COMPETITIVENESS IN MESO-LEVEL OF BIOFORTIFIED FOODS IN THE SOUTH OF BRAZIL

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ABSTRACT

The dichotomy of micro and macro competitiveness presents some limitations as a result of the business arrangements experienced in the contemporary period. The systemic competitiveness in meso-level makes it possible to understand the interconnection between actors, involving private companies, nongovernmental entities and public policies for a particular arrangement or sector of the economy. The present study aims to analyze the Value Chain of biofortified foods in Southern Brazil, which enables to look at the link among players, based on the theory of competitiveness in meso-level approach. For that, a qualitative research was developed, with interviews being conducted, seeking to understand the participation of each player in the context of biofortified foods and the interactions and interrelationships to sustain the competitiveness of this segment in the south of Brazil. As a result, it is identified that the evolutionary path of competitiveness in bio-feed foods is found in the so-called origin phase, due to the development of initial rules, defined the meso-level conceptions with the interaction between the different actors, typical of the origin phase, but that needed to be adjusted, remodeling the relations and the insertion of new actors to maximize the competitiveness of the analyzed sector. The results also showed Meso-level activities in technology, training, and education, finance, infrastructure, trading and associations have been contemplated by several of the studied players. There are also associations among the three main studied actors (Fundetec, Biolabore and Fundação Itaipu) for supporting rural producers. In relation to trade, it is carried out with multiple sources, including institutional purchases, as well as sales to industry and the final consumer. Technology is strongly being used in developing genetic material, monitoring systems and production and point of sales monitoring, as well as in the industrialization process. Despite several requirements in regard to meso-level competitiveness being met currently, its constitution is still pretty fragile, and several players perceived risks in the Project.

Key words: Biofortified foods, players in the value chain, theory of competitiveness, systemic competitiveness, meso-level, Parana, Brazil

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RESUMEN

La dicotomía de competitividad micro y macro presenta algunas limitaciones como resultado de los arreglos comerciales vividos en la era contemporánea. La competitividad sistémica en el nivel meso permite comprender la interconexión entre actores, que involucra empresas privadas, entidades no gubernamentales y políticas públicas para un arreglo o sector particular de la economía. El objetivo fue analizar la cadena de valor de los alimentos biofortificados en el Sur de Brasil. Se llevó a cabo una investigación cualitativa, con base en entrevistas semiestructuradas, a fin de comprender la participación de cada actor en el contexto de los alimentos biofortificados y las interacciones e interrelaciones para sostener la competitividad del nivel meso en dicha zona. Como resultado, se identificó que la ruta evolutiva de la competitividad en los alimentos biológicos se encuentra allí en la denominada fase de origen, debido al desarrollo de reglas iniciales, definidas las concepciones mesonivel con la interacción entre los diferentes actores–propios de la fase de origen–, pero que necesita ser ajustada, remodelando las relaciones e incorporando nuevos actores para maximizar la competitividad del sector analizado. Los resultados también mostraron que las actividades de nivel meso en tecnología, capacitación y educación, finanzas, infraestructura, comercio y asociaciones han sido contempladas por varios de los actores estudiados. También existen asociaciones entre los tres principales actores estudiados (Fundetec, Biolabore y Fundação Itaipu) para apoyar a los productores rurales. En relación con la comercialización, esta se realiza con múltiples fuentes, incluyendo compras institucionales, ventas a la industria y consumidor final. La tecnología se utiliza notablemente en el desarrollo de material genético, sistemas de monitoreo y monitoreo de producción y puntos de venta, así como en la industrialización. Aunque actualmente se cumplen varios requisitos con respecto a la competitividad de nivel meso, su constitución es aún bastante frágil y varios actores perciben importantes riesgos en el Proyecto.
Palabras clave: alimentos biofortificados, actores de la cadena de valor, teoría de la competitividad, competitividad sistémica, nivel meso, Paraná, Brasil

