Scientific Paper

Technology management in the university-Cuban state animal husbandry enterprise relation. Part II. Implementation and validation of the model

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Abstract

This paper presents the procedure to implement the Technological Innovation Management in the university-Cuban state animal husbandry enterprise relation and its validation in the case study University of Pinar del Río and Camilo Cienfuegos Genetic Animal Husbandry Enterprise. The procedure had three phases, with their corresponding steps (eight); in addition, 18 indicators, considered relevant for technology management in the university-enterprise relation, were identified, organized in four dimensions: institutional feedback, economic productive, environmental and social pertinence. These indicators become a key aspect for the evaluation of the model. It was determined that the three indicators with the best results were: the degree of application of the diagnosis in the enterprise, with the companionship of the university per year; the degree in which training generated changes and transformations in the use of the technologies per year; and the degree of planning, organization and contracting of R + D + i projects per year.

Keywords: diagnosis, development projects, technology

Introduction

In the face of the environment in which organizations develop their activities, the maintenance of stable relations as become an essential tool to try to guarantee survival between the university and the enterprise (Vega-Jurado *et al*., 2007). The main organization that generates knowledge, develops and innovates technologies is the university, for which it is closely related to the technological and economic growth of society (Castillo and Reyes, 2015). Nevertheless, Jiménez (2016) considers that still incipient technology transference is observed, and, as consequence, the academic production is focused on the elaboration of papers and books (copyright) and not on the creation of technology and industrial applications (patents and usefulness models).

According to González and Núñez (2012), within the main problems present in the technological management in the university-enterprise relation are the few procedures which guarantee harmony in managing the technology for its transference to the Cuban state animal husbandry enterprise, as well as the non-definition of the functions of universities and enterprises, so that each one contributes to science and innovation management and its implementation.

Additionally, in Cuban agriculture there is scarce experience in strategic management, in its most integral vision: strategic planning, implementation and control (Campos *et al*., 2013). García-Bode *et al*. (2013) reported that technology and knowledge management are not effective yet in the productive basis and gaps persist from the methodological point of view, which are shown in the productive competitiveness of organizations. Against this reality, the need of interaction between the knowledge area and the entrepreneurial sector is essential, according to Silva *et al*. (2013).

There have been many attempts to approach science to the entrepreneurial sector, and the latter has begun to search for ways to increase the efficacy and efficiency of its innovation processes, according to Pedraza-Amador and Velázquez-Castro (2013).

This paper presents the procedure to implement the Technology Management Model in the university-Cuban state animal husbandry enterprise and its validation in the case study University of Pinar del Río (UPR) and Camilo Cienfuegos Genetic Animal Husbandry Enterprise (EPGCC, for its initials in Spanish).

Methodology

Procedure used for the model implementation

From the pertinence of higher education with the entrepreneurial sector, the procedure developed to facilitate the implementation of the Technology Management Model is in correspondence with the classical elements of every management process (planning, organization, execution, evaluation and control).

Phase 1. Characterization of the starting situation for technology management.

Step 1. Diagnosis of the technological needs of the enterprise along with the university.

The initial purpose was that the enterprise made its internal diagnosis and determined what its needs were in the technology management process (TMP). Castro and Herreño (2011) consider that the enterprise does not have all the capacities to define its problems, together with the lack of vision to develop strategies of inter-sectorial cooperation. This generates the need for both institutions to work together to make the diagnosis, and that is developed on participatory and pertinent methods. Thus, the TMP needs will be defined in the enterprise.

On the other hand, once the result of the diagnosis in the enterprise is obtained, the university will define where to aim the efforts with regards to scientific development, and thus establish the coherence with its mission and the impact it should make on the surroundings (Alarcón-Ortiz, 2015).

To develop this action, three exchange and collective discussion activities were carried out among professors, members of the Extension System of the Institute of Animal Science (SEICA, for its initials in Spanish) members of the management board of the enterprise and unit chiefs. In addition, the financial statements and fulfillment of the production plans were analyzed; lastly, key decision-makers[1] of the enterprise were interviewed.

Phase 2. Determination of technological alternatives in the university-enterprise relation.

Step 2. Search for variants of technological solutions between the university and the enterprise, which respond to the needs of the state animal husbandry enterprise.

