

New Doctoral Program in Agricultural Technical Sciences

Nuevo Programa de Doctorado en Ciencias Técnicas Agropecuarias



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ABSTRACT. The objective of the new program is to train Doctors (PhD) in Agricultural Technical Sciences of high level of scientific development and, at the same time, to increase their visibility, with an integrating approach considering all the branches of knowledge of the specialty of Agricultural Engineering in Cuba and internationally. The program has been developed with three training components, focused mainly on Research, as well as the Methodological Theory and the preparation for the Predefense and Defense of the thesis. The component of research training in the program presents 80 credits, for 66.66% with respect to the 120 total credits of the program, the theoretical methodological component a total of 24 credits for a 20%, and the one of Preparation of the thesis for predefense and defense, a total of 16 credits for a 13.33%. It presents seven lines of research related to the specialty of Agricultural Engineering. The general and specific basic courses offered in the program are chosen according to the research line chosen by the doctoral student who must attend at least six, in correspondence with the minimums of the specialty established by the National Commission of Scientific Degrees of Cuba (NCS D) and approved by the Academic Committee of the Program. This program was approved in November 2017 by the NCS D of Cuba.

Keywords: Agricultural Engineering; Doctoral Training; Specialty.

RESUMEN: El objetivo del nuevo programa consiste en formar Doctores en Ciencias Técnicas Agropecuarias de alto nivel de desarrollo científico y a su vez aumentar su visibilidad, con enfoque integrador considerando todas las ramas del conocimiento de la especialidad de Ingeniería Agrícola en Cuba e internacionalmente. El programa ha sido elaborado con tres componentes de formación, centrado fundamentalmente en la Investigación, así como la Teórico Metodológica y la de preparación para la Predefensa y Defensa de la tesis. La componente de formación investigativa en el programa presenta un total de 80 créditos, para un 66,66 % con respecto al total de los créditos del programa de 120, la componente teórica metodológica un total de 24 créditos para un 20 %, y la de preparación de la tesis para predefensa y defensa un total de 16 créditos para un 13,33 %. Presenta siete líneas de investigación relacionadas con la especialidad de Ingeniería Agrícola.

Los cursos básicos generales y específicos ofertados en el programa se escogen atendiendo a la línea de investigación por la que opte el doctorando, debiendo cursar hasta seis como mínimo, en correspondencia con los mínimos de la especialidad establecidos por la Comisión Nacional de Grados Científicos de Cuba y aprobados por el Comité Académico del Programa. Dicho programa fue aprobado en noviembre de 2017 por la CNGC de Cuba.

Palabras clave: Ingeniería Agrícola, formación doctoral, especialidad.

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INTRODUCTION

For the rapid development of science in developed and developing countries such as Cuba, it is very important to have scientific institutions specialized in the different branches of science, as well as scientific expertise who are capable of contributing to their development, according to ([Saborido, 2018](#)). For this reason, at the national and international level, the training of high-level specialists who contribute to the socioeconomic development of the countries has been a priority in different institutions since 1970 ([Vela, 2000](#)). Nowadays it has gained a greater boom, with the development of different doctorate programs in the branch of Agricultural Engineering and Technical Sciences, according to ([Lillo, 2001](#)) ([Hassi, 2002](#)); ([Iglesias, 2006](#)); ([Llanio et al., 2008](#)) y ([Pérez, 2014](#)). In Cuba, the Center for Agricultural Mechanization (CEMA) of the Faculty of Technical Sciences of the Agrarian University of Havana was founded in 1969 at the University of Havana, as part of the national policy of integration of the University for economic and social development of the country. It plays, at the national level, an important and leading role in doctoral training in the area of knowledge related to Agricultural Technical Sciences (Agricultural Engineering), particularly with Agricultural Mechanization.

In this center, for the tutelary modality, 11 doctors have been trained from its foundation until 2005. They were tutored by the doctors of CEMA that were formed in the countries of the socialist field USSR, Bulgaria, Hungary, etc., representing more than 60% of doctors trained in other institutions and abroad during the same period at the national level in that specialty. Subsequently, with the execution and coordination of Doctorate Programs: Technical Agricultural Sciences Tutelary Program, approved since 2005 and Collaborative Curricular Program (DCCP) in Agricultural Mechanization, since November 2006 (current Agricultural Engineering, since February 20, 2013), until that year, 23 theses had been defended by authors from various institutions throughout the country, including four foreigners, in the last 11 years. Programs have been accredited of Excellence, since January 2013 granted by the National Accreditation Board (NAB).