RÉSUMÉ

La dichotomie entre la micro et la macro-compétitivité présente certaines limites en raison des arrangements commerciaux en vigueur dans la période contemporaine. La compétitivité systémique au niveau méso permet de comprendre l'interconnexion entre les acteurs, impliquant les entreprises privées, les entités non gouvernementales et les politiques publiques pour un dispositif ou un secteur particulier de l'économie. Cette étude vise à analyser la chaîne de valeur des aliments biofortifiés dans le sud du Brésil. Pour cela, une recherche qualitative a été développée, basée en entretiens, cherchant à comprendre la participation de chaque acteur dans le contexte des aliments biofortifiés et les interactions et interrelations pour soutenir leur compétitivité. En conséquence, il est identifié que le chemin évolutif de la compétitivité dans l'alimentation biologique se trouve dans la phase dite d'origine, en raison du développement des règles initiales et de conceptions définies au niveau méso. Ce chemin devrait être ajusté en tenant compte de l'interaction entre les différents acteurs, en réaménageant leurs relations et en incorporant de nouveaux intervenants dans le but de maximiser la compétitivité du secteur analysé. Les résultats ont également montré que des activités au niveau méso dans les domaines de la technologie, de la formation et de l'éducation, de la finance, des infrastructures, du commerce et des partenariats ont été envisagés par plusieurs des acteurs étudiés. Des partenariats existent également entre les trois principaux acteurs étudiés (Fundetec, Biolabore et Fundação Itaipu) pour soutenir les producteurs ruraux. En ce qui concerne le commerce, les échanges se font avec des multiples sources, notamment les achats institutionnels, les ventes à l'industrie et au consommateur final. La technologie est particulièrement utilisée dans le développement du matériel génétique, des systèmes de production et dans le suivi des points de vente, ainsi que dans l'industrialisation. Bien que plusieurs exigences en matière de compétitivité de niveau méso soient actuellement satisfaites, sa constitution est encore assez fragile et plusieurs acteurs perçoivent des risques importants dans le projet.
Mots-clés : aliments bio-fortifiés, acteurs de la chaîne de valeur, théorie de la compétitivité, compétitivité systémique, niveau méso, Paraná, Brésil

RESUMO

A dicotomia de competitividade em nível micro e macro apresenta algumas limitações em decorrência dos arranjos empresariais vivenciados no período contemporâneo. A competitividade sistêmica ao mesonívelpossibilita compreender a interligação entre atores, envolvendo empresas privadas, entidades não governamentais e políticas públicas para um determinado arranjo ou setor da economia. O presente estudo visa analisar a competitividade sistêmica ao mesonível dos alimentos biofortificados no sul do Brasil, o que possibilita olhar para o elo entre os

atores, com base na teoria da competitividade. Para tal, desenvolveu-se uma pesquisa qualitativa, com a realização de entrevistas, buscando compreender a participação de cada ator no contexto dos alimentos biofortificados e as interações e interrelações para sustentar a competitividade deste segmento no sul do Brasil. Como resultado identifica-se que a trajetória evolucionária da competitividade ao mesonível dos alimentos biofortificados encontra-se na fase denominada origem, em virtude de terem sido desenvolvidas regras iniciais, definidas as concepções ao mesonível com a interação entre os diversos atores, típica da fase de origem, mas que precisou ser ajustada, remodelando as relações e a inserção de novos atores para maximizar a competitividade do setor analisado. Os resultados também mostraram que atividades ao mesonível nas áreas de tecnologia, treinamento e educação, finanças, infraestrutura, comércio e parcerias foram consideradas por vários dos atores estudados. Também existem parcerias entre os três principais atores estudados (Fundetec, Biolabore e Fundação Itaipu) para apoiar os produtores rurais. No que se refere ao comércio, as trocas são feitas com múltiplas fontes, em especial compras institucionais, vendas à indústria e ao consumidor final. A tecnologia é utilizada principalmente no desenvolvimento de material genético, sistemas de produção e monitoramento de pontos de venda, bem como na industrialização. Embora vários requisitos de competitividade aomesonível sejam atendidos atualmente, sua constituição ainda é bastante frágil e diversos atores percebem riscos significativos no projeto.
Palavras-chave: alimentos biofortificados, atores na cadeia de valor, teoria da competitividade, competitividade sistêmica, mesonível, Paraná, Brasil

1. INTRODUCTION

Rural businesses are very relevant in Brazil as they represented about 23% of GDP in 2016 (Portal Brasil, 2017). In addition, according to data provided by Instituto Brasileiro de Geografia e Estatística (IBGE, 2021) agriculture was responsible for more than half of economy in more than 20% of Brazilian towns in 2014 and presents growth estimation of nearly 30% by 2026 (MAPA, 2016).

Despite the large production, there is a market segment in agriculture which is still being developed, and it is biofortified foods, following a global trend that emphasizes research and innovation. Biofortification is the «process where conventional techniques of plants reproduction are used to enrich basic foods and increase the levels of Vitamin A, zinc and iron» (IFPRI, 2016, p.69). In such process some selected micronutrients which are needed to supply nutritional deficiency in population – through diet, supplementation and trade of biofortified foods – are introduced into the seeds of those foods (Saltzman *et al.*, 2016).

Several foods, like fruits, vegetables and legumes, have already been biofortified in different parts of the world, as example lettuce (Smoleñ, Kowalska and Sady, 2014), sweet potato (Alves, Ito, Carvalho, Meloand Godoy, 2012), corn (Cardoso *et al.*, 2009), beans (Figueiredo *et al.*, 2017), and red chilli (Li *et al.*, 2017).

Therefore it is noticed that biofortification, represents innovation in food sector, as biotechnology is used for food safety and reducing problems that result from inappropriate quantity of micronutrients absorbed from foods. In addition, benefits resulting from biofortification have already been consolidated in academic area.

