanthus sonchifolius, camu camu - Myrciaria dubia and sacha inchi - Plukenetia volubilis L.). To accomplish this, a representative sample of 64 people was interviewed. This sample consisted of researchers, masters or PhD's, with experience in the mentioned products and that presently work in 8 research institutions: 5 universities and 3 research institutes of 4 Peruvian departments. With the information obtained, a profile of those researchers was elaborated in

relation to their main motivations for scientific collaboration and their expectations in regard to it. In addition, the quantitative methodology of Social Network Analysis (ARS) with the use of Gephi software was applied to measure the main characteristics of the mentioned collaboration network.

The results of ARS not only confirmed the initial hypothesis about the low level density of the network, which means that currently the researchers are not integrated, but highlighted the critical condition of the problem because, although the degree of density or connectivity was expected to be below 10%, it was not expected to be so low (2,1%).

Therefore, this study confirms the incipient level of the biodiversity research network, not only as to the number of links but also their strength. This is the first study that quantitatively measures the Peruvian scientific collaboration networks and as such, aims to provide a baseline which through a systemized process can be used to measure its evolution on time.

Key words: collaboration networks, scientific collaboration, innovation, knowledge, Social Network Analysis (ARS)

INTRODUCTION

The main question this research seeks to understand is about the connectivity level in 2017 of the Peruvian scientific network that researches on Peruvian agrodiversity priorized chains products (maca, yacón, camu camu and sacha inchi. To answer it, the objective was to measure the characteristics and performance of the agrobiodiversity products research network, and to analyze the main characteristics of the profile of researchers that work with these products in Peru, highlighting their motivation to establish collaboration strategies.

The applied methodology considers both quantitative and qualitative tools. The first ones focus on objectively analyzing the critical peculiarities of the profile, experience and opinion of the researchers that are included in this study. Likewise, the position of each researcher within the network is characterized with indicators. The qualitative methodology focused on collecting and analyzing complementary information to explain the findings and triangulate the results of the quantitative analysis. For this purpose, 8 institutions were identified with a total of 141 researchers; 64 interviews were in person (78%) and the rest by telephone (22%). This sample has 90% confidence level and 10% margin of error. The purpose is to set the grounds to analyze the scientific collaboration strategy for the advantageous use of Peruvian biodiversity in the four priority chains with a sustainable development perspective.

VALORIZATION OF PERUVIAN BIODIVERSITY

Peru is recognized as one of the seventeen mega-diverse countries in the world (Conservation International, 1998) which together have 70% of the planet's biodiversity (MINAM, 2014). It concentrates 84 of the 104 life zones of the planet

and its different altitudes and climates generate exceptional conditions for the development of crops and species. It is estimated that Peru has 25 000 species of which 22% are endemic. It is also recognized as one of the world's largest centers of genetic resources on the planet with 182 plant species and is identified as an agriculture origin center (Sánchez, 2013; CONCYTEC, 2016).

It is considered as the second Latin American country and the fourth at world level in extension of tropical forests. In addition, is has 20375 flora species (CONCYTEC, 2016; MINAM, 2014) and is mainly considered as the first country in the world in number of plant species (4400 species) with known and used properties (PROMPERU, 2014).

In spite of this indicators, the National Council of Science, Technology and Technological Innovation (CONCYTEC), through the Transverse National Program of Science, Technology and Innovation of Biodiversity Valuation (VALBIO), identified insignificant value enhancement of the biodiversity components (ecosystems, species, genes) (CONCYTEC, 2016). In this document the authority of the National System of Science, Technology and Innovation (SINACYT) explained that two directly associated causes of this problem are the slight scientific knowledge and little capacity and institutional articulation in Peru.

PERUVIAN RESEARCH NETWORK

It is important to consider that in Peru there is significant gap between qualified human capital available and the needed for its value enhancement with a sustainable development approach. According to the National Directory of Researchers and Innovators (DINA) of CONCYTEC, to 2016 there were 660 masters and 676 PhD's linked to specialties for the study of biodiversity in the areas of Natural, Medical and Agricultural Sciences and Engineering and Technology.

Moreover, it can be observed that only 7% of the researchers with Master's degree are in the National Registry of Researchers in Science and Technology (REGINA). However, the more striking fact is that less than a third part of these professionals have a PhD degree (27%). REGINA was created by CONCYTEC to identify researchers who have validated capacities to work on scientific research and/or technological development. Among the set criteria are: academic degree with greater score to those who have Master or PhD, obtained patents, publication of articles, books or chapters, training on human resources as thesis advisor, research projects and participation in conferences as speaker.

This indicates that besides not having a critical mass of researchers with post graduate degree, the research capacities objectively validated are also an important limitation.

METHODOLOGY

To describe the applied methodology, the scope and approach as well as the research strategy are presented. This includes the sample selection method, the

survey structure, the procedure for information collection and finally its analysis. The research scope is descriptive with a quantitative approximation. The Social Network Analysis (ARS) enables the description of the relationships between stakeholders, in this case, scientific researchers. For this study, the national scope of Peruvian researchers on Peruvian biodiversity registered in the National Directory of Researchers and Innovators (DINA) managed by CONCYTEC is considered.