Currently Cuba, under the direction of the National Commission of Scientific Degrees, according to [CNGC \(2016\)](#), carries out an improvement for the doctoral training in order to its improvement, both, in quality and in number of doctoral students defended ([Borroto & Salas, 2000](#)). The previous program covers contents only of three minimums of the specialty in Agricultural Engineering, according to [CNGC \(2012\)](#); The objective of the new doctoral program is to train doctors in Agricultural Technical Sciences of high level of scientific development and disseminate, socialize and increase its visibility. It is performed by the Center for Agricultural Mechanization (CEMA) that belongs to the Faculty of Technical Sciences, at Agrarian University of Havana as an authorized institution in Cuba in that branch of science. That program comprises a more integrative approach considering all branches of knowledge that includes the specialty of Agricultural Engineering in Cuba and internationally.

TOPIC DEVELOPING

Methods

The preparation of the new doctorate program in Agricultural Technical Sciences is based on the CNGC Indications for Doctorate Programs Elaboration, according to [CNGC \(2012\)](#); The following premises were considered.

The quantitative and qualitative expression of the program's academic credit system was carried out in accordance with the requirements established in Regulations for Postgraduate Education of the Ministry of Higher Education, according to Resolution No.132 / 2004 ([MES, 2004](#)) and

Resolution No.166 / 09 ([MES, 2009](#)). The amount of credits of the doctorate program must be made with a minimum of 100 and a maximum of 130 credits, among which mandatory and optional credits must be considered.

The structure of the program should include three fundamental components. One is Research Training or Research Work, which is the main component of the program, and should cover 50% or more of the credits and activities of the program. Another one is Theoretical-Methodological Training, whose essential contents and the corresponding credits, that contribute to the general and specific training to develop the research by the aspirants enrolled in the program must be specified and cover a maximum of 30% of the program credits. Moreover, the last one is the Preparation of the Thesis, Pre-Defense and Defense. It includes the writing and revision of the thesis for the defense, with a maximum amount of credits of 20%, by assuming the minimum percentage of the research component of 50% and a maximum in the theoretical - methodological of 30%.

Analysis and synthesis, deductive and logical are used as methods.

RESULTS AND DISCUSSION

Basic Structure of the Doctoral Program

The authorized institution coordinating the program is the Agrarian University of Havana (UNAH), which provides the coordinator of the program and more than two thirds of the members of the academic committee (eight) for 80% of the total (10) and 5 representatives of the seven research lines of the doctoral program. A national and international leadership in Agricultural Engineering, with 44 research projects in execution or executed in the last five years, where aspirants are inserted to carry out their theses. Among the members of the program faculty there are 16 professors working in the research lines, for 66.66% and delivering 19 courses for 67, 85%, with respect to the total of 24 and 28 respectively.

This program is carried out in the Agricultural Mechanization Center (CEMA) of the Faculty of Technical Sciences of UNAH, where all members of the faculty are actively involved in research in areas related to the program with scientific production because of it. The Research Institute of Agricultural Engineering also participates and there are six collaborating institutions throughout Cuba. The degree of the doctoral program established is Doctor in Agricultural Technical Sciences.

Objectives of the Doctoral Program

General Objectives

To train Doctors in Agricultural Technical Sciences with a high national and international level of development, in the specialty of Agricultural Engineering, offering the doctoral student a solid theoretical, methodological, technical and investigative training. That will allow contributing new knowledge and scientific results in the lines covered by the Doctoral Program and, at the same time, enrich the general and specialized scientific culture of the institution to which it belongs, as well as its own, with a high social commitment.

Specific Objectives

- To prepare comprehensive doctors for research, development, teaching and other functions, with a high qualification, for the institutions that require them, capable of participating actively in the current transformation and perspective of agriculture.
- To conduct research by doctoral students that contribute to their scientific training for successfully completing their doctorate and for developing technologies and means, in the research lines included in the program, through approved research projects to the effect.

- To organize and promote the discussion of the results of doctoral students in scientific collectives with other doctoral students, tutors and other collaborators whose interaction, based on related research lines and work by projects, contributes to the scientific training of the applicant, aimed at the solution of complex problems in the field of Agricultural Engineering.
- To promote the work of multidisciplinary collaboration and in networks between different dependencies of the University or with other national and foreign institutions that have similar lines of research.
- To achieve the interrelation of the applicant with other figures of the undergraduate, postgraduate, such as masters, specialties, diplomas, courses, internships and trainings.