In Brazil such foods have already been researched and genetically improved through a conventional method which has been applied for more than 10 years by Empresa Brasileira de Pesquisa Agropecuária (Embrapa, 2021). According to Rede Biofort (2017) this kind of food has already been found in fourteen Brazilian states. Food safety is an ongoing topic discussed by United Nations Organization, and such topic is specially related to starvation reduction and hidden hunger. International Food Policy Research Institute (IFPRI, 2016) has presented a report about hunger scenario in the world and its several modalities, and it highlights the importance of political consistency and cooperation in all government levels and economic sectors to fight hunger in the world. IFPRI (2016, p. 26) highlights in this report that due to «effective social protection programs and nutritional interventions there has been a dramatic fall in poverty, hunger and

malnutrition» in Brazil, to less than 2% of child mortality (as result of hunger) and malnourished population in 2015. Therefore, to continue improving nutrition in Brazilian population, a study about biofortified foods as a mean of increasing production and consumption is substantiated.

The study of biofortified foods can be carried out in different ways, and the proposal of this study is to evaluate from the perspective of the value chain analysis from the theory of competitiveness at meso-level.

Competitiveness is about being engaged and efficient in high-value activities (Mulatu, 2016), being possible to explore it from strategies based on unique or difficult to attain resources (McDougall, Wagner and MacBryde, 2022).

According to Santarius (2016) two classification pairs are more commonly used in traditional economic approach: micro-economic versus macro-economic. However, for evolutionary perspective there cannot be only micro and macro perspectives, but one which is called «meso», in which an integration between agents can be seen, allowing scale and scope simultaneously (Dopfer, Foster and Potts, 2004).

From the perspective of systemic competitiveness at the meso-level, the creation of a support structure capable of promoting, complementing and deepening the efforts of companies is examined (Esser, Hillebrand, Messner and Meyer-Stamer, 1996).

At the meso-level new rules and dynamism occur for each analyzed population, i.e. for the players which belong to this group. The «players behavior and interaction and how they adopt and apply the rules» typify meso-level (Dopfer *et al.*, 2004, p. 269).

In addition, meso-level perspectives analyze capacity, institutions, knowledge, interactions, variety, connections, population and a complex process system, as proposed by Dopfer *et al.* (2004). As organizational examples in the evolutionary meso-economic perspective authors mention industrial districts, local knowledge clusters or even local productive arrangements, inter-firm industrial organizations, national innovation systems, networks with strong and weak links and technical support communities.

House *et al.* (1995) *apud* Frink *et al.*(2016) suggest three requirements in order a research can be considered as meso-level: i) At least one individual or group-basis process or construct must be included in the analysis; ii) At least one organizational construct must be integrated; and, iii) The analysis must be consisted by a link between the levels previously mentioned. To that extent, in a meso-level analysis there must be interaction among heterogeneous players (Levidow, Lindgaard-Jørgensen, Nilsson, Skenhall and Assimacopoulos, 2016).

Meso-level competitiveness can be obtained through industrial clusters and organizations network that seek dynamic development and potentialities of the analyzed region. It occurs by means of relation among organizations that may create and support business environment and increase association demands, and also through other public policies and non-governmental players (Altenburg, Hillebrand and Meyer-Stamer, 1998).

Amaral Filho (2001, p. 269) highlights these economic players networks that integrate non-governmental entities, private companies and state politics all facilitate local bodies and contribute for «capturing information and also maintaining interaction between producers and consumers on real time». The present study aims to analyze the value chain of biofortified foods in southern Brazil, which enables to look at the link among players, by theory of competitiveness in meso-level approach. To analyze in order to understand innovations production, institutional arrangements, market governance and how different agents impact on development projects and policies formulation and implementation.

2. MATERIALS AND METHODS

The present research can be characterized as qualitative, descriptive and exploratory. For data collection face-to-face interviews were undertaken between May and June of 2017, with different players of biofortified foods network, like a representative for Embrapa Canoinhas/SC; representative for rural producers/PR; administration manager of Fundetec – Cascavel/PR; director and partner of Quinta das Cerejeiras Alimentos

Inteligentes, representative for food industry –Tijucas do Sul/PR.

The interviews followed the protocol in which script for open questions was sent beforehand to Embrapa Canoinhas, Fundetec and Quinta das Cerejeiras, in order it could firstly be looked at before the scheduled date, when public politics, investments, infrastructure, market and other subjects could be discussed with the players. For rural producers a copy of the script with open questions was handed at the interview date. In all cases a Consent Form was explained and signed, as well as an Authorization Form for using Company´s name and interviews recording.

After the interviews it was done the transcription of all speeches, and each player received a copy of it for checking and agreeing with all that had been reported. After consenting the results could be presented.