The applied strategy is survey-type study because the provided information is intended “to answer questions such as who, what, where and how much” (Saunders et al., 2009 in PUCP, 2015, p. 45) with respect to habits and characteristics of scientific collaboration. The survey-type study allows knowing specific characteristics of an organizational phenomenon based on the collected and analyzed information (PUCP, 2015, p.47). Prior to the sample selection process, the characteristics of the studied population were defined. It is important to note that this population is registered in DINA and that this platform was presented by CONCYTEC at the beginning of 2015. This institution has promoted and widely encouraged the register of resumes by researchers during the past two years.

For the purpose of this research, three main filters of DINA directory were considered: Profile, Products analyzed and Academic degree, according to Table 1.

Table 1: Database and applied filters

Database	National Directory of Researchers and Innovators (DINA), database of information about Peruvian professionals that work in science, technology and innovation (CTI) both in the country and abroad	
Applied filters	Profile	Scientific researchers
	Products analyzed	Scientific production and/or experience in research projects related to "maca", "yacón, "camu camu" y "sacha inchi"
	Academic degree	Master or PhD (Doctor)

Afterwards, a database was elaborated with the information in Table 2

Table 2: Database for survey application

General information	Surname
	Name
	Region
	Speciality
Academic background	Bachellor (Name)
	Bachellor (Place)
	Master (Name)
	Master (Place)

	Doctor (Name)
	Doctor (Place)
Experience and achievements	Researcher in REGINA
	Current position
	Current work center
	Type of work center
	Investigated products
	Research projects
	Scientific production
Contacto	Email

It is important to mention that email data, critical for contact with researchers, is not available in DINA due to a user database policy. Thus, secondary sources were used to get this information, especially corresponding universities directories. This contributed to achieve a balance between the importance of the selected institutions in regard to the analyzed subject, the number of researchers and the prestige as to their research institutional experience. This way the target population was narrowed up to researchers from 8 institutions. Finally, from a total of 141 scientists who work in these research centers or universities, 53 had to be interviewed in order to have a representative sample as it is shown in Table 3.

Table 3: Representative sample calculation

Total population (N)	141
Confidence level (1-α)	90%
Accuracy (d)	10%
Proportion	50%
SAMPLE SIZE (n)	46
Expected proportion of losses (R)	15%
SAMPLE ADJUSTED TO LOSSES	53

Organization of surveys

For the structure of the survey, the first step was to decide on the general topics to address. This included: researcher profile, research experience, and scientific collaboration. A fourth topic, determinants of linkage, was included. It considered both motivation for collaboration and expected results, with the purpose of approaching collaboration as a process as proposed by Gonzáles Alcaide and Gómez Ferri (2014, p.6). Therefore, the first 6 questions of the survey, presented in Table 4, are related to the first topic considered, general information about the researcher's profile. It is important to note that questions 1, 3, 4 and 6 were obtained from DINA register.

Table 4: Scientific researchers' survey – First topic

	QUESTIONS	TYPE OF	SUBTYPE OF CLOSE QUESTION

			QUESTION					
			Open	Close	Unique choice	Multiple choice	Ranking	Scale
I. RESEARCHER PROFILE								
	1	Names and Surnames	✓					
	2	Age range		✓	✓			
	3	Gender		✓	✓			
	4	Current work center	✓					
	5	Role in current work center		✓	✓			
	6	Specialty		✓	✓			

In the second topic of the survey, questions 8 and 10 were based on the study conducted by Villanueva et al. (2014). However, because the purpose was to know the experience in biodiversity Peruvian studies, specifically in the four predetermined products, other questions were formulated. The objective was to know more about the research dynamics of each respondent as well as the results reflected in their scientific production.

Questions 7 and 9 were part of the initial database; they were included in this part as a validation process under the hypothesis that DINA records might not necessarily be updated because it depends on the dedication and time allocation of each researcher.

Table 5: Scientific researchers' survey – Second topic

		QUESTIONS	TYPE OF QUESTION		SUBTYPE OF CLOSE QUESTION			
			Open	Close	Unique choice	Multiple choice	Ranking	Scale
II. RESEARCH EXPERIENCE								
7		Products you research or have investigated		✓		✓		
8		Total research experience (years)	✓					
		Research experience in current institution (years)	✓					
9		Scientific production in biodiversity (number of articles in indexed journals)	✓					
		Scientific production in analyzed and investigated products	✓					

		(number of articles in indexed journals)						
10		Time distribution (in percentage)	✓					
11		Belonging to research groups		✓	✓			

In the third topic, although at general level the study of Villanueva et al. (2014) was considered, there was an important adaptation. In the mentioned study the purpose was to explore relationships outside the researcher's institution, additionally, the present study also considered relationships within the institution. Also a question was included to determine the level of collaborative research with producers, food processors and/or distributors of the analyzed product as appropriate.

Table 6: Scientific researchers' survey – Third topic

	QUESTIONS		TYPE OF QUESTION		SUBTYPE OF CLOSE QUESTION			
			Open	Close	Unique choice	Multiple choice	Ranking	Scale
III. SCIENTIFIC COLLABORATION								
	12	Name of research group	✓					
	13	Name of scientific collaborators (in the institution)	✓					
	14	Type of relationship with scientific collaborators (in the institution)		✓		✓		
	15	Name of scientific collaborators (outside the institution)	✓					
	16	Type of relationship with scientific collaborators (outside the institution)		✓		✓		
	17	Self-assessment of collaboration level		✓				✓
	18	Collaborative work with companies in research projects		✓	✓			
	19	Name(s) of the company(s) with which you collaborated	✓					

Adapted from: Villanueva-Félez, Fernández-Zubieta y Palomares-Montero (2014)

Table 7 shows the detail of the questions formulated to determine the type of relationship with scientific collaborators. Both ends were formulated according to the study carried on by Hara et al. (2003). On one end the most basic collaboration type is identified; it is called “soft collaboration” or “connection”, which are the queries that require complementary knowledge or skills among researchers. On the other end are the research groups where, according to the mentioned authors, personality compatibility is required because scientific collaborators must actively participate in defining the research problem, refining ideas and analyzing results.