An analysis was made of the technological potentialities of the university, which, according to the criteria expressed by Enrique (2014), allowed to determine the real possibilities shown by its technological portfolio and manage the generation of knowledge that responds to the needs of the enterprise.

The university, from this result, requested support from the Institute of Animal Science (ICA) and acted as interface between it and the enterprise. Olivera-Fernández (2011) refers that the interface catalyzes the implementation of solutions which, in the scientific-technical order, is demanded by the entrepreneurial sector.

Step 3. Determination of technological alternatives between the university and the enterprise.

The university and ICA defined the different variants that were made available for the enterprise, and organized a document of the technologies which included: i) description; ii) productive, economic, environmental and social evaluation; iii) practical guide for the implementation; and iv) experiences of technological studies about the impact in similar contexts.

Once the technological variants were presented, the enterprise analyzed the organizational aspects to be considered for the technology transference (Castro *et al*., 2014), according to the legal framework, which include:

- Availability of raw materials and feasibility of their acquisition.
- Availability of funds and cash flow, as well as of human capital disaggregated by: labor force and intellectual potential.
- Correspondence between the performance of climate variables and technological requirements.
- Habits and traditions of the idiosyncrasy of the enterprise where the technology transference in question will be carried out.
- Elements of the technology that can be subject to resistance to change.
- Cost-benefit ratio implied by the transference and its sustainability in time.
- Paying-off period of the investment, relevance status of the technology and harmony with the environmental and human health legislation.
- The technology supplier has good referents on the type of technology that is transferred.

Step 4. Re-elaboration of the innovation strategies for the university and the enterprise.

This step constituted the strategic planning for the university and the enterprise; once the technology transferences and improvements to be carried out by both were evaluated, the bases for technology management from the university were defined (fig. 1). On the other hand, the technological strategy of the enterprise was composed by its interests for the technology improvement and/or introduction, as recommended by Suárez (2003).

[1] The are considered persons who, because of their management or leadership responsibility, are decision makers within the enterprise.

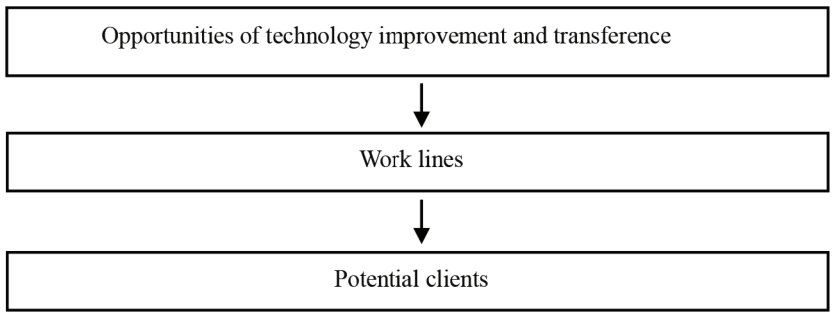

Figure 1. Bases for technological management from the university.

Phase 3. Implementation of technology management actions in the university-enterprise relation.

Step 5. Design and planning of technological development and innovation projects.

Projects constitute the main organizational form for the planning, fund securing, execution, evaluation and control of the actions expressed in the technological strategy, according to what is established for projects, in correspondence with the System of Science and Technological Innovation of the country.

A multidisciplinary group was formed integrated by the scientific council of the university (school), the advisory technical council of the enterprise and the Government, which participates as regulator in the proactive interaction among the university, the scientific environment and the enterprise. This group regulates and rules the ways of cooperation in order to follow up agreements and contribute mutual benefits, as all the agents of development interact (Castillo and Reyes, 2015).

The group determined the established objectives and the project scope, the planning of the main activities and the election of the human capital, material resources and necessary and available infrastructure in the entities to execute the project; as well as the technical-economic pre-feasibility analysis (for innovation projects) and the analysis of the general budget.

Step 6. Execution of projects.

In this step the project team to execute the actions was consolidated. There was participation of undergraduate and graduate students, as human capital under training to conduct course, diploma and master of science works through the project actions. The corresponding contracting was established, and the schedule of activities at short-, medium- and long-term was specified.

Phase 4. Evaluation and adjustment of the proposed model.

Step 7. Evaluation based on a system of indicators.