3. RESULTS AND DISCUSSION

Meso-level competitiveness addresses different players with a definition of a set of predetermined rules. Afterwards, participation of each player is described and a discussion of the perspective of meso-level competitiveness takes place.

Participation of players is on the logical sequence for the project development, along with genetic material developer, intermediation institution, rural producer and food industry.

3.1. BRAZILIAN AGRICULTURAL RESEARCH AGENCY (EMBRAPA)

In relation to biofortified foods between «2003-2020, Embrapa invested almost R$ 15 million[4] in projects related to biofortification of agricultural products» (Embrapa, 2021, p. 125). The cultivars that have already been biofortified by Embrapa are cassava and sweet potato with high levels of Vitamin A; rice, beans and caupi-beans richer in zinc and iron; corn enriched with pro-vitamin A; lettuce richer in folic acid, or vitamin B9; a hybrid of BRS Zamir tomato enriched with lycopene carotenoid. In addition, following a global trend of biofortification in animal production, biofortification is ingested by cows through their diet and «it aims to improve nutritional quality of products such as milk, meat and eggs» (Embrapa, 2021, p. 125).

At Embrapa branch in Canoinhas has it was undertaken an interview with its manager, who «has worked for more than ten years with genetic improvement programs. Population [...], have already started perceiving […]» importance of foods that have a function, i.e. *functional foods,* through biofortification or genetic improvement (Personal interview). In some varieties of cultivars biofortification is intensely present, although such denomination does not reach population, as cassava, which is related by Manager that from these «six types of cassava all are biofortified in some way. There are two of them which are pink, since, since they have lycopene, and four of them are yellow or beige due to having beta-carotene» (idem). At the branch that was interviewed it has also been researched and reproduced:

> For a long time, potato, sweet potato, mandioquinha (Arracacia), and we should come back to vegetables that are called traditional and non-conventional, like yam, taioba, and old yam, among others of this kind. Also ora-pro-nobis, that nowadays is being dried to be sold as concentrated protein. (Personal interview)

Due to weather diversity in Brazil one challenge consists of adapting cultivars to Southern region, whichs hows a temperate climate and presents a number of cold-hours much higher than other Brazilian regions. Such adaptation for Southern region began in 2009, according to reported by manager, «we would have effective 8 months a year to grow cultivars, the rest of the year is cold and they do not grow» (Personal interview). Different techniques have been used to minimize this limitation, unsuccessfully though. This way, plantation of branches or genetic improvement clones for sales occurs in a period that respects the climate of Southern region, particularly Canoinhas/SC, from September/October to April/May.

[4] [Editor' note] At the end of the year 2020, the market exchange rate was approximately 5.19 R$/US$. Thus, in nominal values, the Brazilian Government invested around US$ 2,890,173 during the 2003-2020 period.

According to this manager, there is a high demand for biofortified sweet potato branches, as well as other products. However, as trading of biofortified sweet potato branches takes place by Embrapa Canoinhas, limiting factor of climate returns, where there are not any ready seeding to be sold in August (end of winter season and beginning of spring, when is the ideal period for growing). As a solution a licensing public notice could be launched, following bidding legal requirements,

> For someone to be licensed to grow branches [...], who would have branches to provide at the beginning of spring season, [...] or is able to provide through the year. [...] By 2018 we want to leave and hand it to private initiative. (Personal interview)

In relation to technology there are two slopes, one is related to genetic improvement, with incentives and public investments, including partnerships with international institutions; and the second one is related to clones replications. Through lectures, meeting and conferences technology related to replication is spread among agricultural associations and rural producers. According to this same manager,

> [...] They are the two technologies. [In fact] we present, [...] the first one is use of high health protection material, and the second one is high health protection and propagation. [...] That is what we need: high health protection and multiplication.

> [...] We advocate that seeds production area, or branches as in the case of sweet potato, may be a totally different conducted area. With a more precise phytosanitary control in any cultivar that has a different characteristic. (Personal interview)

In addition to finance for activities conducted by Embrapa, in researches and dissemination, the Government also publishes public notices for acquisition of branches belonging to Biofort program, aiming to distributed across North and Northeast regions, so that nutrition may be improved for the population of these regions.

The biggest difficult faced by biofortified foods pointed by manager results from rural producers showing some resistance against newness, since cost and production handling do not show any differences. In fact even improvements are noticed when comparing with traditional methods. In some situations production costs are «even lower, [as in the case] of Beauregard that has potential to produce a lot in less time. In our climate [it produces] in 90 days, and other potatoes in 140, 150 days, more than 120 days. So the cost is even lower» (Personal interview). Besides producing more per hectare, between «20 and 50 tons per hectare/harvest, depending on fertilization, irrigation, handling and plagues and diseases control» (Fernandes, Amaro, Madeira, Cavalieri and Melo, 2014, p. 22).