Table 7: Possible types of collaboration

Collaborator	Inquiries/ information exchange	Course, workshop, symposium or seminar	Services	Research project	Publication	Publication in indexed journal	Research group
Name 1							
Name 2							
Name n							

Finally a question was included which expected the researcher to self-assess his scientific collaboration level according to Likert scale.

Finally, the fourth topic was based on the study of Gonzáles Alcaide y Gómez Ferri (2014). In their work “Scientific collaboration: main research lines and future challenges” they propose an approach of this topic as a process. The questions include both the pre-collaboration stage (motivation) and the post-collaboration stage (expected results). Questions 20 and 21 used references from these authors to determine the value of the variables.

Table 8: Scientific research survey – Fourth topic

		QUESTIONS	TYPE OF QUESTION		SUBTYPE OF CLOSE QUESTION			
			Open	Close	Unique choice	Multiple choice	Ranking	Scale
IV. DETERMINANTS AND EXPECTED RESULTS LINKAGE								
	20	Collaboration motivators		✓		✓		✓
	21	Expected collaboration results		✓		✓	✓	
	22	Opinion on the importance of scientific collaboration networks	✓	✓	✓			
	23	Intention to integrate through a scientific collaboration network		✓				

Collection of information

Two stages were determined to collect the information: contact and field work. Initial contact was made through a personal email where the 141 researchers were invited to participate in this study through an estimated 20 minute personal interview. The response rate was 32%, that is, 45 researchers answered with their availability, which enabled to coordinate the interview. With the rest, the interview would be coordinated in situ.

Table 91: Summary of field work

	Lima	Outside Lima
Initial contact medium	email	
Type of interview	In person/Telephone	Telephone
Visited institutions	UNMSM (Seats: University Campus, San Fernando and Pathology Institute of the National Hospital Nacional Arzobispo Loayza), UNALM, UPCH, INIA, CIP	IIAP, UNDAC, UNC And other researchers abroad (internship or residency)
Interview period	November 21 – January 20	
Interview days	11	10
Total number of interviews	50	14

Information analysis

Once the information was collected, a database was elaborated with the answers. This was analyzed in two blocks: research profile and ARS. For ARS its

main elements were taken into account: stakeholders or nodes and links or relational ties. With regard to the type of relationship, the discrimination between strong and week ties was made according to Table 10 which was developed on the basis of the study of Hara el al. (2003). This identifies the different collaboration types required for different integration levels between researchers.

Table 102: Link level according to relationship type

Researcher	**Inquiries / information exchange**	**Course, workshop, symposium or seminar**	**Services**	**Research project**	**Publication**	**Publication in indexed journal**	**Research group**
Name collaborator researcher	1	2	3	4	5	6	7

As a tool for the application or ARS methodology, the Gephi software was used. It is an open code interactive platform for visualization and exploration of all types of networks and complex system by means of dynamic graphs. Its application will validate or reject the general hypothesis of this study: “Scientists that investigate Peruvian agrobiodiversity products in analysis (maca, yacón, camu camu and sacha inchi) are not articulated”. This is evidenced in the low density levels of the network (less than 10%). Besides, individual indicators will be calculated to determine the position of each researcher within the network as well as general indicators about its structure.

Table 11: Social Network Analysis Indicators (ARS)

Indicator	Description
Degree of input or Indegree	Number of relations toward one node
Degree of output or Outdegree	Number of relations of a node with the rest
Centrality Degree or Centrality	Relationship of one node with its entire network
Intermediation or Betweenness	Intermediation capacity of one node in relation to two other nodes that belong to the network
Degree of closeness or Closeness	Ability to access other stakeholders of the network

RESEARCH RESULTS

The findings of the research will be presented in two blocks: the first one will show the main results of topics 1, 2 and 4 dealing with researcher profile, research experience, as well as determinants and expected results of the scientific collaboration; the second block, with the use of ARS, will explain the findings about the characteristics of the research itself. In this aspect 64 researchers were interviewed, so according to the minimum size sample calculated in Table 3, the results that will be presented are representative of the whole population.

Researcher profile

i. General characteristics

57% of the researchers are 50 years old or more which could imply that generational replacement of researchers is not being covered. The study defined as a filter that researchers at least should have the academic master degree, which influences the results. Likewise, 55% of researchers that work with the selected products of the Peruvian biodiversity are masculine gender. This relative balance differs from the participation of women in research in general terms. According to CONCYTEC (2014), only 34% of Peruvian researchers are feminine gender while average in Latin America is 44%.