In order to measure the model effectiveness, a start was made from the dimensions determined in the research (institutional feedback, economic-productive, environmental and social pertinence), from which the indicators were constructed (table 1) for each of the dimensions; each indicator was evaluated once per year, which allowed follow-up in step 8.

According to Núñez-Mora (2011), the indicators put at the service of management instances allow to make accurate and timely decisions; to adopt, in time, the correction measures of the critical or key aspects of the institutions with regards to the objectives or foreseen goals.

Step 8. Follow-up and feedback of the Technology Management Model in the university-Cuban state animal husbandry enterprise relation (TMM-UCSAHER).

Quarterly workshops were designed, which allowed to follow up the execution of the projects, suggest revisions to the action plans and evaluate the partial results. To analyze the annual results, a workshop based on the comparative analysis of the model indicators; its results constituted the basis to establish an action plan for their solution; this allowed the model adjustment. The identified group to carry out this activity is described in step 5.

This model evaluation and adjustment phase is connected to the phase of characterization of the starting situation for the technology management process, and thus feedback occurs.

Results of the procedure application

Characterization of the starting situation for the technology management (results of phase 1)

Step 1. Diagnosis of the technological needs of the enterprise along with the university.

In the diagnosis of the technological needs, the following were identified as main problems of the productive process:

Table 1. Indicators for each of the dimensions.

Dimension	Indicators
Institutional feedback	Degree of application of the diagnosis in the enterprise, with the companionship of the university per year
	Degree in which training[2] generates changes and transformations in the use of the technologies per year
	Degree of planning, organization and contracting of I+D+i projects per year
	Degree of students' participation (undergraduate and graduate) linked to research or innovation projects per year
	Degree of achievement of awards and recognition, from the results reached in the enterprise and the university per year
	Degree of participation of enterprise professionals, professors and students in events, publications and elaboration of theses that socialize the results reached per year
Economic-productive	Degree of technology introduction or improvements of the university and its scientific environment per year
	Degree of improvement of productive processes per year
	Degree of improvement of economic processes per year
Environmental	Degree of management of solid wastes per year
	Degree of management of waste water per year
	Degree of intensity of carrying capacity per year
	Degree of soil use management and amendments performed per year
	Degree of water reserve management per year
	Degree of reforestation per year
Social pertinence	Degree of satisfaction of the link with the university and other research centers per year
	Degree of satisfaction of entrepreneurs involved in the university-enterprise relation per year
	Degree of satisfaction of workers depending on the productive results reached after the introduction of the technologies per year

[2]Quantity of courses, workshops, talks and exchange activities that take place in the training process.

- In the animal husbandry units of the EPGCC the fresh integral diets, based on the combination of protein plants and grasses, are not offered to cattle, in the sheds or during milking.
- The technology of biomass banks of *Cenchrus purpureus* cv. Cuba CT-115 is not used.
- The biomass availability of forage grass varieties, such as Cuba CT-169 or OM-22, is insufficient in animal husbandry units; they constitute an important component in the elaboration of fresh integral diets, which can be used mainly during the dry season.
- The use of distillery waste (vinasse) in cattle feeding and its combination with other feed sources (silage elaboration) does not constitute a generalized resource that would allow to improve the feeding balances in the animal husbandry units of the EPGCC.

This diagnosis of technological needs constituted the basis to develop the later stages, and it was discussed among the UPR, ICA and EPGCC, because, according to García-Delgado *et al*. (2014), the identification of the knowledge needs is a highly important stage for the innovation process.

Determination of technological alternatives in the university-enterprise relation (results of phase 2)

Step 2. Search for variants of technological solutions between the university and the enterprise, which respond to the needs of the state animal husbandry enterprise.

For the search of technological solution variants between the university and the enterprise, the technological portfolio of the Forestry-Agronomy School of the UPR was updated, and finished technologies were selected, such as the ones identified by Delgado (2012).

The few solutions presented by the technological portfolio of the school, against the enterprise demands, motivated the development of networking with the ICA, which provided advisory and collaboration through its extension system and served as interface to the university and the EPGCC. This allowed to determine the technological alternatives shown in step 3.

Step 3. Determination of technological alternatives between the university and the enterprise.