According to the manager, rural producers «accept it since they believe it will sell. However, it is an only personal gut instinct». Beauregard sweet potato, in special, has a high level of carotenoids, so it can be noticed by its orange color, and «it is beautiful, attractive and a lot of people appreciate its texture. There are many people who do not like it, though». Whatever is not possible to generalize. And rural producer argues consumers do not like it does not continue growing. However, a post-harvest procedure that should be respected by rural producers has consisted of maturing potatoes. It is not often respected, though. «If it is for fresh consumption, Beauregard needs to mature for 20 or 40 days, depending on the climate. It will lose some water and concentrate sugar» (Personal interview).

3.2. SCIENCE AND TECHNOLOGY DEVELOPMENT FOUNDATION – FUNDETEC

Science and Technology Development Foundation (Fundetec) is a public foundation in Cascavel District, which covers all the Western part of Paraná State and is funded by public municipal resources and aims to develop cooperation process that promote local socio economic development. In 2017 it had a staff board of 35 employees, from which 4 were involved with biofortified foods projects (Fundetec, 2017).

At Fundetec a 33 minutes interview was carried out with Ms. Zambiazi, who then held

the post of Administration Manager and coordinated the project of biofortified foods in the Foundation. Such project began around 2013 through a partnership with Embrapa, particularly with Biofort project team. According to Ms. Zambiazi, it was very clear on the cooperation term that the aim was «culture diffusion of the cultivars» (Personal interview). Then, Fundetec pursued the construction of a link between biofortified foods and rural producers. «Because Fundetec has the duty of disseminating technology and also assisting social factors» (idem). This way Fundetec aimed integrating several agents that could show interest in biofortified foods, such as Embrapa, rural producers, Agricultural Secretariat of Cascavel, rural extension associations and food industry.

Dissemination work was built through time and in 2016 there was more intense work for culture dissemination. A field day was carried out where there were lectures delivered by Embrapa biofortified foods specialists for producers, as well as the participation of the food industry in order to identify alternative points of sale. Fundetec was in charge of promotion, and it was offered and shown on media, besides a promotion carried out by Agricultural Secretariat technicians who followed up the producers that attend Governmental programs for school meals.

150 rural producers took part and received seeds and saplings of biofortified foods, beginning the dissemination of biofortified cultivars. However, as it is reported by Ms. Zambiazi, «we distributed, organized the field day, but are not able to follow it up. We expected Fundetec would have the role of disseminating and Agriculture [Agricultural Secretariat of Cascavel] would do the extension bit. It did not work though» (Personal interview). It was justified by limitation of technicians, stablished priorities and resources.

Facing this scenario, new rules and partnerships have been built. So the Project of biofortified foods coordinated by Fundetec was reframed and it started again, aiming to seek viability for following up the producers and collecting production figures, points of sale and profitability. It was signed a partnership after definitions and alignments, with Biolabore (Biolabore Work Cooperative and Technical Support of Paraná) and Itaipu Foundation for continuity and definition of «responsibility of this part inside the project» (idem).

Inside this new scenario Fundetec avails a certain amount of seeds/sapling that is partially acquired in form of donation by Embrapa at Biofort Project and partially with Fundetec resources. Also Itaipu Foundation will «demarcate with GPS [...] nine experimental areas and provide via allowances, a financial increment for 20 technicians» at Biolabore in order a follow-up can be made close the producers who are already growing biofortified foods (Ms. Zambiazi personal interview).

In parallel Fundetec has been developing an app to demarcate area carried out by Itaipu and collecting figures of each producer. The main goal of this app is to create a database that will be part of nutritional food safety program in order to have criteria and indicators related to productivity, sales or any criteria that are able to sustain competitiveness and make the region of Cascavel a reference and disseminator of biofortified foods production in trade scale in Brazil.

Beside the partnership above mentioned there are also partnerships with local universities that are receiving «two scholarships». The goals of the scholarship holders is the «characterization on field, [...] of culture, to see the growth, to see potato technic specifications, [...] in different periods of the year» as a mean of checking adaptations due to «region, climate, growth», and confront it with the theory around this food (Ms. Zambiazi personal interview).

3.3. RURAL PRODUCER

Among rural producers involved in the Project one has been shortlisted for a 15 minute interview according to the criteria of accessibility. The choice of interviewing Mr. Helfensteller, was in reason of he is a crucial link in the process of biofortified foods. Mr. Helfensteller has a 12 years´ experience in agricultural production and 2016 was his first year with biofortified foods.

Information about biofortified foods occurred as during an informative and support visit it was promoted by the Agriculture

Secretariat Technician there would be a meeting at Fundetec. On the day of the meeting, which was called by Fundetec as field day, there were lectures and distribution of seeds/saplings.