Figure 1: Age of surveyed researchers

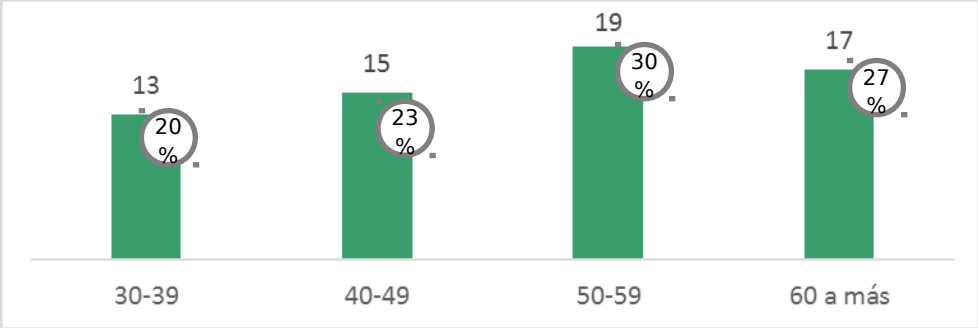
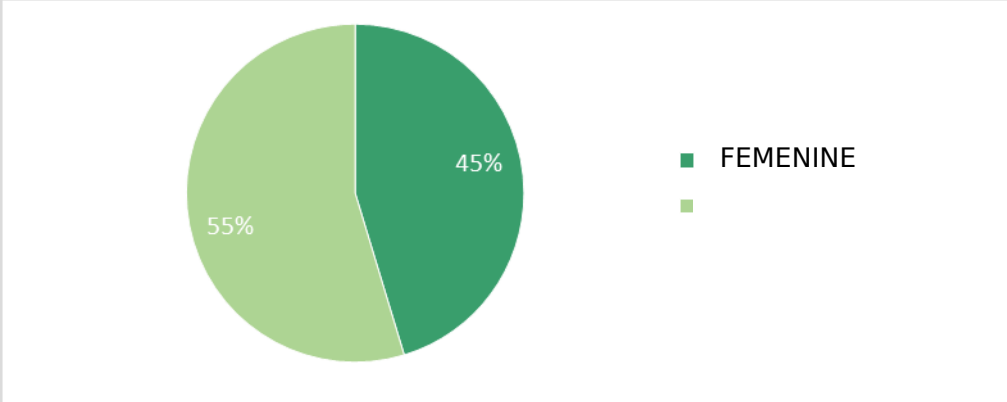
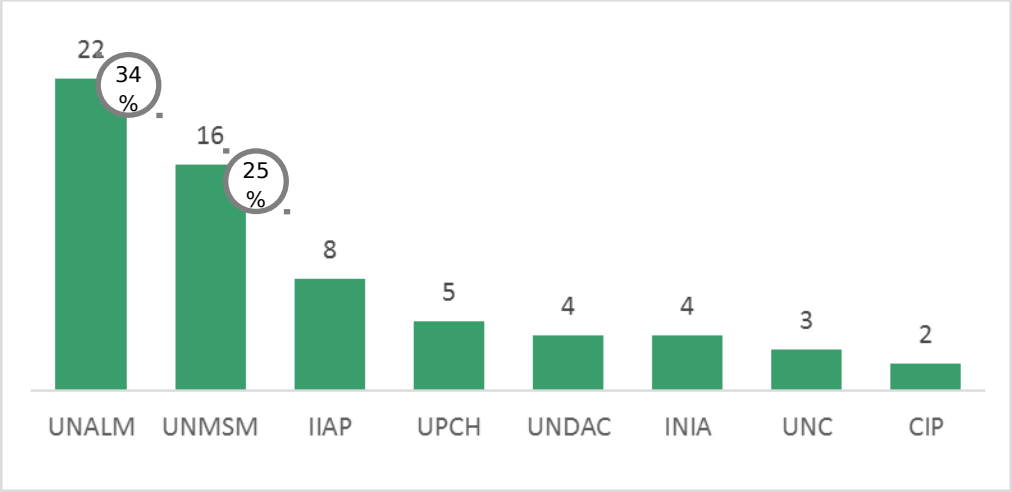


Figure 2: Gender of surveyed researchers



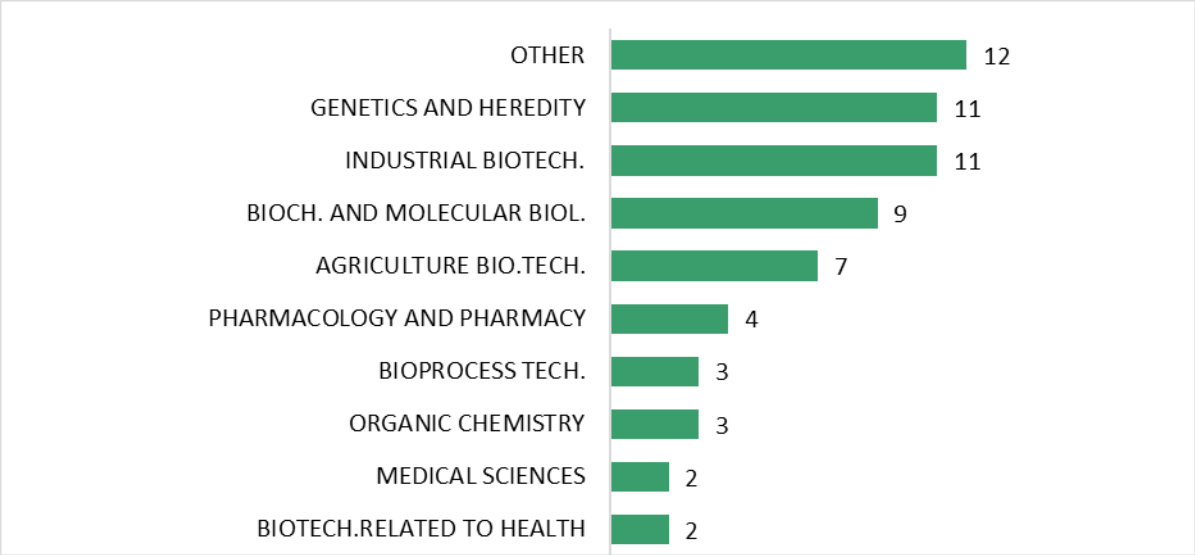
59% of the surveyed researchers currently work either at the National Agrarian University La Molina (UNALM) or at the Major National University of San Marcos (UNMSM).

