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Certain Artificial Grasslands

Center of the Province of Buenos

Highlights

Balkan Mountain in Bulgaria

Analysis of Capabilities and Innovation

Discovering Thoughts, Inventing Future

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On the Behavior of Certain Artificial Grasslands on the Slopes of the Central Balkan Mountain in Bulgaria

By Dimitar Mitev

Summary- The research includes several studies on the behavior of some meadow grasses of local origin, which are the result of our selection. They are grown either as a monoculture or in a mixture on the slopes of the Central Balkan Mountain in Bulgaria with different exposure to the main directions of the world and a variety of soil gleying. The duration of the study is different. During the study period in the 10th-13th experimental years, a relative equality of productivity by habitat was established, with solid and weak soil gleying, respectively, on the low or high part of the slope, especially with eastern and southeastern exposure of the mountain slope. The principle of rhythmicity in Nature (increase or decrease in productivity in even or odd years), fixed in the ancient Bulgarian calendar, finds expression in the manifestations of cultivated grasslands.

Keywords: meadow grasses, slopes, Balkan Mountain, hypotheses.

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On the Behavior of Certain Artificial Grasslands on the Slopes of the Central Balkan Mountain in Bulgaria

Dimitar Mitev

Summary- The research includes several studies on the behavior of some meadow grasses of local origin, which are the result of our selection. They are grown either as a monoculture or in a mixture on the slopes of the Central Balkan Mountain in Bulgaria with different exposure to the main directions of the world and a variety of soil gleying. The duration of the study is different. During the study period in the 10th-13th experimental years, a relative equality of productivity by habitat was established, with solid and weak soil gleying, respectively, on the low or high part of the slope, especially with eastern and southeastern exposure of the mountain slope. The principle of rhythmicity in Nature (increase or decrease in productivity in even or odd years), fixed in the ancient Bulgarian calendar, finds expression in the manifestations of cultivated grasslands.

Red fescue (*Festuca rubra* L. var. genuina Gr. et Good) is the structure-determining component of the grasslands. Some understandings are shared about principles in the interrelations between meadow grasses in the community. Specific questions of allelopathy, as a natural

phenomenon, are considered. The response of some meadow grasses grown in areas weeded with eagle fern was studied.

We accept that the diversity in the behavior of the plant material is due to inequality in terms of Time, which is specific to each variant, with all the resulting consequences. It is relative in the organismic world and differs from its physical magnitude. Grasslands probably can have a particular "temporal resource" at their disposal that determines their longevity in individual and evolutionary terms. The question of what is primary in Nature has arisen. The formulated hypothesis about the "origin of species", the species' Evolution, along with the potentiality for the emergence of "energy-informational systems" during their coexistence, develops a theoretical premise in the attempt to start predicting and modeling species' behavior in the environment, with certain economic and environmental consequences.

Keywords: meadow grasses, slopes, Balkan Mountain, hypotheses.



Picture 1: A Panoramic View of the Region – Photo Credit Peter Savov

INTRODUCTION

The discussion on the advantages and disadvantages of simple (Mitev and Petrov, 1999) and complex (Hector, 1998) mixed grasslands and their comparison with a monoculture has had a long

history (Darwin, 1872; Mitev and Petrov, 1999). It has continued over the years with unceasing power (Sanderson et al., 2004). Global climate changes require the selection of specific combinations of species to provide such diversity in grasslands that they can withstand extreme environmental habitat conditions (Ives et al., 2000). Grassed areas occupy a significant share in the roughage production of, which in turn forms a positive return rate in agriculture (Totev et al., 2000).

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Grasslands allows to cross traditional boundaries in common agriculture, ecology, conservation and land management, and to include sustainable development, reduction of pesticides and artificial fertilizers, soil protection (Krueger et al., 2002; Mitev and Naydenova 2008a). The change in the transfer of nutrients and the decomposition of the created organic mass (Koukoura, 1998) allows to look for a "conservation approach in the restoration of degraded terrains" (Ene and Mocanu 2013; Mitev and Naydenova 2008b), which have been registered in some regions of Bulgaria. Several studies conducted in Bulgaria have shown the impossibility of imported seeds to create qualitative and long-lasting meadow grasslands (Totev, 1984; Mitev, 1997; Stoeva 2001, etc.). The latter differs from the idea of realization of the Evolution of Increased Competitiveness (Bossdorf et al., 2005). Sometimes, introduced species can create enormous economic hardship (Perrings et al., 2000). We establish a difference (Goranova-Naydenova, 2002; Mitev, 1997, etc.) with the authors mentioned above (Bossdorf et al., 2005; Perrings et al., 2000, etc.), concerning meadow grasses, necessitated conducting of a wide-ranging selection program to create cultivars of meadow grasses of local origin suitable for habitat conditions. Species of local origin are a considerable source for creating new cultivars (Goranova-Naydenova, 2002; Mitev, 1997, etc.). Many regions on the Balkan Peninsula in general, and Bulgaria in particular, include several secondary centers of species formation, directly related to the main one of the Alps. All of them are part of the common Balkan formative center (Kozhuharov, 1986). This leads to the formation in Bulgaria of some of the most affluent natural and semi-natural communities in the world (Martinkova et al., 2018). Each particular region is distinguished by a specificity that can make it ecologically unique (Sanderson et al., 2004; Wardle et al., 1987). The impact of species diversity on grassland production is highly complex (Schmid, 2002). Different authors prefer to focus on one of them. The cultivation of monoculture crop or mixed grasslands, with a smaller or larger number of components, is determined by the specific habitat conditions (Sanderson et al., 2004).