Mr. Helfensteller showed interest in growing biofortified sweet potato, caupi beans and biofortified corn. According to it was reported, «potato was the best one, the income was huge, a big difference, [...] time was shorter [production] in comparison with ordinary sweet potato» (Personal interview). In addition, there was «less cost, as it quickly closed and production was ready» (idem).

Biofortified beans were sold for PAA project [Government Food Supply Program], while potatoes were sold for school meals and also for the industry. In Mr. Helfensteller own words, «my intention is to continue [...] with the potato, and a little with the beans » (Personal interview).

Due to the high performance Mr. Helfensteller has not noticed any difficulties, confirming what was studied by Fernandes *et al.* (2014), and there was less intensity of insects attack due the cover was quicker formed comparing with ordinary sweet potato.

Finally, in relation to rural producers, it is noticed by Fundatec Rural Extension the importance of relations among players for culture diversification of family rural producers, as well as points of sale, government programs for food supply, school meals and potential of industrial use.

3.4. FOOD INDUSTRY: QUINTA DAS CEREJEIRAS ALIMENTOS INTELIGENTES LTDA.

This company is based in Tijucas do Sul, State of Paraná. It had two manufacturing plants in 2017, one emphasized organic foods and the second one emphasized conventional foods. The purpose of the company is to optimize raw materials *in natura* and transform them into industrialized and stabilized products in order to provide whole supplies for other companies/industries.

The search for biofortified foods consisted of diversifying their higher nutrition potential products. Mr. Fernando [the enterprise manager] got to know about the biofortified foods Project through the Embrapa website where Biofort Project appears. After contacting the person in charge of the Project it was indicated that Fundetec was coordinating the dissemination of these foods in the State of Parana. At Fundetec, he was prompt seen and included in the Project as he was perceived as an alternative point of sale for rural producers. It became effective with the sale of Beauregard sweet potatoes.

It was reported the company has already been demanded Beauregard sweet potato (biofortified), but at that time there was no raw material for providing the order. In2017 the contact with the client was made once more but the Project had been suspended due to the political-economic crisis experienced in Brazil in 2016-2017. However, there was prospection of other clients and biofortified foods started to become part of the company's product list.

3.5. ANALYSIS OF THE VALUE CHAIN IN MESO-LEVEL OF BIOFORTIFIED FOODS

According to Frink *et al.* (2016), one of the requirements for analyzing meso-level is to assess at least two levels of analysis. In this study, it was accomplished as several levels of analysis have been addressed in order to assess competitiveness construction. The perspective of Embrapa Canoinhas has as genetic material supplier, Fundetec as an agent of promotion, and links among players, rural producers, and industry have all been looked at. According to Esser *et al.*(1996), when a requirement of meso-level competitiveness perspective is analyzed, there is a relation between the State and social players which aims to establish structure and coordinate learning process.

Assessing the specific case under national meso-level perspective (Meyer-Stamer, 2005), it is confirmed there is relation with Embrapa since it is a federal public body focused on agricultural research and it enables public resources to be destined to high quality genetic material generation in addition to Biofort belonging to Embrapa as a disseminator and distributor of seeds and saplings to a specific segment of the society with food unsafety.

Under regional meso-politics perspective (Meyer-Stamer, 2005), Cascavel funds Fundatec for technological development of Western region in Paraná and also as a mean of

improving competitiveness in rural producers through interaction with several non-profit organizations, private and public.

In addition, Dopfer *et al.* (2004) report meso-level analysis presumes the definition of rules and behavior as well as interaction among players. At this stage, it is important to highlight Fundetec plays the role of establishing rules and intermediating interaction among players in Cascavel. In 2016 the Field Day was carried out with lectures for rural producers and other interested people, where Embrapa researchers on biofortified foods and the food industry *Quinta das Cerejeiras Alimentos Inteligentes* took part in. On the same day, Fundetec also distributed free of charge seeds and saplings of biofortified foods included in Biofort project to rural producers.

Fundetec initially stated there would be tracking of biofortified foods in the region of Cascavel through a mobile app developed in companies incubated in Fundetec. However, such a rule had to be adjusted due to the company having left the project of biofortified foods. So a news company was hired for continuity of the mobile append in June 2017 pilot tests for validating took place. According to Ms. Zambieri the app aims to build a database as a mean of making the region of Cascavel a reference in production and disseminations of biofortified foods in Brazil.

In addition another rule established in Fundetec consisted of Agriculture Secretariat technicians of Cascavel to follow and monitor rural producers, which did not take place as often and communicative as players wished. According to the rural producer Mr. Helfensteller, an Agriculture Secretariat technician carried out three or four visits during the harvest for following up the production, including biofortified foods. Fundetec Field Day was promoted to Mr. Helfensteller by Agriculture Secretariat technicians. It shows interaction of Agriculture Secretariat technicians in Cascavel with the Project, despite communication difficulties to present results to Fundetec.