Figure 3: Institutions in which the surveyed researchers work



On the other hand, the main specialties of the researchers are Genetics and Heredity, Industrial Biotechnology, Biochemistry and Molecular Biology and Agricultural Biotechnology.

Figure 4: Specialty of interviewed researchers



ii. Research experience

38% of researchers have 26 or more years of experience, which is consistent with their age.

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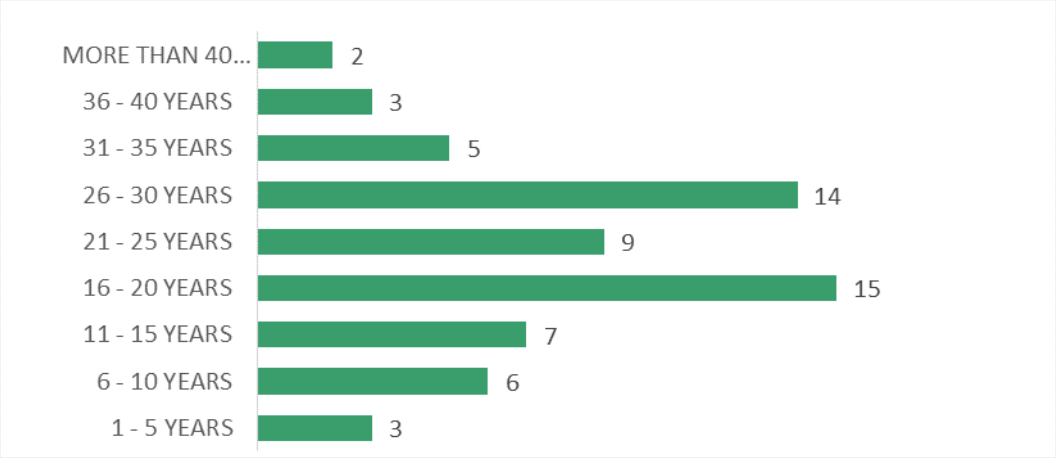
Figure 5: Research experience (years) of surveyed researchers



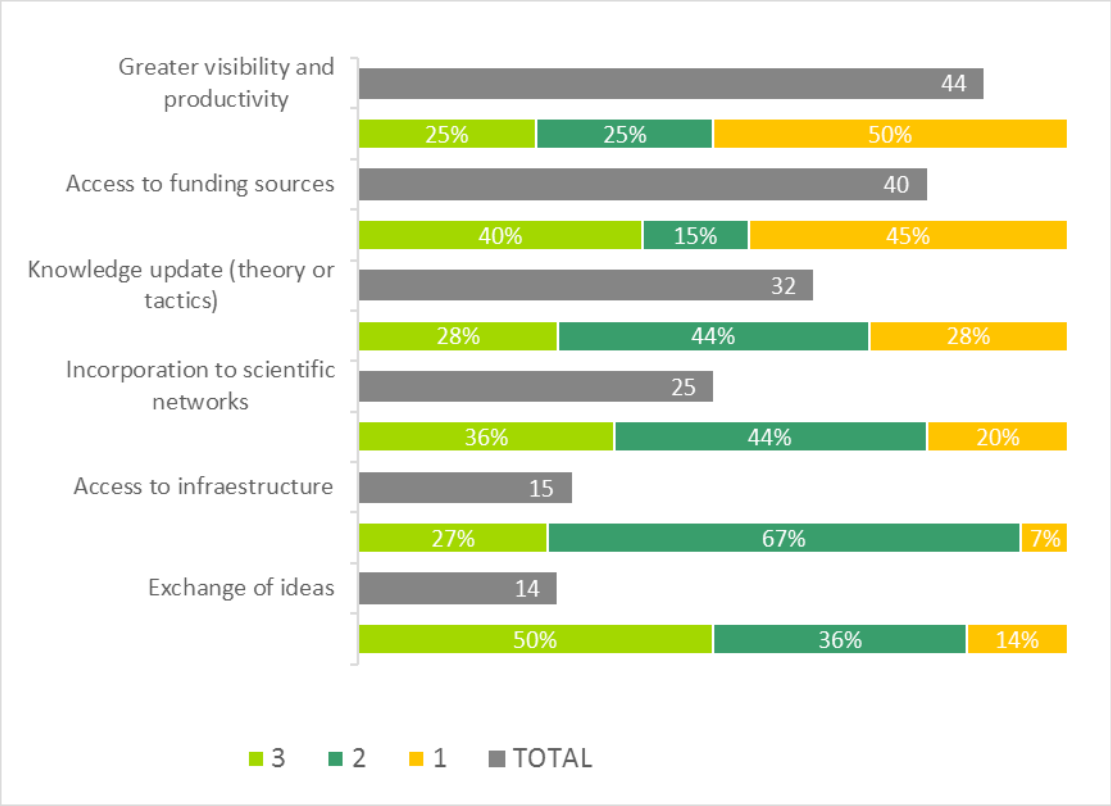
With regard to the number of publications in indexed scientific journals, on average, researchers have 5 publications dealing about Peruvian biodiversity products. From these publications, 4 correspond to the products studied in this work. In addition, 36% declare to be part of a national or international research group, institutional or not, that includes lines of work related to biodiversity.