After the technological variants were determined (step 2), the university and ICA delivered to the enterprise the essential information of the new technologies or technological improvements to be made. From it, the enterprise evaluated the variants according to the organizational aspects to be considered for the technology transference, and determined the following as necessary:

- Utilization of fresh integral diets, based on protein plants and grasses.
- Completion or sowing of 30 % of the areas per unit with biomass banks of *C. purpureus* cv. Cuba CT-115.
- Sowing of forage varieties, such as cv. Cuba CT-169 u OM-22, for biomass production during the dry season.
- Use of distillery waste in cattle feeding (vinasse).
- Improvement and management of the silvopastoral system with *Leucaena leucocephala* and herbaceous legumes

Step 4. Re-elaboration of the innovation strategies for the university and the enterprise.

For the re-elaboration of the innovation strategies they were analyzed, in the university as well as the enterprise, which allowed an adaptation of the technology transference process from the needs of the latter. In the case of the university the bases defined in step 4 of the procedure were taken into consideration.

Implementation of technology management actions in the university-enterprise relation (results of phase 3)

Step 5. Design and planning of development and technological innovation projects.

The group responsible for the design and planning of the projects determined the degree of implication of the involved actors, among which were:

- The Government supervised that the objectives of the formulated projects responded to the needs identified in step 1 of the methodology; besides playing its role as regulating entity of legality among the enterprise, university and research center.
- The actors (UPR, ICA and EPGCC) established agreements for the fulfillment of the main activities, for the transference and improvement of the technologies.
- Each institution defined the necessary human capital for the fulfillment of the project actions.
- The enterprise defined, from the needs of actions to be carried out, the budget and necessary resources for its development.

After making this analysis, two entrepreneurial projects were designed:

1. Design of a technology management model to contribute to the enhancement of the university-state animal husbandry enterprise relation. Case study UPR-EPGCC.
2. Implementation of an organizational management in dairy units of the EPGCC for the transference of animal husbandry technologies.

Both projects were visualized in the website http://www.geteca.co.cu; they guaranteed the execution of the actions and the satisfaction of the enterprise needs, identified in the diagnosis. Such site facilitated the communication for technology management in this relation that, according to Serrate-Alfonso *et al*. (2013), is considered an instrument that facilitates the link between the scientific and entrepreneurial communities for the consultation of specialists and decision-makers in the enterprise.

Step 6. Execution of projects.

During the execution of the projects training actions were carried out in the EPGCC in the period 2012-2014, which comprised: enhanced dairy farms, use of fresh integral diets and citrus pulp with urea, rotational grazing, electrical fencing, biomass banks with Cuba CT-115 for the solution of the feed deficit during the dry season, and technology transference.

Phase 4. Evaluation and adjustment of the proposed model.

Step 7. Evaluation based on a system of indicators.

In order to validate the management model a questionnaire was elaborated, which was answered by eight of the management board members (92 %) of the enterprise, after a work session in which the final result of the research was presented. In this questionnaire a Likert scale of five categories was used, in which a maximum score of five (5) points represents total conformity and agreement with the

exposed statement, and a minimum score of one (1) point means otherwise; intermediate scores can exist.

The results of the general validation of the model from the analysis of its indicators (table 2) showed the indicators with the best results:

- Degree of planning, organization and contracting of R+D+i projects per year.
- Degree of application of the diagnosis in the enterprise, with companionship in the university per year.
- Degree in which training generated changes and transformations in the use of the technologies per year.

These results allowed to know the viability of the model application, and the three indicators with the best results were included within the dimension institutional feedback. This dimension, throughout the research, was considered a basic system for providing feedback to the substantive processes of the university with the enterprise, and constituted a novelty for the research.

The economic-productive dimension was favored with the implementation of the methodology; however, inside the productive and technology management processes complex problems occur that need the influence of many factors in order to be solved, and which not only depend on innovation.

Tangible results

Associated to the implementation of the Technology Management Model in the case study UPR and EPGCC, tangible (tables 3, 4 and 5) and intangible results were generated. The comparative analysis

Table 2. Results of the general validation of the model from the analysis of its indicators per dimensions, according to Likert scale.