Therefore, a new rule was established for following up, monitoring, and feeding data in the tracking app of biofortified foods, through a partnership among Fundetec, Biolabore, and Itaipu Foundation. In this new arrangement among players, technicians of Itaipu Foundation will «demarcate with GPS points» (Ms. Zambieri) geolocation of each property and variety of cultivated foods, as a mean of beginning data insertion in the mobile app and enabling the construction of a database for each property. At this stage of the project 150 rural producers registered at Fundetec and segmented in 9 regions were chosen as they have already started growing biofortified foods.

In parallel, Itaipu Foundation is funding 20 Biolabore technicians (Ms. Zambieri) for doing the follow-up, monitoring and strengthening biofortified foods Project in Cascavel. As it is a cooperative for rural extension, Biolabore will follow up production, plantation preferences, sale destination by proposing the inclusion of such information in the system (app). Biolabore will also offer training for the families as a mean of enabling use diversification of biofortified foods.

In respect of meso-level activities an interaction among different players for building competitiveness to biofortified foods is noticed, as Table Nº 1 shows, and each player has some relevance in its context. Therefore it is noticed Embrapa contributes with technology, education and training, infrastructure and seeds and sapling trade of biofortified cultivars. Fundetec is a link among players with emphasis on associations that have been built for developing and disseminating biofortified cultivars. The rural producer is a player who is in charge of effective production of cultivars, and despite they do not use technologyas it originates from family agriculture they have the expertise in food production. Finally, food industry is in charge of product stabilization and capacity of increasing consumer market.

Facing such scenario, the evolutional path was identified, as it is reported by Dopfer *et al.* (2004). Meso-level analysis of biofortified foods can be understood as belonging to the initial stage, named after origin, due to having been established initial rule and defines meso-level conceptions with the interaction among different players, typically found at the origin stage, but which had to be adjusted. At this stage rules are being adapted as well as the reach

Table 1
Summary of the players and their relations with meso-level and meso-space activities

Entity	Framework	Coverage	Technology	Training and Education	Finance	Infrastructure	Trade	Associations
Embrapa	Public body bounded to Agriculture Ministry	National	Genetic improvement researches and further spread to rural producers	Lectures when invited	Public resources for funding research, genetic improvement and biofortification Acquisition of saplings to be distribute in needy regions	Laboratories and clone Garden for replicating biofortifies cultivars	Limited due to climate	(1)
Fundetec	Public Foundation	Regional	Development of app for geolocation of properties and database for following-up indicators	Lectures with specialists and follow-up with Biolabore technicians	Saplings and seeds received as donation. Other items through resources provided by the District of Cascavel	Limiting factor, only 4 employees	Trade channels used by rural producers are unknown to Fundetec	Partnership with Biolabore and Itaipu Foundation
Rural Producer	Private	Local	No use	Provided by Embrapa at Fundetec and also through Agriculture Secreatariat technicians	Seeds and saplings received by donation. Other items with own resources.	Area for production	School meals, PAA and industry	Assistance by Agriculture Secretariat and Fundetec
Quinta das Cerejeiras	Private company	National	Production technology	Courses carried out by Sebrae, participation in fairs and events and business rounds	Own and third- party resources	Equipment and installing for production	Private companies	Fundetec, Sebrae; universities; Fiep

Note: (1) Embrapa associations were not the focus of the study, but their contribution to other players.
Source: Own elaboration

of the organizations, according to it was reported by Dopfer *et al.* (2004), a constant fact that has been observed during the interviews was emphasized by Ms. Zambieri from Fundetec, who points out the project is «restarting, [...] it was reframed to start again» (cited interview).Therefore, it cannot be considered at the diffusion state, when rules are institutionalized due to necessity of adaptations.

According to Hipgrave, Alderman, Anderson and Soto (2014), despite the evolutional path of meso-level relations some risks are identified in relation to the continuity of the project at Fundetec, as the project is strongly bounded to Ms. Zambieri, Fundetec Administration Manager, along with three other employees. Ms. Zambieri centralizes relations and interactions construction among players. In addition, at the current stage there is lack of information for decision-making, which has already been realized, and new partnerships are sought in order to minimize effects. At the current stage there is no control either, as According to original meso-level conception Agriculture Secretariat technicians should contribute with the follow-up, as they hold extension responsibilities. There has not been information, creation to feed eventual controls by da Fundetec.

When the perspective of Embrapa Canoinhas is analyzed it is noticed the weather

factor is the main risk for competitiveness of the Project, due to the fact the region which holds the only registered clonal Garden in Brazil has temperate climate and shows colder temperatures (for Brazilian standards) between May and September, and it is not suitable for providing/selling branches and saplings in late July and early August when demand is higher. This risk has already been identified by the author who suggests launching a public notice to qualify «a country nurseryman, [...] he goes planting and selling branches as we do. We want it by 2018, or so, to withdraw ourselves and leave it for private initiative» (Embrapa Canoinhas' Manager). Alternatively, there are two companies that sell biofortified sweet potato saplings in the State of Rio Grande do Sul, but the biding approved small size saplings, and it is not viable for large scale production due to volume and acquisition and transport costs necessary to service the main productive centers in Brazil.