iii. Determinants and expected results of collaboration

The three most critical aspects for the selection of a scientific collaborator are: “complementary or specialized knowledge”, the “instrumental contribution” (equipment or laboratories) and the “academic training”. On an importance scale from 1 to 5, being 5 the most important, the “complementary or specialized knowledge” received a score of 5 and the other two of 4. On the other hand, the less considered criteria are gender, geographic nearness and cultural aspect.

It is important to understand the incentives that determine collaboration between researchers. As shown in Figure 7, as result of collaboration, researchers expect to obtain “greater visibility and productivity”, “access to funding sources” and “update of theoretical or tactical knowledge”. Undoubtedly, “greater visibility and productivity” which is evident in scientific production, is the main incentive for collaboration. Likewise, the fact that “access to funding sources” is the second motivational factor for collaboration, might mean that there is little access to funding or knowledge of where to obtain it.

Figure 7: Expected results of scientific collaboration

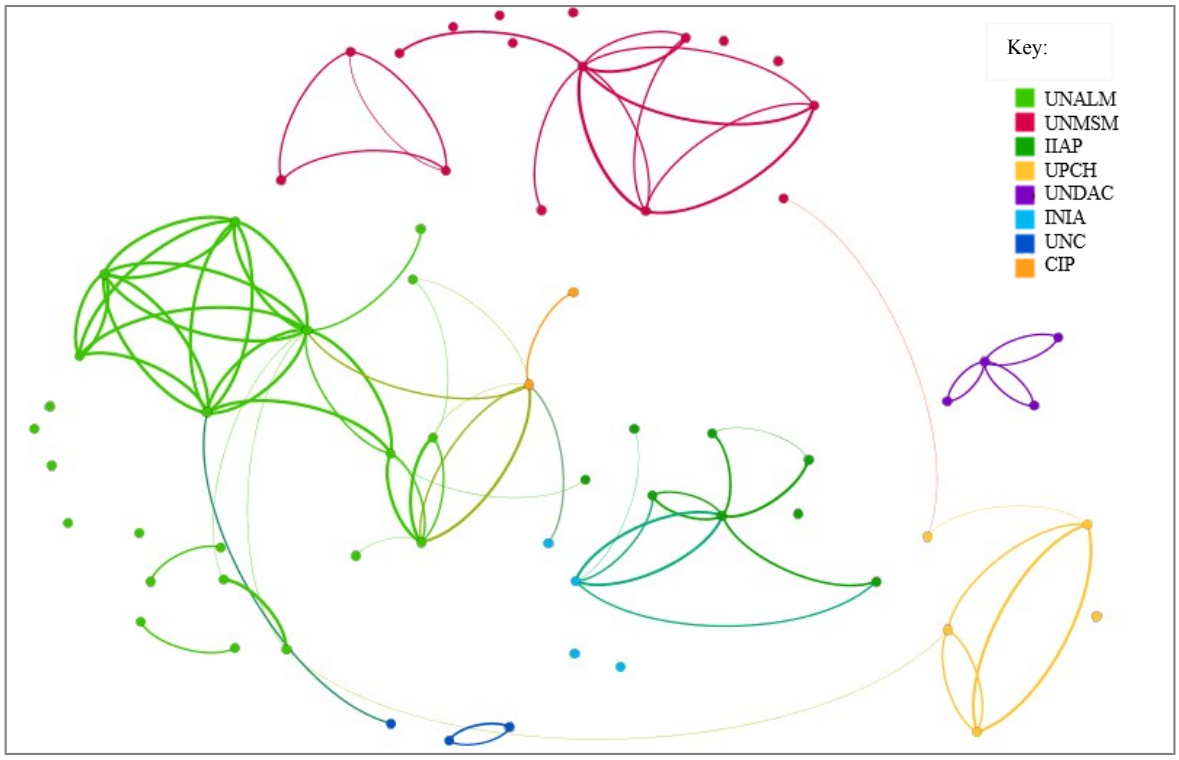


Social Networks Analysis (ARS)

To start, it is useful to make a comparison between perception and reality about the current scientific collaboration level. In this aspect, 85% of the researchers evaluated this variable on a Likert scale and maintained that they consider having a medium to high collaboration level with other researchers.

In contrast to these perception or opinion answers, Figure 8 shows the general structure of the surveyed researchers' network. Even though there are specific groups whose nodes (researchers) are articulated, 15 out of 64 researchers (23%) belonging to the same institution (university) are isolated. The indicators that will be shown below back up these observations to conclude that the researchers' network studying the selected products of Peruvian agrobiodiversity is still incipient, not only in terms of number of links, but also in terms of their strength.