Description of the Methodological Theoretical Component

In theoretical-methodological component of the Doctoral Program, up to 27 postgraduate courses are offered, three of them basic general and 24 basic-specific elective courses. Their selection depends on the research line of the program that each candidate enters, related to the subject of his/her thesis. Candidates have to attend, up to three courses at least to accumulate the minimum necessary credits, for six courses as total for each doctoral student.

For their delivery, postgraduate courses have been structured in two blocks:

General basic block (CG). This block is related to the general basic knowledge that the candidate must acquire for the development of his/her thesis. The list of courses and their credits are shown in [Table 1](#) and they can be studied or demonstrated in a proficiency test to obtain nine credits.

Specific basic - optional block (CB). This is related to the specific basic courses about branches of knowledge on agricultural engineering. The list of courses, their credits and their relationship with the research lines of the program, are shown in [table 2](#). The course basic contents to be overcome must be related to the specific area of knowledge in which the applicant researches for the thesis work. These contents are offered in the program depending on the researching line to which the applicant is incorporated, which may also be completed or demonstrated in a proficiency test. The credits obtained for approving these contents (7) together with those previously obtained (9) and the credits of the seminars or thesis workshops (10) of the research component, will allow the applicant the right to be exempted from the Minimum Exam of the Specialty Basic Program, with previous evaluation and approval of the doctoral committee for each particular case.

TABLE 1. Block of General Basic Courses - 9 Credits

Code	Postgraduate Course	Credits
CG-1	Methodology of Scientific Investigation	3
CG-2	Statistics and Experimental Design for Engineers	3
CG-3	Specific Research Methods in Agricultural Engineering.	3
	Subtotal of credits	9

TABLE 2. Block of Specific-Basic Courses Optional -7 Credits

Code	Postgraduate Course	Credits	Line
CB-1	Theory and Design of Agricultural Machines	3	1, 3
CB-2	Agricultural Machinery Drives	2	1, 3
CB-3	Technology of Agricultural Machinery Construction	2	1,2
CB-4	Operation of Machinery	3	2, 3

CB-5	Technical Operation	2	2
CB-6	Testing and Evaluation of Agricultural Machinery	2	2,1
CB-7	Maintenance and Repair Management	3	2,6,1
CB-8	Reliability and Maintenance	2	2,1
CB-9	Manufacturing Technologies and Parts Recovery	2	2,1
CB-10	Postharvest Processes	3	3, 1
CB-11	Traditional and Non-Destructive Methods Used in Post-Harvest	2	3
CB-12	Conservation Technologies for Agricultural Products	2	3
CB-13	Thermal and Mass Exchange Processes	3	4,2
CB-14	Use of Fossil Energy in Agricultural Processes	2	4,2
CB-15	Use of Renewable Energy in Agricultural Processes	2	4
CB-16	Soil Physics	3	5, 7
CB-17	Water Requirements of Crops	2	5, 6, 7
CB-18	Agrohydrological Models	2	5, 7
CB-19	Irrigation Engineering	3	6, 5, 7
CB-20	Drainage Engineering	2	6, 7
CB-21	Hydraulics and Hydrology Applied to Irrigation and Drainage	2	6, 7
CB-22	Operation of Irrigation and Drainage Systems	3	7, 6, 2
CB-23	Water Balance	2	7, 5, 6
CB-24	Operation of Irrigation and Drainage Works	2	7, 6
	Subtotal of credits	7	

In the doctorate program, the courses to be taught are articulated with the Master's Degree in Agricultural Engineering Systems, which consists of the same lines of research as in this program.

This initial stage also includes the need to demonstrate the mastery of knowledge of a Foreign Language of those recognized by the National Commission of Scientific Degree according to [CNGC \(2005\)](#) and of the Social Problems of Sciences applied to the specialty and to the research topic. That is in accordance with what is generally required for the training of doctors in Cuba. The aspirants will have to demonstrate the mastery on these matters through proficiency tests or, otherwise, they must find a way of acquiring them to meet the requirements and obtain four credits since the program does not include them within its content system.

If it is needed for the matter of research, the doctoral student can overcome contents of at least two additional courses in the specific branch of knowledge related to the thesis, to obtain four additional credits, which may or may not be among those offered by the Program. The set of accumulated credits will serve as complement to be exempted from the Minimum Exam of the Complementary Program of the Specialty, with prior assessment and approval of the doctoral committee for each particular case.