The Rural producer has not identified difficulties in the production of biofortified foods. However, the Manager from Embrapa Canoinhas has identified related risks as he highlights the acceptance from rural producers for continuing production often derives from «gut instincts [...] if they think it will sell», not being sure or studying consumer behavior (Embrapa Canoinhas' Manager). In addition to being a risk, it can impact on the collective purchase decision of saplings/branches/seeds by agriculture cooperatives.

Ms. Zambieri from Fundetec also recognized this risk as she reported if the producer was not able to sell he would not plant again. Mr. Helfensteller found institutional purchases as a way of minimizing this product, and according to him, «I sold potato for school meals, [...] and beans to PAA [Government Supply Foods Program], corn I did not sell though» (personal interview).However, replanting intention lies in biofortified sweet potato. Biofortified corn had not been harvested at the time of the interview due to a lack of demand.

Quinta das Cerejeiras pointed out that lack of industrial production is seen as a risk for continuing biofortified foods supply. Meso-level relations that are coordinated by Fundetec try to minimize such risk, as a registration system of cultivars and production of each producer has been built.

Finally, despite its evolutional path, setting up meso-level relations for biofortified foods should not be characterized as a competitive segment, due to the fact they are still in the consolidation process. According to the meso-level perspective, there are requirements in the medium and long term in order for the consolidation of meso-level competitiveness of biofortified foods in Southern Brazil to occur. It is configured by the relation among non-governmental, private, and public entities which aim for the participation of several players, intermediated by Fundetec.

5. CONCLUSIONS

Meso-level competitiveness assumes that different players are related among themselves, and it includes public, private, and non-governmental perspectives. Such prerogative has been addressed in this study through analyzing a federal public institution (Embrapa), a municipal public institution (Fundetec), private entities like the rural producer who is seen as part of family agriculture and food industry, in addition to non-government entities like Biolabore and Itaipu Foundation that undertake partnership with Fundetec. All players showed interest and a growing relationship with biofortified foods.

The biggest focus of this study was the Southern region of Brazil. So it analyzed Embrapa Canoinhas, located in the state of Santa Catarina, and Fundetec, a rural producer and Quinta das Cerejeiras Alimentos Inteligentes that are located in the state of Paraná. This way it can be considered the previous requirement of attending local meso-space was met, as despite Embrapa being a federal institution, which could be considered as a national meso-space, all the units have not been studied in order a conclusion about national behavior could be drawn.

Meso-level activities in technology, training and education, finance, infrastructure, trading, and associations have been contemplated among those several players who have been studied. There are also associations among Fundetec, Biolabore, and Fundação Itaipu for supporting rural producers through training programs and data insertion into a personalized system in order of enabling results control and assessment

efficiency and effectiveness of the Project. The trade was identified by multiple sources, including institutional purchases (PNAE – School Meals National Program and PAA –Food Supply Program) in addition to sales to industry and the final consumers. Technology is strongly being used in developing genetic material, monitoring systems and production and point of sales monitoring, as well as in the industrialization process.

However, despite, several requirements regarding meso-level competitiveness are being met, the constitution of this competitiveness is still pretty fragile. It can be confirmed by the stage which is found the relations among players. The origin of rules among players is being recreated and adjusted, as some initial rules have not generated the expected results. The rules and relations so far have not entered a stage of institutionalization, as they still need some time for maturing and consolidation in the order they can migrate towards the diffusion stage.

In addition, several players perceived risks in the Project. Each player identifies specific risks, like rural producers losing interest in these cultivars; the Project is centralized in the Administration Manager of Fundetec, as well as lack of information for decision-making; risk of climate for generating branches and seeds; lack of continuity in projects that use such; among others.

Finally, it is noticed a big fragility in the competitiveness of biofortified foods in Southern Brazil. However, as such foods are considered a big innovation for global food safety, meso-level relations constitution is already seen as a positive factor for the continuity of the Project and building competitiveness of biofortified foods in Brazil in the medium and long term.

Therefore, for future research, it is recommended the verification of meso-level relations currently in existence in other regions of Brazil due to cultural and climate differences among several regions. It is also suggested to assess periodically meso-level relations among the players presented in this study, as well as other agents, which can be included as a mean of verifying the consolidation of meso-level competitiveness in biofortified foods in Southern Brazil. Finally, it is believed the present study has been the first one on identifying characteristics of meso-level relations in Brazilian Agricultural Business, and it can be expanded to other segments and sectors.

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