Dimension	Indicators	Average
Institutional feedback	Degree of application of the diagnosis in the enterprise, with the companionship of the university per year	4,82
	Degree in which training generates changes and transformations in the use of the technologies per year	4,65
	Degree of planning, organization and contracting of I+D+i projects per year	4,88
	Degree of students' participation (undergraduate and graduate) linked to research or innovation projects per year	4,35
	Degree of achievement of awards and recognition, from the results reached in the enterprise and the university per year	4,22
	Degree of participation of enterprise professionals, professors and students in events, publications and elaboration of theses that socialize the results reached per year	4,22
Economic-productive	Degree of technology introduction or improvements of the university and its scientific environment per year	4,45
	Degree of improvement of productive processes per year	4,58
	Degree of improvement of economic processes per year	4,58
Environmental	Degree of management of solid waste per year	3,68
	Degree of management of waste water per year	4,07
	Degree of intensity of carrying capacity per year	4,28
	Degree of soil use management and amendments performed per year	4,09
	Degree of water reserve management per year	4,13
	Degree of reforestation per year	4,01
Social pertinence	Degree of satisfaction of the link with the university and other research centers per year	4,35
	Degree of satisfaction of entrepreneurs involved in the university-enterprise relation per year	4,04
	Degree of satisfaction of workers depending on the productive results reached after the introduction of the technologies per year	3,63

showed an improvement of the indicators in the evaluated period, which allows to re-program and re-define the strategies, for the university as well as for the enterprise, and to legitimate the relation between them.

Intangible results

- Re-elaboration of innovation strategies for the university and the enterprise, in correspondence with production needs.
- Establishment of an alliance between the UPR, the EPGCC and the Institute of Animal Science.
- Stable participation in national and international scientific congresses.
- Design of the website as technology management tool for the animal husbandry sector.

Step 8. Follow-up and feedback of the TMM-UCSAHER.

Quarterly workshops were carried out for follow-up in the project execution, besides corrections to the action plans and a year closing workshop for the projects, which allowed the comparative analysis of the established indicators (step 7). This step contributes to the model updating, from the systematic evaluation of the execution of implementation methodology.

Conclusions

The developed procedure was structured in a set of phases with their corresponding steps, which generated 18 indicators structured per dimensions (institutional feedback, economic-productive, social pertinence and environmental).

The validation of the procedure for the model implementation allowed to verify its feasibility, through its utilization as methodological instrument to improve the management process between the university and Cuban animal husbandry enterprises; tangible and intangible results of such implementation were observed.

Bibliographic references

Alarcón-Ortiz, R. *La extensión universitaria promotora del cambio y la transformación sociocultural*. Conferencia inaugural presentada en el XIII Congreso Latinoamericano de Extensión Universitaria. La Habana: Unión Latinoamericana de Extensión Universitaria, Ministerio de Educación Superior de la República de Cuba, 2015.

Campos, Maybe; Suárez, J. & Ojeda, R. Modelo de gestión estratégica para la toma de decisiones en entidades agropecuarias. Implementación en una UBPC del municipio Martí (Parte I). *Pastos y Forrajes*. 36 (1):95-105, 2013.

Castillo, L. del & Reyes, Susana. Los modelos de relación universidad-empresa. *RCCS*. 7. http://www.eumed.net/rev/caribe/2015/07/universidad-empresa.html. [30/11/2016], 2015.

Castro, Eliana & Herreño, Elisabeth. Una alternativa pedagógica para el mejoramiento de las condiciones

Table 3. Changes associated to the model implementation in the institutional feedback between the UPR and the EPGCC.

Results in the institutional feedback	2011	2014
Total number of students linked to the project	2	8
Quantity of studies who conducted research work component	17	38
Diploma theses carried out in the enterprise	-	6
Quantity of contracted projects	-	2
ACC and Technological Innovation (provincial) awards	-	2

Table 4. Changes associated to the implementation of the model in the economic indicators of the EPGCC.

Economic indicators	Measurement unit	2011	2014
Total expenses	Peso	386 396,79	515 444,50*
Incomes for milk sale	Peso	1 334 803,09	1 337 454,50
Profit or loss	Peso	948 406,30	822 019,90*
Production cost of the milk liter	Peso	0,72	0,90*
Mean salary per worker	Peso	582,13	590,50

*Total expense, production cost of the milk liter and increase of the losses were higher in 2014, because there was an increase in the price of concentrate feed for dairy cows from 602,25 a 2 073,00 CUP/t; nevertheless, the incomes for milk sale increased in 2 651,41 pesos.