With the Doctorate Committee's decision, it is possible to validate the selected courses, from the contents studied in the last 5 years by the doctoral student (whose supporting documents are shown and approved by the Doctoral Committee) on that subject and whose quality and depth are considered appropriate or equivalent to those required by the program.

The development of the thesis should be included within Projects developed by the research group where the doctoral student is inserted as part of the Science and Technical Programs established and supported by national and international collaboration projects. The design of the research constitutes the first step in the doctoral student's training as a researcher.

If the thesis topic proposed by the candidate opens a new project, which does not exist until now, this stage culminates with the formulation of the project and its approval by the Science and Technology Program where it is inserted.

In [Table 3](#), the total of credits to be obtained in this stage that are 24 and their distribution by the contents to be studied.

TABLE 3. Total Credits to Accumulate in Stage 1: 24 Credits

N _o	GENERAL, BASIC AND SPECIFIC COURSES	Credits	
		Obligatory	Additional
STAGE I. METHODOLOGICAL THEORETICAL TRAINING			
1	Social Problems of Science and Technology	2	
2	Foreign Language	2	
3	Basic-General Knowledge	9	
4	Basic Knowledge-Specific Minimum of the Specialty.	7	
5	Credits to be Achieved by Other Postgraduate Courses (2x2)		4
SUBTOTAL		20	4

Description of the Component Research Formation

The research activity of the candidates is carried out according to the research line chosen by the applicant to carry out his/her thesis, among the seven lines offered by the program:

1. Administration and Technical Assistance of Agricultural Production Engineering Systems.
2. Development and Improvement of Engineering Systems for Agricultural Production
3. Postharvest Engineering and Quality of Agricultural Production.
4. Efficient Use of Energy in Agricultural Production.
5. Interaction of the Soil, Water, Plant and Atmosphere System.
6. Irrigation and Drainage Engineering.
7. Efficient Water Management and Use.

These lines are formed directly on the basis of scientific research groups with a leader of recognized prestige and of projects approved in the National, International, Institutional, Business Defendant and other Programs, of the authorized institution coordinating the program or of the participating institutions or collaborators

The fundamental activities of the doctoral student's training as a researcher, involve his/her active participation in seminars, individual and collective reports, seminars and workshops scheduled in the postgraduate courses, presentation of the advances of the thesis in the Scientific Council of the Faculty and CEMA, participation in predefense and defenses of doctorate of the specialty in Agricultural Engineering. Participation as speakers in international scientific events such as: Conference on Agricultural Engineering (AgrIng), of CEMA, Agrosociencias of UNAH; Agrocentro of UCLV, International Convention of Agricultural Engineering of IAgriC and others of recognized prestige, both, national and international. On the other hand, the publication of the research work's results in the Agricultural Technical Sciences Journal of CEMA, in the Journal of Agricultural Engineering of IAgriC and other referenced and Cuban and foreign impact journals can be made.

This stage constitutes the fundamental section of the program and is integrated by a group of components that the doctoral student will develop systematically working in the research line group where it is inserted, directed by the tutor and supported by consultants, other aspirants and collaborators. In it, he/she must obtain at least 80 credits, of which 57 correspond to activities with

mandatory character and the remaining 23 may be obtained from the additional activities, in both cases as described in [Table 4](#).

The actions to be developed during this stage will be the following:

- The doctoral student must systematically present the results of their work before the group of the research line and the department or research center. This stage begins with the presentation by the doctoral student of the methodological design of the research (5 credits), who must also make a minimum of three presentations during the period for the evaluation of the advances in the research by the doctorate and scientific committee. The student accumulates five credits for each presentation (15 credits) with satisfactory results, for 20 obligatory credits. He/she must also carry out at least two thesis seminars and / or workshops (the first must be done at the end of the basic - general courses and the second one at the end of the basic - specific courses), accumulating five credits for each, for 10 obligatory credits. The objectives and timing of each of the presentations, as well as the seminars or workshops to be carried out, will be defined in the training plan approved by the doctoral committee, so that it is possible to evaluate the development of the research and the fulfillment of the objectives drawn up in stages.
- The presentation and discussion of the results before the research group and the department or center aims at the collective analysis and the preparation of the doctoral student for this type of scientific activity. Therefore, the research group, led by the representative of each line of research can plan, during the training process, all activities of this type considered appropriate to meet this objective, although only the credits previously established will be granted.
- The doctoral student must systematically present the results of their work in national or international scientific events. Ensure that during the whole stage you have presented as the main author the results in at least two events of recognized international prestige, each of which will provide 4 credits, for a total of 8 obligatory credits. In addition, the aspirants will accumulate 2 additional credits for each presentation of their results in scientific events where the main author is. In case of co-authoring work at events, the doctoral student will receive 1 credit regardless of the type of event. The Academic Committee will establish the events of recognized international prestige to consider.
- The doctoral student must systematically publish the results of his/her work in national or foreign specialized journals related to the research topic that he/she develops. During the whole stage, he/she must meet the requirement of sixteen credits with a mandatory nature that can be obtained by publishing in journals of groups 1, 2 or patents, providing eight credits for each. Furthermore, with additional character, the journals of groups 3 and 4 will contribute four credits per publication in case of being the main author. Likewise, as a co-author of group 1 he/she accumulates four credits, of group 2, he/she accumulates three credits and of group 3 and 4 he/she accumulates two additional credits per publication. This ensures a level of adequate publishing of the aspirant's results in scientific journals.
- The doctoral student must insert the topic of the thesis in an officially approved research project, fulfilling the tasks assigned to him/her as a participant in the project, obtaining three obligatory credits for each project in which he/she participates. In addition, if the thesis topic opens the possibility of a new project and the aspirant is the leader, 5 additional credits are awarded.
- Collaborate in the theses of candidates who take the Master's Degree that is taught by the group of the line where they are investigating and collaborating with them in turn, in the

tutorial to Diploma Work or Student Groups of Scientific work. The aspirant will accumulate four and two additional credits for each Tutored Diploma Work and Master's Thesis in which he/she collaborates, respectively. The subjects of the Diploma Works and / or the Master's Theses must be related to his/her research topic.

- On the other hand, obtaining research awards with the necessary endorsements, related to the research subject of the doctoral student, will allow him/her obtaining two additional credits for each one.
- Collaborate in the teaching of undergraduate and postgraduate courses, Masters or Diplomas that develops the group of the research line where it is inserted will allow the candidate accumulating two additional credits for every 15 hours of direct teaching, both, for undergraduate as for postgraduate.
- Depending on the subject, internships can be organized for short stays in other research centers or universities in the country or abroad, where they can acquire knowledge and necessary specialized information, as well as acquire practical experiences and training, or develop experimental laboratory or work investigations. The doctoral student will accumulate two additional credits for every 48 hours of work in these activities.
- The total of obligatory credits to obtain in Stage 2 as well as the activities that describe the possible additional credits, are shown in [Table 4](#).

TABLE 4. Total Minimum Credits to be Accumulated in Stage 2: 80

II	Training as a Researcher	Credits 80	
		Obligatory 57	Additional
1	Presentation, defense and approval of the research design of the thesis subject, before the scientific council of the faculty.	5	
2	Participation in research projects related to the subject of the thesis, at least one, (1x3)	3	
	Project leader, (1x5)		5
	Presentation of papers at national and international scientific events, at least two.		
3	Lead author, international event, at least two, (2x4)	8	
	Lead author, national event, additional at least one, (1x2)		2
	Co-author, additional one credit per publication (1x1)		1
	Publications		
	Main author journal group 1, 2 or patent, at least two, (2x8)	16	
4	Senior author journal group 3 and 4		4
	Coauthor journal group 1		4
	Coauthor journal group 2		3
	Coauthor journal group 3 and 4		2
5	Thesis seminars and / or workshops, coordinated by a member of the committee, making presentations of the research topic in a successful way, (2x5)	10	
6	Presentation and approval of advances of the thesis before the scientific council of the faculty or other councils (at least three presentations), (3x5)	15	
7	Tutoring of diploma works related to the subject of the thesis, four credits for each one.		4

8	Collaboration with master's degrees, specialties, diplomas, courses, internships and trainings, additional two credits for each activity.	2
9	Awards and endorsements obtained related to the theme, additional two credits for each one.	2
10	Teaching related to the subject of research, for every 15 hours	2
11	Short research stays inside or outside the country for every 48 hours	2

Description of the Component Preparation for the Drafting of the Thesis, Pre defense and Defense

Table 5 shows the activities to be carried out and the credits for stage 3 related to preparation for writing, pre-defense and defense of the thesis. The Thesis and Research Seminar that is offered in the research component, is considered as one of the activities that directly contributes to this component. Seminars must be held within the same presentation of the thesis advances, scientific writing, exercises for the writing of scientific articles for journals and events, among others, that allow the doctoral student using the language and grammar of the Spanish language. Likewise, the tutors are the maximum responsible for the joint with the candidate in the correct and scientific writing of the thesis, so they must pay the maximum possible attention to the correct use of the orthographic rules of the language, which otherwise is considered invalidating for the defense of the thesis.