Red fescue (*Festuca rubra* L. var. genuina Gr. et Good), the subject of the author's selection (Mitev, 1996), is a structure-determining component in the grasslands in the region, grown as a monoculture or in a mixture (Mitev, 1997; 2014; Mitev and Naydenova, 2012, etc.). It is a xeromesophytic species (Adoyan, 1984), which allows it to be successfully grown in Bulgaria, both in areas characterized by heavier droughts (Stoeva, 2001) and in the wetter conditions of the mountains (Mitev, 1997; 2014, etc.). There are diverse interconnections between a monoculture crop that was created and the germinating seeds of different species that had already been in the soil, (Mitev et al., 2013; Tracy and Sanderson 2004).

The significance of the impact of interrelations among species on the performance of grasslands is accepted (Schmid, 2002). A point of discussion here is what is decisive in this case: Do the interrelations among plants influence the consumption of environmental resources (Bostan et al. 2012; Virteiu, Ana Maria, 2015, etc.), or do their consumption form them (Luo et al. 1995). The synthesis of allelopathic compounds requires sufficient energy and nutrients in plants. If these by-products can change the conditions for competition and those of the environment, they are obviously of evolutionary significance (Luo, 2005). Some authors categorically reject the role of allelopathy in the interrelations among plants (Delgado et al., 2014). The biotest is an integral part of studying the nature of allelopathy (Oliveira, 2006, cited in Bostan et al., 2012). During research, an interaction was found between several grass and legume meadow species, even when their seeds germinated together (Mitev, 1995a). An allelopathic effect was established through fog, dew and rain (Mitev 1995b; c, etc.). There are cultivar characteristics in the allelopathic effect. *The power of impact is greater, the more geographically distant are the studied cultivar* (Mitev, 1995c; e). The presence of genetic control on the synthesis of compounds with allelopathic effects has been established (Wang Ying et al., 2013, etc.). One-sidedness in research needs to be overcome. There are quite a lot of studies that focus only on allelopathy, others on the struggle for environmental resources, etc. The complexity of the processes requires the combined efforts of biochemists, ecologists, molecular biologists, microbiologists, soil scientists. The nature of the study will determine the type of cooperation required (Romeo, 2000). Besides laboratory, pot, and field experiments were also conducted with cultivars and populations of meadow grasses created by the author (Mitev, 1997; 1998; 2000, etc.). There is a tendency to develop cultivars with increased allelopathic potential that will allow them to successfully cope with local habitat conditions (Georgieva et al. 2015). The idea arises to find another approach in this direction. The studies have shown that the increased allelopathic potential leads to over-expenditure of resources and, accordingly, lowers the productivity of grasslands (Mitev and Belperchinov, 1996; Mitev and Yasheva, 1998). It is possible to create more productive and sustainably developing meadow associations based on the existing potential. This is achieved through differentiated sowing of the components of the grasslands for the conditions of the Central Balkan Mountain. Each of them (grass or legume) is sown in the period suitable for it, perpendicular to the previously sown component (Mitev⁽³⁾, unpublished), which creates a specific "protective umbrella" against the local weed complex. In the experiments mentioned above (Mitev and Belperchinov, 1996; Mitev and Yasheva, 1998), the

interaction among plants was established without any direct contact with their vegetative parts. There is only a probable explanation on what basis this takes place. The location of the mixed grasslands of grass and legume species on the mountain slopes, with an orientation depending on the main directions of the world (Mitev₍₂₎ unpublished), is essential for the productivity, longevity, protection of the associations from the impact of the local weedmixture.

Our research activity led to the patenting of a utility model of "Grass mixture for hay use on gray forest soils," No. 97250

The problem with "eagle fern" (*Pteridium aquilinum* (L.) Kuhn) (photo #2) is relevant in more than 165 countries of the world in several aspects: business, economic, social and ecological. It is one of the five

most common plant species in the world. Until now, there is still no evidence of its presence in Antarctica (Gil da Costa et al., 2012). It has been established that allelopathy in the eagle fern is a major limiting factor for the growth and development of other plant species in the community (Guerin and Sociedade, 2015; Mitev and Petrov, 1997; Petrov and Mitev, 1988; etc.). The predominant water-soluble biochemicals found in the fern are phenolic-based. In some cases, the allelochemicals identified (Mitev and Petrov, 1997) differ from those known in the literature (Granados et al., 2003; etc.). Our research on the effect of eagle fern on meadow grasses follows the sequence mentioned above, such as biotest, pot experiments, field experiments (Mitev and Petrov 1997; Mitev and Petrov⁽¹⁾ (unpublished), Petrov and Mitev 1989, etc.)



Photo 2: Areas Covered by Eagle Fern - Photo Credit by Zhivko Stoilov

The different parts of the eagle fern (leaves, rhizomes) have allelopathic effects of varying strength. Red fescue, compared to other studied grasses, was found to have a higher tolerance to eagle fern's effects (Petrov and Mitev, 1989). Its tolerance to the toxins released by the eagle fern was also higher in the pot experiments (Petrov and Mitev, 1987). The experiments on the impact of meadow grasses on the manifestations of the eagle fern are impressive. During pot experiments, the effect of Kashubian vetch (*Vicia cassabuca* Scop.) grown as a monoculture crop and in a mixture with several meadow grasses, on the sprouting and growth of dormant buds of eagle fern was established (Mitev and Petrov₍₂₎ unpublished). Experiments were conducted to establish the suitability of several meadow grasses for cultivation in areas weeded with eagle fern (Mitev and Petrov, 1995; 1997; Mitev and Petrov₍₂₎ unpublished; Petrov and Mitev, 1985, etc.). The conducted field experiments show the opportunity to solve environmental and production tasks in parallel. The condition of the leaves of this weed under the influence of Kashubian vetch (*Vicia cassabuca* Scop.) suggests impaired sporulation. This manifestation is considered a very favourable development in that «problem»! Weak seed formation in

Kashubian vetch, in our opinion, does not allow the application in practice of a patented invention under No. 43196 of a «method of biological control against eagle fern» (Petrov et al., 1987), No. 43196.