Table 5. Changes associated to the model implementation in the productive indicators in the EPGCC.

Productive indicators	Measurement unit	2011	2014
Total milk production	Liter	505 975	532 395
Liters of milk per milking cow	Liter	7,4	8,0
Milking cows	Head	42	43
Sales to the industry	Liter	492 224	529 676

de trabajo en pymes. Rev. *Fac. Nac. Salud Pública*. 29 (4):504-512, 2011.

Castro, N. A.; González, E. & Guzmán, F. Transferencia tecnológica, la integración, ciencia, innovación tecnológica y medioambiente en la empresa. *Ingeniería Industrial*. 35 (3):277-288, 2014.

Delgado, Sheyla. Para generalizar bien hay que planificar mejor. *Periódico Granma*. http://www.granma.cu/granmad/2012/02/23/nacional/artic01.html. [30/11/2016], 2012.

Enríquez, A. Knowledge management and university: study of the terms of interface with the external. *Psicología desde el Caribe*. 31 (1):1-24, 2014.

García-Bode, O. E.; Díaz-Abreu, Dulce M. & Jorge-González, Lisandra. Gestión del conocimiento y desarrollo agrario: Fundamentos teóricos para un estudio de Caso (Parte 1). *Tlatemoani*. 13 (1):2-15. http://www.eumed.net/rev/tlatemoani/13/capital-intelectual.html. [30/11/2016], 2013.

García-Delgado, Beatriz M.; Delgado-Fernández, Mercedes & Infante-Abreu, Marta B. Metodología para la generación y gestión del conocimiento para proyectos de I+D+i a partir de sus factores críticos. *Rev. cubana Inf. Cienc. Salud*. 25 (3):285-302, 2014.

González, Maricela & Núñez, Saray. La Universidad cubana actual y la gestión de la innovación en función del desarrollo local. *Gestión de las Personas y Tecnología*. 4 (10):70-77. http://www.revistas.usach.cl/ojs/index.php/revistagpt/article/viewFile/647/612. [30/11/2017], 2011.

Jiménez, A. M. Relaciones universidad-empresa: Hacia una productividad basada en innovación. G*estión y Tendencias*. 2 (1):7-10. http://dx.doi.org/10.11565/gesten.v2i1.11,2016. [30/01/2017], 2016.

Núñez-Mora, A. N. Sistema de indicadores de gestión para la UNA (SIGUNA). *Informe de Investigaciones Educativas*. 25 (2):43-66, 2011.

Olivera-Fernández, J. *Propuesta de acciones que contribuya al perfeccionamiento de la filial universitaria municipal como interfase en un destino turístico*. Tesis presentada en opción al título de Máster en Dirección. Pinar del Río, Cuba: Universidad de Pinar del Río, 2011.

Pedraza-Amador, Elba M. & Velázquez-Castro, Judith A. Oficinas de transferencia tecnológica en las universidades como estrategia para fomentar la innovación y la competitividad. Caso: Estado de Hidalgo, México. *J. Technol. Manag. Innovat.* 8 (2):221-234, 2013.

Serrate-Alfonso, Annia de los A.; Horta-Abreu, R.; Gómez-Luque, E. & Sánchez, N. Diseño de un software para la evaluación de la cultura organizacional. *Revista Avanzada Científica*. 16 (1):1-13. http://Dialnet-DisenoDeUnSoftwareParaLaEvaluacionDeLaCulturaOrgan-4324727.pdf. [30/11/2016], 2013.

Silva, A. de P.; Schimiguel, J. & Rosetti-Junior, H. Estudo de estratégias para aproximação do relacionamento entre as organizações empresariais e a academia. *Observatorio de la Economía Latinoamericana*. 183:1-12, 2013.

Suárez, J. *Modelo general y procedimientos de apoyo a la toma de decisiones para desarrollar la gestión de la tecnología y de la innovación en empresas ganaderas cubanas.* Tesis en opción al grado científico de Doctor en Ciencias Técnicas. Santa Clara, Cuba: Universidad Central "Marta Abreu" de Las Villas, 2003.

Vega-Jurado, J.; Fernández-de-Lucio, I. & Huanca-López, R. La relación universidad-empresa en América Latina: ¿apropiación incorrecta de modelos foráneos? *J. Technol. Manag. Innov.* 2 (2):97-107. 2007.

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