TABLE 5. Activities to be Developed Stage 3: 16 Credits

	Component Preparation for the Writing of the Thesis, Pre-Defense and Defense	Credits
1	Termination of the thesis writing by the corresponding chapters, with letter of approval from the tutor.	5
2	Realization of the thesis pre-defense successfully. Preparation for defense	5
3	Writing of the thesis correcting the indications of the pre-defense, with letter of approval from a designated commission.	3
4	Delivery of documentation and successful defense of the thesis.	3
Subtotal de credits		16

Program Calendar

The minimum and maximum periods for each stage are between 3 and 4 years, depending on the dedication if it is full time or part time, respectively. It is proposed to start the courses once a year, between the months of January and February, during a week per month.

Finally, Figure 1 shows the distribution of the amount of credits to be obtained by the doctoral student and the percentages by stages that they represent with respect to the total of the program credits amounting to 120, of these 93 obligatory and 27 additional. There, it is appreciated that the component of training as a researcher, corresponding to stage 2, represents the largest amount of credits with 80 and the highest percentage of the program with 66.66%. That is in correspondence with the indications of the National Commission of Scientific Degrees, according to CNGC (2016). The theoretical methodological component (Stage 1) represents 20% and the preparation component for writing, pre-defense and defense of the thesis (Stage 3) 13.33%, below 30 and 20%, respectively. These stages coexist in time and not chronologically.

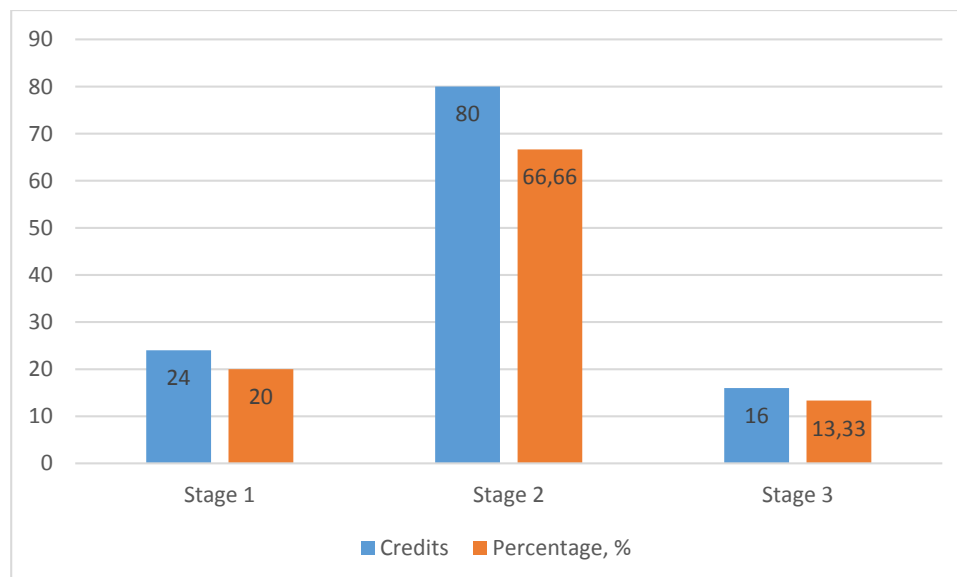


FIGURE 1. Graphic representation of the amount of credits and percentage for each of the stages of the program.

CONCLUSIONS

- The elaboration of a new comprehensive doctoral program in Agricultural Technical Sciences that covers all the contents of the branch of knowledge in the specialty of Agricultural Engineering in Cuba and internationally.
- The amount of maximum credits to be obtained by the doctoral student amount to 120, of these 93 obligatory and 27 additional. Divided into three stages: the training component as a researcher is the core of the program and represents the largest number of credits with 80. Therefore, it represents the highest percentage with 66.66%, above 50%. The theoretical methodological component represents 20% and the preparation component for thesis writing, predefining and defending, the last stage, 13.33%, below 30 and 20%, respectively.

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