No available information has been found in the literature about the adverse effects of phenolic compounds on human health and farm animals. There has been uniformity in a series of phenolic compounds indicated in the eagle fern (Granados et al., 2003, Mitev and Petrov, 1997, etc.), grasses (Bostan et al., 2012; Mitev and Petrov, 1997, etc.), fruits (Dimkova et al. 2017; Mihova, 2016, etc.), grapes and wine (Kennedy et al., 2002; Singleton et al., 1986 etc.).

The development of technologies for research and identification (of biochemical substances extracted from plants) allows the attention of researchers to be reoriented over time (Andersen and Markham. 2006; Figueiredo, 2009, etc.). It is considered as necessary to note the impact of the eagle fern not only on other plants, but also on people and some animal organisms (Peev, 2016, etc.). The causes of toxicity in this direction are already specified qualitatively and quantitatively (Gil da Costa et al., 2012; Peev, 2016; Rasmussen. et al., 2015, etc.). Its impact can be carcinogenic (Gil da Costa et al., 2012), mutagenic (Schmid et al., 2005) or

teratogenic (Evans et al., 1982). The effects mentioned above of the eagle fern do not cover all the available information, nor do they shed light on the problem itself. This is not the goal of the current work of the author. It only hints at the possible problems, especially in the animal organism.

The understanding of the interconnection between the energy essence of Nature and the state of specific "structural units" (... , species, population, variety, ...) was developed in some author's publications (Mitev and Belperchinov, 1996; Mitev and Yasheva, 1998; Mitev and Naydenova 2012; 2016; Mitev₍₂₎, unpublished, etc.). The opinion is expressed that their behavior in the environment is determined by the reached "level of energy saturation." Its change leads to contraction or expansion in the distribution area, i.e. creation of new forms of structures (Mitev and Yasheva, 1998). All living things on the planet Earth obey a certain rhythm of energy impact (on behalf) of the Universe. The time of ripening of the seeds, their harvesting, storage and sowing dates have a great impact. The latter understanding led to the study of the behavior of successively created grasslands, with some of the seed progeny of red fescue (Mitev and Naydenova, 2012). The estimation of the genotypic variance shows that the observed differences in productivity are because of a proven genotypic influence, i.e., individual offspring/generations behave as different cultivars. With a great deal of convention (given the shortness of the covered period of 10 years), it could be said that the tested offspring formed grasslands that "anticipate" the environmental changes. The comparison of the results and especially of the "contradictions" with what has been indicated by other authors (Baggott, 2000; Wong, 1997; etc.), points to the thought that the difference in the behavior of the plant material is due to inequality concerning Time – it is different for each variant, with all the consequences that follow. One of them is probably the transfer of genetic material. Each "structural unit" (... , species, population, cultivar, variant, ...) is likely to be distinguished by a specific "energy configuration." The manifestation results in "sliding and accumulation of past and future in the present moment" (Mitev and Naydenova, 2012). The principles of symmetry of Time (equivalent to the directions "future"- "past" for each moment) point directly to the law of conservation of energy (Mitrani, 1989), as they have an impact on productivity, longevity, sustainability of development, self-recovery, self-purification of weeds, etc. in the cases we have discussed. From this point of view, Evolution is "happening right now," however long it may otherwise be. In this sense, there is a possibility that it (theoretically) will "repeat." Each particular "unit" probably represents a kind of "projection in Time," which determines its ability to "locate in it." This forms the specificity in the means of expression. It can easily be assumed that access to environmental factors is

variable. Probably there are "specific zones," which become available to the specific genetic material, depending on the presence or absence of synchrony with the rhythm in Nature (*Mitev and Naydenova, 2012*). A series of different grasslands, arranged eight times in a certain repeating pattern, on the mountain slopes were studied. They have a different level of soil gleying and exposure compared to the main directions of the world. The presence of a certain rhythm in the formation of the fodder mass was established. The yields were higher in the odd years (1995, 1997, 1999, 2001) compared to the even ones (1996, 1998, 2000). The sequence changed in 2002, 2004, 2006, 2008, 2010. The yields were again higher in the odd years (2011, 2013) than 2012. Certain shades in this direction were found by habitat. For the experimental conditions, the variation in productivity by variants and years was significantly reduced as a result of the inclusion of red fescue in the mixtures (Mitev, 2020). Red fescue grown as a monoculture in this experiment also shows another peculiar characteristic. On south-east facing, highly gleyed soils, the average dry matter was more for a 13-year period, compared to seven different types of mixed grasslands. This is how the debate about the advantages and disadvantages of grasslands with a monoculture or mixed crops has been renewed repeatedly (Darwin, 1872; Mitev and Petrov, 1999; Sanderson et al., 2004, etc.). Given the early dropping out (3rd-4th vegetation) of other meadow grasses sown together with it, in a specific variant (bird's-foot-trefoil, red clover, cock's foot), it is believed that the obtained (at most in this case) production over 20 years confirms our hypothesis for a change in the access of genetic material to "specific zones" of environmental factors. Other manifestations, different from those traditionally accepted, in the species' behavior were also found. Tracking the results in the present experiment, as well as those described in previous publications (Mitev and Naydenova, 2016; Mitev and Yasheva 1998, Naydenova and Mitev 2010a, b, etc.) creates the impression of a kind of "pulsation of the systems." The factors of environment (soil, climate, space, etc.) differ depending on the exposure and the location on the slope. Within each specific habitat, they are the same. What then forms the variety of behavior by variants?