Figure 8: General graph of the researchers' network



Next, an analysis is made on the basis of the measurements obtained from the software. For each measure a graph will be shown and the results will be interpreted from the ARS theory.

i. Density

A density of 2.1% is shown, which means that it is a network with a minimum connectivity level. It is valid to stress that at this analysis level, the intensity of the relationships is not evaluated. It would be enough for researchers to state that they have made queries/exchange of information at some moment with another of the other 63 researchers to be included as an existing relation in this indicator. Although it was intuited that the density level network was low, it was expected to be around 10%. However, the findings evidence an incipient network.

ii. Centrality Degree

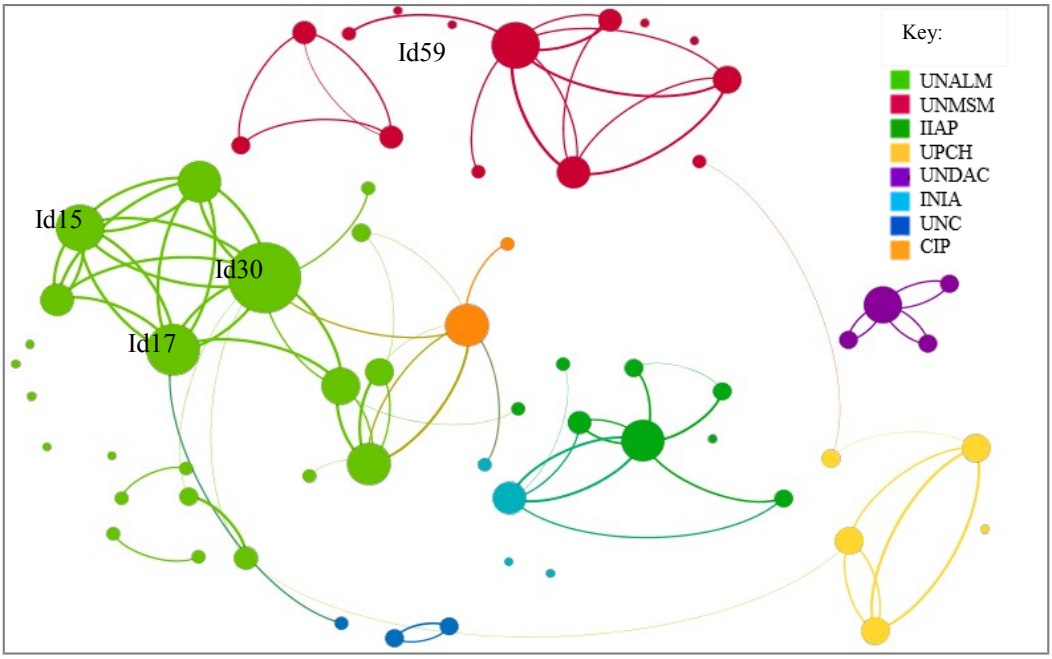
This is the first indicator that analyzes the individual performance of each node (researcher) within the network. In Figure 9 the nodes can be appreciated with different sizes according to their degree. The type of relation, or if they are input or output relations, is irrelevant to evaluate this indicator. In order to make observation easier, a special Gephi algorithm called Fruchteman-Reinfold was applied; it groups the nodes with greatest number of links. According to the applied analysis, the average degree is 2.6 which implies that each node of this network has less than three links. This is very low considering that the total number of possible links in a 64 node network could be 128.

The comparative analysis of the degrees of the nodes makes possible to identify those that have a better position within the network. The four nodes with the best positions will be analyzed. The node with the highest degree represents researcher CAMPOS GUTIERREZ, DAVID CARLOS who has a degree of 13, equivalent to 10% of the total possible links. The second place in this indicator belongs to CHIRINOS GALLARDO, ROSANA with a degree of 9. The third and fourth places are for BETALLELUZ PALLARDEL, INDIRA and RESEARCHER UNMSN ID 59, both with a degree of 8.

The first three researchers belong to the Industrial Biotechnology Institute (IBT) of the UNALM integrated by a total of 6 researchers. The number of relationships of the 4 stakeholders analyzed is due, basically, because they form part of a research group or university. Also, it has been analyzed that relations with researchers from the other 7 institutions included in this study, are limited or do not exist. So, analyzing the links of the mentioned scientists, in general terms, only 2 of 38 correspond with researchers outside their current work center.

Even when the centrality degree indicator analyzes the relationships in a generic way, attention is drawn to the fact that the 4 researchers most linked to the network, are really linked, almost exclusively, with a narrowed group of researchers within their work center.