A probable hypothetical explanation is that each "structural unit" (... species, population, cultivar, ...) is a "unique projection in Time" (Mitev, 2004; Mitev and Naydenova, 2012). It is believed that the diversity in the behavior of plant material is due to a difference in the attitude towards it. It is perfectly acceptable for the interaction among them to take place on a "time level", with all the ensuing consequences (Mitev and Naydenova, 2014; 2015b). The "time resource" available to the "structural units" probably determines their behavior in the specific habitat, the consumption of environmental factors, the exchange of biologically

active compounds, the result of their physiological activity, etc. We believe that Time in the organismic world is relative and differs from its physical quantity. The change in its "configuration" causes an adequate response in the genome of organisms and their corresponding state. In this way, the realizing of a kind of "guided natural selection" could be influenced. This idea has been discussed in some publications (Borza and Coste, 2002 - cited in Bostan et al. 2012; Evans et al., 1989; Mitev and Yasheva, 1998), but now it receives a specific interpretation. The subtle strength of selection, relative to neighbor specificity (Turkington et al., 1977), found when examining meadow grass interrelations, is likely consistent with this idea. Each community can only be composed based on interacting coexistent selected individuals (from individually selected coexisting species) (Borza and Coste, 2002 - cited by Bostan et al. 2012). Probably this is an opportunity to get an answer to the question "in what manner and which hereditary information is transmitted in time." (Mitev and Yasheva 1998). It is known that under the influence of biologically active compounds isolated from some weeds belonging to the genus *Centaurea* (*Centaurea maculosa* Lam.; *Centaurea diffusa* Lam.), there was a change in the genome of the neighboring meadow species that receive them. In this way, their basic life processes are blocked. Thus Bais et al. (2003) argued against the traditional understanding of the role of allelopathy mainly in competition for environmental resources. It could be assumed that the same occurs in the interaction between the individual meadow species, as a result of the biologically active compounds they release with allelopathic effect. The influence of weeds on cultivated species is usually studied (Ali Zohaib et al., 2014) and less often the opposite (Georgieva and Kirilov, 2016; Petrov and Mitev, 1994). According to the author's understanding, each "structural unit" is a kind of "energy information system" (Mitev and Naydenova 2015b), which in the conditions of formed communities, enters into specific interactions with others, according to the rhythm in Nature, which determines the general status. The understanding of ancient people is that the Earth is subjected to a constant energy impact with a certain rhythm. Its change determines an adequate reaction in Nature (Baggott, 2000; Bakhshi Iman, 1680, cited by Madzharov et al. 2002; Wong, 1997, etc.). Each species is subject to various interdependences (Kunz et al., 2011, etc.). At the same time, there are irrevocable rules that led to the creation of the calendars of some ancient people. People's oldest ideas about cosmogony found their final form in the "Book of Changes" (I CHING, 1996), and the structure of the ancient Bulgarian calendar shows a direct connection with them (Velev, 2000). Each specific year obeys a corresponding constellation and trigram (Fig. 1) (Bakhshi Iman, 1680, cited by Madzharov et al., 2002). Trigrams reflect fundamental concepts in the ancient knowledge of the

world (I CHING, 1996). The ancients assumed that all phenomena in the Universe stem from the law of energy change. It distinguishes "five rotations/elements" (Fig. 2) ("water"; "fire"; "earth"; "wood"; "metal"). The "five rotations" are degrees of qualitative changes in energy that depend on the change of the "five elements." After the completion of each cycle, there is a new genesis. The term "rotation" speaks of the cyclical nature of the changes. The calendar is made up of 10 "heavenly trunks" and 12 "earthly branches" (Madzharov et al., 2002). The ten "trunks" are characterized by the turning of positive beginnings into negative ones and vice versa: odd "trunks" are positive (with an excess), and even ones are negative (with a shortage of a given energy). The "trunks" characterize the heavenly energy, whereas the "branches" - the earthly. The ten "heavenly trunks" (Fig. 2) are combined with the twelve "earthly branches" (Fig. 3) in a 60-year cycle (Madzharov et al., 2002). Depending on the complete rotation of the axis of the Earth in space, a period of 20160 years can be covered (Valchev, 1986). There is an impressive coincidence of the boundary year between two decades with the change in the rhythm of fodder mass formation during the studied period (Mitev, 2020). Our notion of the essence of Nature gives birth to the idea to start a research program to predict and model the behavior of crops. In this way, there is an opportunity to touch the knowledge of the ancient Bulgarians. Gradually, one comes to the classic question of what is primary in Nature. The answer could be found 2000 year ago in the Gospel according to John (1:1): "In the beginning was the Word (the information); And the word was with God; and the Word was God" (Bible, 2001). There are some exciting arguments of Borza and Coste (2002) (cited by Bostan et al. (2012) that the interactions among plants can be achieved at least in three aspects: substantial, energy, and informational. The most important aspect seems to be significant for two reasons: 1) because substances in the developing interaction can provide energy and information; 2) because in any case, at a particular moment of information impact, each signal is transformed into a changed molecular structure of life. There is an energy information impact of DNA (deoxyribonucleic acid) on the status of higher organisms (Gariaev, 1997). It is believed that the strength of energy information fields exceeds that of the genetic code (Lazarev, 1996). When Information passes into matter gives birth to energy in a broader sense. Energy becomes a substance that seeks to accumulate energy and information. All this is within a natural cyclic sequence (Lazarev, 1997). Information, respectively, in a little different aspect as an enigma is neither a matter, nor energy, but it's a bearer of matter and energy. On a larger scale, it is a quantum elativus self-bearer of matter and energy (Mateev, 2004).



Fig.1



Fig.2

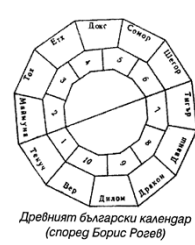


Fig.3

Water receives, preserves, and transmits information (Emoto, 2006). It is well known that it prevails in the cells (in this case) of plants. It is believed that its chemical formula (H_2O) contains and exhibits only part of a number of its specific properties (Deunov, 1940, cited by Mihailov, 2002). It can be focused on the idea of the energy information impact of DNA (Garyaev, 1997) and then that the energy information fields are inherent in biological beings (Lazarev, 1996). The manifestations of Time and Space are mutually determining and are an inseparable relation within them. To understand the essence of the biofield, it is necessary to establish the difference between living space and non-living space. It turns out that it is possible to approach their study as a phenomenon with a structure (Vernadsky, 1975). The essence is that all living beings form a thin biological layer in which they interact. In addition to what has just been presented, the understanding can be developed that their biofield contains information about Evolution that happens in Time. Thus, a more comprehensible form is given about the understanding shared in a previous publication that (theoretically) Evolution can be repeated (Mitev and Naydenova, 2012). On a more general (Universal) level, the existing information could materialize again under certain circumstances.

The reader is suggested to take into account one's understanding of the essence of Nature and reflect on the thesis of Borza and Coste (2002) (cited by Bostan et al. 2012), enriched with that of Bais et al., (2003) and added by Garyaev, (1997); Lazarev, (1996; 1997); Mateev, (2004), including the discussion moment in this publication.

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Agrotech Ecosystems: Towards an Analysis of Capabilities and Innovation Outcomes in R & D Centers at the National University of the Center of the Province of Buenos Aires, Argentina

By Dra. Camio, María Isabel, Mg. Ardití, Andrea Belén, Sr. Vicente, Joaquín & Dra. Carattoli, Mariela

Abstract- The growing global demand for food, coupled with the challenges posed by conventional production methods to sustainability, as well as the emphasis on value addition at the source and differentiation, make it imperative to incorporate new technologies into agricultural enterprises. These new technologies, known as Industry 4.0 technologies, are giving rise to the AgTech phenomenon by expanding capabilities.

There are regions where technology hubs or parks are situated, featuring the presence of large companies, as well as technological small and medium-sized enterprises (SMEs), research and development (R&D) centers, and extension and transfer institutions, indicating the existence of "ecosystems" coexisting with other actors in the pursuit of agro-oriented innovations.

Keywords: *capabilities - innovation - R&D centers - U-I linkages – AgTech.*

GJSFR-D Classification: *LCC Code: S1-972*



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Agrotech Ecosystems: Towards an Analysis of Capabilities and Innovation Outcomes in R & D Centers at the National University of the Center of the Province of Buenos Aires, Argentina

Ecosistemas Agrotech: hacia un Análisis de Capacidades y Resultados de Innovación en Centros de I+D de la Universidad Nacional del Centro de la Provincia de Buenos Aires, Argentina¹

Dra. Camio, María Isabel^α, Mg. Ardití, Andrea Belén^σ, Sr. Vicente, Joaquín^ρ
& Dra. Carattoli, Mariela^ω

Resumen- La creciente demanda mundial de alimentos, y los retos que imponen los métodos de producción convencionales a la sustentabilidad, así como el agregado de valor en origen y la diferenciación, hacen imprescindible la incorporación de nuevas tecnologías en las empresas agropecuarias. Estas nuevas tecnologías, denominadas tecnologías de la Industria 4.0, están generando una expansión de nuevas capacidades dando lugar al fenómeno AgroTech.

Existen regiones en las cuales se sitúan polos o parques tecnológicos, con presencia de grandes empresas, también PyMEs tecnológicas, centros de I+D, instituciones de extensión y transferencia, que denotan la existencia de "ecosistemas" que coexisten con otros actores en pos de la generación de innovaciones orientadas, en este caso al agro.

Este estudio se inserta en una investigación más amplia cuyo propósito es mapear la oferta y demanda de tecnología para el Ecosistema Agrotech e identificar el grado de acople entre oferta y demanda en la región de influencia de la Universidad Nacional del Centro de la Provincia de Buenos Aires (UNICEN). Como resultado, se espera un prototipo de una plataforma online georreferenciada que integre información de los actores, y que brinde una medida de cuán acoplada/desacoplada está la oferta y la demanda tecnológica.

Particularmente este trabajo se centra en identificar los resultados y las capacidades (tecnológicas y relacionales) de los núcleos científico-tecnológicos de la UNICEN

orientados al desarrollo de tecnologías para el sector AgroTech. El estudio incluye el análisis de fuentes secundarias: las Memorias Académicas del último trienio de 13 Núcleos de Actividades Científico-Tecnológicas (en adelante NACTs) de la UNICEN, y la realización de entrevistas en profundidad a los referentes institucionales y a los líderes de los NACTs con resultados significativos en AgroTech. Para el análisis de las capacidades se proponen un conjunto de dimensiones y variables condicionantes asociados a los determinantes de vinculación Universidad-Industria (en adelante U-I) (Carattoli, 2020).

Palabras clave: capacidades - innovación - centros I+D - vinculación U-I - AgroTech.

Abstract- The growing global demand for food, coupled with the challenges posed by conventional production methods to sustainability, as well as the emphasis on value addition at the source and differentiation, make it imperative to incorporate new technologies into agricultural enterprises. These new technologies, known as Industry 4.0 technologies, are giving rise to the AgTech phenomenon by expanding capabilities.

There are regions where technology hubs or parks are situated, featuring the presence of large companies, as well as technological small and medium-sized enterprises (SMEs), research and development (R&D) centers, and extension and transfer institutions, indicating the existence of "ecosystems" coexisting with other actors in the pursuit of agro-oriented innovations.

This study is part of a broader research initiative aimed at mapping the supply and demand for technology within the AgTech Ecosystem and identifying the degree of alignment between supply and demand in the influence region of the National University of the Center of the Province of Buenos Aires (UNICEN). As a result, the expectation is to develop a prototype of a georeferenced online platform that integrates information from various actors and provides a measure of how aligned or misaligned the technological supply and demand are.