Figure 9: Graph of the network based on centrality degree



iii. Input and output degree or Indegree and Outdegree

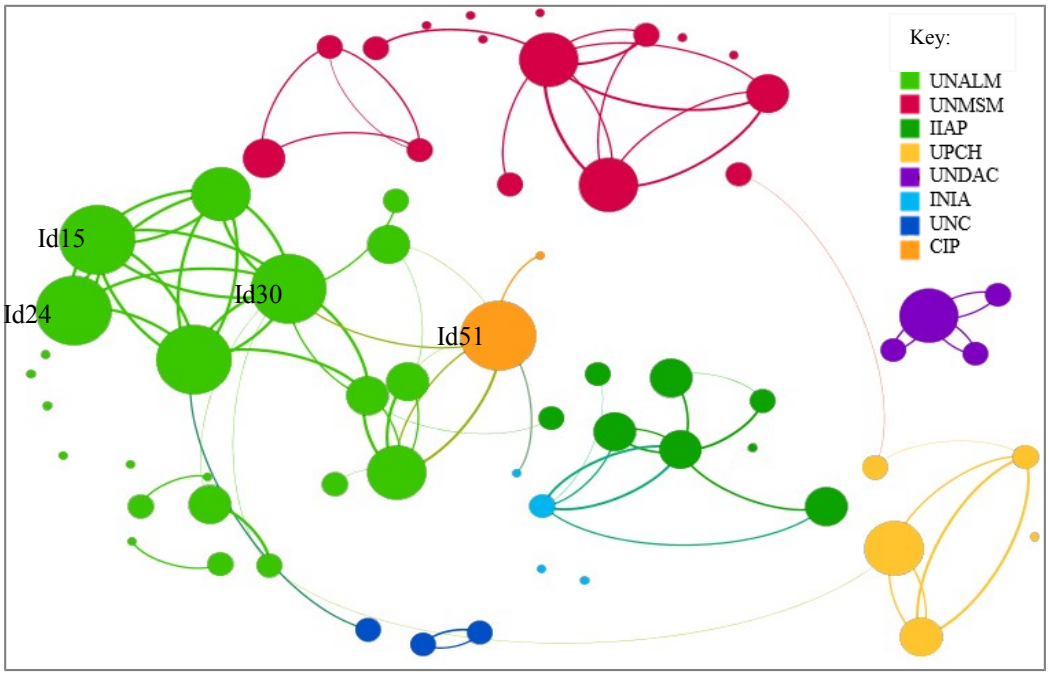
For the input degree or Indegree, researcher C1 leads the list of 64 researchers with 9 links. The interpretation is that 14% of the network stakeholders state that they have had at least a basic collaboration (inquiries or information exchange) with this researcher. A critical aspect of the network in general is that 47% of the researchers, that is almost half of them, were not mentioned by any

of the others. Also, 21% received only one mention from the members of the network.

To continue with the analysis, Figure 10 shows greater homogeneity among stakeholders with respect to the researchers with more output links: 5 researchers obtained an output degree of 4 which means that they claimed to have collaborated with 4 professionals of the network. These were: C1 (UNALM); C2 (UNALM); I1 (UNALM) and RESEARCHER CIP ID 51. In the first three cases, as can be inferred from previous statements, the mentioned collaborations were exclusively with researchers from the IBT group. On the other hand, the case of the CIP researcher strikes attention because of the different behavior. This researcher mentioned having collaborated with three colleagues outside his current work center, 2 from the UNALM and one from the UNC. Although the possibility that researchers from institutes would be more linked than those of universities was initially considered, findings evidence that it is not true. Of the 14 surveyed scientists from research centers, except for the case of RESEARCHER CIP ID 51, all mentioned between 0 and 2 output links.

In general terms, a total of 41 stakeholders (64%) do not show output relation with the rest of the network.

Figure 10: Graph of the network based on output degree



iv. Weighted Degree

So far the different types of relationships have not been considered because in a first level of analysis it is necessary to identify whether or not links exist to later determine their strength or intensity. Following are the 5 researchers with highest weight average.

Table 12: Average weight degree

ID	Label	Institute	Degree	Weighted degree	Average
15	B1	UNALM	8	56	7.00
14	A1	UNALM	7	49	7.00
24	I1	UNALM	5	35	7.00
17	C2	UNALM	9	60	6.67
30	C1	UNALM	13	70	5.38

It is interesting to find that all are members of IBT of the UNALM. B1 and I1 have the highest indicator which a priori shows that the types of links that they have established are strong. As can be observed, the weight average (7) corresponds to the score given to relationships coming from research groups. Without doubt, this collaboration type requires a greater degree of proximity than previous levels.

However, it is important to deepen the analysis. When analyzing input and output links, it was mentioned that both C1 and C2 have one input link each with UNC and CIP researchers. In both cases, they were specific collaborations in research projects. This collaboration type has a score of 4 according to the predefined methodology. In addition, C1 received collaboration references from UNALM researchers who claimed to have participated in joint research projects for specific components or to have consulted or exchanged with the mentioned researcher. If the impact level is considered by the significance that a researcher can have when contributing with other members or the scientific community, it becomes valid to encourage the behavior of the last two researchers.

v. Betweenness Centrality

This indicator measures the articulator role that a researcher can have. The highest score of this indicator goes to those who act as “bridges” among stakeholders with greater frequency. Likewise, geodetic roads are considered, that is, shortage routes to access other network members. C1 stands out for having the greatest number of links and thus has greater possibilities to play the facilitator role to link between researchers. Besides him, there are other 4 researchers who only have 3 to 5 links, but they hold a relatively strategic position because either they have a greater diversity of contacts or they are the only possible link between a researcher outside their work center and their internal network.

Table 13: Intermediation degree

ID	Label	Institute	Betweenness centrality
30	C1	UNALM	117.83

43	T1	UNALM	85.00
16	B1	UNALM	77.17
51	RESEARCHER_CIP_ID 51	CIP	56.17
41	RESEARCHER_UNALM_ID 41	UNALM	55.00

CONCLUSIONS

The indicators used as part of ARS methodology seek to provide objectivity to the scientific collaboration network analysis in the specific study area selected. The low network connectivity hypothesis is verified. As to researchers' profile, although their position in the network varies depending on the measured attribute, undoubtedly there are improvement opportunities in terms of network articulation in the level of number of links as well as in their strength.

Therefore, there is a great opportunity to implement initiatives that improve the linkage level of this network. As previously mentioned, this could facilitate information generation and exchange to subsequently improve the promotion of added-value products in which this information or knowledge is used during its formulation. This is a way to contribute to the advantageous use of Peruvian biodiversity with a sustainable development perspective.

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