Specifically, this work focuses on identifying the outcomes and capabilities (technological and relational) of the scientific and technological cores at UNICEN oriented towards the development of technologies for the AgTech sector. The study includes the analysis of secondary sources: the

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¹Una versión preliminar de este trabajo fue presentada ante el XX Congreso Latino - Iberoamericano de Gestión Tecnológica y de la Innovación - ALTEC 2023, realizado de manera presencial del 20 al 22 de septiembre de 2023 en la ciudad de Paraná, provincia de Entre Ríos, Argentina. Argentina fue sede a cargo de la Asociación Latino-Iberoamericana de Gestión Tecnológica y de la Innovación (ALTEC) y la Universidad Nacional de Entre Ríos (UNER), con el apoyo institucional de la Secretaría de Ciencia y Tecnología del Gobierno de Entre Ríos, y otras instituciones auspicientes de la Argentina.

Academic Reports of the last three years from 13 Scientific and Technological Activity Cores (hereafter NACTs) at UNICEN, and conducting in-depth interviews with institutional representatives and leaders of NACTs that have achieved significant results in AgroTech. For the analysis of capabilities, a set of dimensions and conditioning variables associated with the determinants of University-Industry linkage (hereafter U-I) are proposed, following the framework by Carattoli (2020).

Keywords: capabilities - innovation - R&D centers - U-I linkages – AgTech.

1. INTRODUCCIÓN Y MARCO CONCEPTUAL

a) Tecnologías de la Industria 4.0 y Ecosistemas AgroTech

El término Industria 4.0 se remite originalmente al "Plan Industria 4.0" de Alemania, y hace referencia a la difusión de nuevas tecnologías en la digitalización y supervisión de procesos de producción. Ciertos autores la definen como "la Cuarta Revolución Industrial" (Schwab, 2017, p. 7), basada en la mayor ubicuidad y movilidad de Internet, que permite la difusión de sistemas de producción ciber-físicos.

Esto ha dado lugar en los últimos años a la aparición de nuevos sectores intensivos en conocimiento, en los que la tecnología es transversal, con un impacto en el funcionamiento de sectores tradicionales de la economía, como la sanidad, la educación, las finanzas y la agricultura (Arditi, Camio, Velazquez & Errandosoro, 2023). En este último caso, esto ha derivado en la aparición del sector AgroTech. Resultan valiosos los aportes de estudios específicos en nuestro país en el sector Agrotech (Lachman, López, Tinghitella, & Gómez Roca, 2021; Navarro et al., 2019).

Tilney, Leclerc & Demarest (2015, p. 2) de AgFunder, conceptualizan el término AgroTech como "las tecnologías individuales o una combinación de tecnologías relacionadas con equipo agrícola, clima, optimización de semillas, fertilizantes e insumos de cultivos, riego, sensores remotos -incluidos drones, gestión de explotaciones agrícolas y, grandes datos agrícolas- que tienen como objetivo mejorar o innovar en la industria global de la alimentación, la agricultura, la ganadería y otras actividades de base biológica".

El sector AgroTech puede ser analizado desde una perspectiva holística del Ecosistema Emprendedor. Este término hace referencia a la interconexión social del conjunto de actores y de factores cuya dinámica aumenta las probabilidades de éxito de los emprendimientos (Isenberg, 2010) y eleva el nivel de innovación y competitividad impactando positivamente en el crecimiento económico de un territorio (Navarro et al., 2019). La evidencia indica que existe cierto nivel de desconexión en el ecosistema AgroTech entre la oferta de tecnología y las necesidades de la demanda de acceso a tecnologías de alto potencial (Trigo et al., 2018; Navarro et al., 2019).

Incluso, desde el punto de vista de la demanda, es fundamental que quienes la componen puedan conocer las alternativas brindadas por los oferentes. En este contexto, las universidades desempeñan un rol importante en prácticas de innovación abierta (Carattoli, Camio, & Marone, 2019), no sólo en la provisión de conocimiento en el marco de vinculaciones universidad-industria (en adelante, U-I), sino en procesos de co-creación de innovaciones en contextos de modelos de cuádruple hélice.

b) Capacidades y Resultados de Innovación a partir de la Vinculación Universidad-Industria

Los procesos de adopción tecnológica no son lineales, y el tiempo transcurrido entre el desarrollo de una tecnología y su demanda puede durar años. Resulta clave el rol de instituciones, como las universidades, que vinculen las empresas con los desarrollos tecnológicos.

En el estudio de la vinculación U-I existen diferentes enfoques con distintos abordajes, que definen las aproximaciones al fenómeno desde diferentes perspectivas y plantean propuestas de operacionalización a través de un conjunto de dimensiones e indicadores. Sin ánimo de ser exhaustivos, se explicitan aportes de distintas investigaciones en línea con los objetivos del presente trabajo.

El Manual de Indicadores de Vinculación de la Universidad con el Entorno Socioeconómico - Manual de Valencia (Albornoz, Barrere, Castro, & Carullo, 2017), resulta referencia central para abordar este aspecto. A partir de una perspectiva sistémica de la innovación y la teoría del enfoque organizacional, se consideran tres vectores implicados en las actividades de transferencia de conocimientos: el contexto, los resultados y los procesos. Asimismo distingue entre "capacidades" (lo que las universidades tienen) y "actividades" (lo que las universidades hacen).

En este modelo, las dimensiones consideradas pueden sintetizarse en: Caracterización Institucional (estructura organizacional, trayectoria histórica, población universitaria y recursos financieros, dimensión y orientación de I+D); Capacidades para las actividades de vinculación (incluye indicadores de desarrollo institucional, de propiedad intelectual e infraestructura física e índices respecto a la la creación de empresas); y Actividades de vinculación (I+D contratada y en colaboración con entidades no académicas).

Los vínculos U-I desde la perspectiva de la intensidad de su interacción permite considerar un aporte (Brown, 2007; Perkmann, Neely, & Walsh, 2011) que propone indicadores de medición del desempeño divididos en categorías que se corresponden con las fases del proceso de colaboración U-I. Tales indicadores se clasifican en insumos o factores de

entrada, actividades, productos e impactos. Como factores de entrada se consideran los recursos, capacidades de los investigadores (cantidad de citas) y motivación de los investigadores. El indicador más directo de la vinculación U-I es el nivel de financiación de la industria hacia la investigación universitaria. Dentro de las actividades, se indica la intensidad de la colaboración, la que facilita conocimientos tácitos frente al intercambio formal de resultados de investigación codificados. Dentro de los productos, se consideran los indicadores de resultados (patentes, publicaciones conjuntas de científicos de la universidad y la industria) y en los indicadores de impacto se incluyen tanto los de tipo económico como los ambientales.

Otra perspectiva teórica que combina la literatura de vinculación U-I, con la literatura de redes, propone un modelo conceptual que relaciona la fuerza del vínculo, las modalidades de vinculación y los beneficios de la vinculación (Carattoli, 2020). La autora analiza y explica los alcances de diferentes Modalidades: Tradicional (unidireccional), de Servicios (distinguiendo entre servicios estandarizados y no estandarizados), Bidireccional (mayor intensidad de la relación y generalmente formalizadas) y Comercial (las universidades logran comercializar sus resultados de investigación - patentes, licencias de tecnología, spin-off, incubadoras, etc.- y obtener recursos).

En términos de obstáculos o desafíos de la vinculación U-I se encuentra cierto consenso entre diversos autores en relación a la falta de recursos y capacidades universitarias (procedimientos administrativos lentos) y que las empresas que en ocasiones desconocen o desconfían que la vinculación les aporte valor real a su negocio (Carattoli, 2020). Se resalta también que las universidades tienden a orientarse hacia la investigación a largo plazo impulsada por la curiosidad, mientras que las empresas están interesadas en los resultados a corto y mediano plazo (Perkmann, Neely & Walsh, 2011).

II. METODOLOGÍA

a) Contextualización

El sitio de investigación es la Universidad Nacional del Centro de la Provincia de Buenos Aires (en adelante UNICEN). La UNICEN, creada en Argentina en el año 1974 cuenta con 10 Unidades Académicas localizadas en sus tres sedes en las ciudades de Azul, Olavarría y Tandil y una Unidad de Enseñanza en la ciudad de Quequén. Estas dependencias brindan 63 carreras de grado, 10 de pregrado y una importante oferta de diplomaturas, maestrías y doctorados. Al año 2017 se registraron más de 15.000 estudiantes de grado y 1.165 estudiantes de postgrado (UNICEN, 2017, p.10).

En cuanto a actividades de investigación, se resalta que el 43,9% de la planta estable docente de la

UNICEN realiza actividades de investigación (UNICEN, 2017, p.11), las cuales se desarrollan en 43² Núcleos de Actividades Científico-Tecnológicas (en adelante, NACTs) y 5 Grupos de Actividades Científico-Tecnológicas de distintas disciplinas. El ranking de Universidades de Scimago 2023, posiciona a la UNICEN en el puesto 156 entre 418 universidades rankeadas de Latinoamérica, siendo el componente más valorado el de innovación y obtención de patentes³ que denotan la existencia de transferencia de tecnología hacia el sector productivo.

b) Diseño metodológico, alcance, fuentes de datos, recolección y análisis

El alcance del proyecto es exploratorio-descriptivo, y busca avanzar en la identificación de capacidades y resultados de innovación para el sector AgroTech en el marco de la UNICEN, pretendiendo especificar cuáles y cómo son las relaciones que existen entre los NACTs con el sector AgroTech.

Para el cumplimiento del objetivo de este trabajo de identificar los resultados y las capacidades (tecnológicas y relacionales) de los NACTs de la UNICEN orientados al desarrollo de tecnologías para el sector AgroTech, se realiza una investigación cualitativa, encuadrada dentro de un diseño de estudio de caso, en virtud de que se apunta a estudiar un fenómeno en el marco de un contexto definido en el cual se evidencia una interacción entre los componentes de un sistema y sus características.

El sitio de investigación es la UNICEN, y la unidad de análisis son los NACTs que ejecutan proyectos de I+D y realizan actividades orientadas al sector AgroTech. Se realizó una clasificación inicial de los NACTs a partir de un criterio propuesto por el BID (Vitón, 2019), el cual distingue las 9 tecnologías principales⁴ y los 9 tipos de innovaciones⁵ (Vitón et al, 2017) más importantes orientadas al sector AgroTech. De esta forma, se seleccionaron 13 NACTs que cumplieran tal requisito.

²<http://secat.unicen.edu.ar/index.php/nucleos/#1576608950595-e6cf584c-860b>.

³<https://www.scimagoir.com/rankings.php?sector=Higher+educ.&country=Latin+America&year=2017>.

⁴El Banco Interamericano de Desarrollo el cual distingue 9 tecnologías de la Industria 4.0 más demandadas por el sector agropecuario: Biotecnología (Biotech.), Big Data, TICs y mobile (TICs), Datos abiertos, Tecnologías Limpias (TL), Robótica, Internet de las Cosas (IoT), Biometría e Inteligencia Artificial (IA) y Realidad Virtual (RV).

⁵El BID distingue las siguientes áreas de innovación en el sector Agrotech: Nuevos sistemas de producción (NSP), Automatización/mecanización de labores, Genética y protección de cultivos (Genética), Big data y agricultura de precisión (BD y AP), SSI para la toma de decisiones (SSI), Plataformas de compra-venta servicios y financiamiento, Tecnologías en la cadena de logística y distribución de alimentos Productos y servicios, Bioenergías y biomateriales (Bioenergía).

Se utilizaron fuentes de información secundarias y primarias a fin de obtener datos cuantitativos y cualitativos de la vinculación U-I, como proxy de las capacidades tecnológicas, relacionales y los resultados de innovación que tienen los NACTs orientados al sector AgroTech. La inclusión de datos cuantitativos y cualitativos en el análisis y la combinación de múltiples fuentes de información, se sustenta por lo que proponen diversos autores (por ejemplo Jensen et al., 2009; Seppo & Lilles, 2012) en relación a que los datos cuantitativos son una fuente importante de información y son relativamente fáciles de recopilar y analizar, pero la obtención de datos cualitativos en entrevistas permiten comprender mejor los cambios y también mapear los problemas y las dificultades quizás antes de que los problemas aparezcan en las estadísticas. El uso de las múltiples fuentes de evidencia, radica en la importancia que destacan diversos autores de la literatura como Yin (1984, 2003), Blaikie (1991), Stake (1994), Martínez Carazo (2006), en el proceso de triangulación de los datos para eliminar los sesgos del investigador y de

esta manera garantizar la validez y fiabilidad del estudio.

Como primer paso, se avanzó en la enumeración de indicadores para la descripción institucional, las capacidades tecnológicas, las capacidades relacionales y los resultados de innovación AgroTechs a partir de indicadores recogidos de la literatura de vinculación U-I (Iborno, Barrere, Castro, & Carullo, 2017; Perkmann, Neely, & Walsh, 2011; Brown, 2007).

A partir de esto, se obtuvieron datos cuantitativos y cualitativos de fuentes secundarias, como ser las Memorias Académicas⁶ de los 13 NACTs de la UNICEN del último trienio (2020-2022) y se realizaron 10 entrevistas en profundidad a referentes de NACTs con vinculaciones mediante diferentes mecanismos con el sector AgroTech; en las mismas se indagó en las modalidades de vinculación con el sector, los resultados de innovación del NACTs y los desafíos y obstáculos existentes en la vinculación con el sector.

Tabla N° 1: Entrevistados por NACTs - UNICEN

Rol del entrevistado	Centro de I+D	Facultad
Investigador	PROANVET	Cs. Veterinarias
Investigador	TECSE	Cs. Veterinarias
Investigador	ISISTAN	Cs. Exactas
Investigador	CRESCA	Agronomía
Investigador	MEVET	Cs. Veterinarias
Investigador	INTELYMEC	Ingeniería
Director	IHLLA	Rectorado
Investigador	PROANVET	Cs. Veterinarias
Investigador	CISAPA	Cs. Veterinarias
Investigador	FISFARVET	CS. Veterinarias

Fuente: Elaboración propia

⁶ Las Memorias Académicas son documentos elaborados por los NACTs que sistematizan las actividades científico-tecnológicas anuales realizadas por el personal docente e investigador que conforman el núcleo a partir del uso de una plataforma web unificada del Plan Integral de Fortalecimiento de los Recursos Humanos de Organismos de Ciencia y Tecnología, que pertenecen a la Administración Pública Nacional. Estas Memorias incluyen los cargos, la formación de Recursos Humanos, la producción científica, actividades de extensión y financiamiento.

Los resultados se exponen combinando el modelo propuesto por Iboroz, Barrere, Castro, & Carullo (2017) del Manual de Valencia, con el modelo de Vinculación U-I basado en procesos (Perkmann, Neely, & Walsh, 2011; Brown, 2007). Los mismos se estructuran en torno a 4 dimensiones: *Insumos o factores de entrada*, que incluye el contexto institucional y las capacidades tecnológicas; *Actividades de vinculación (en proceso)*, las cuales incluyen las capacidades relacionales y las modalidades de vinculación de los NACTs; los *Productos*, que son los resultados de innovación medidos en términos de productos, prototipos, y demás bienes creados y

orientados al sector Agrotech; y los *Impactos* (económicos y socioambientales).

A fin de clarificar la operacionalización de la metodología para cumplimentar el objetivo planteado se expone en la Tabla N° 2. La información para dar respuesta a estos indicadores de capacidades tecnológicas, capacidades relacionales y los resultados de innovación AgroTech de los NACTs de la UNICEN se obtiene de las Memorias y de acuerdo a lo propuesto por varios autores que estudian indicadores de vinculación Universidad-Industria (Perkmann, Neely, & Walsh, 2011; Seppo & Lilles, 2012; Alborno, Barrere, Castro, & Carullo, 2017).

Tabla N° 2: Indicadores y Operacionalización de Variables de Capacidades Tecnológicas, Relacionales y Resultados de Innovación Vinculados a la Literatura de U-I

CONTEXTO INSTITUCIONAL	
Actividades de vinculación de la Universidad, RRHH afectados, estructura organizacional, regulaciones.	
CAPACIDADES TECNOLÓGICAS	CAPACIDADES RELACIONALES
Proyectos de I+D AgTech por NACT y descripción en el trienio.	Fuente de Financiamiento de organizaciones externas al SCyT: Nombre de las organizaciones.
Financiamiento público: nombre de instituciones que financian proyectos de I+D.	Vinculación con organizaciones externas al SCyT: nombre de las organizaciones.
Recursos Humanos: Doctores y Becarios de grado y postgrado del SCTN. (Planta estable al 2022)	Formalización de la vinculación: SI (si existen convenios, acuerdos u otro) NO (si no existe)
Producción científica: Libros, Partes de Libros, Artículos Científicos, y Trabajos en eventos CT publicados en el trienio.	Tipo de Vinculación: descripción de la actividad.
Premios y Distinciones: cantidad en el trienio	Publicaciones Conjuntas: SI-NO
Citación: Cantidad de citas de director y codirector -si existe- del NACT (Fuente: Google Scholar).	
RESULTADOS DE INNOVACIÓN	
Tipo de Resultado: Producto – Servicio Estandarizado – Servicio no Estandarizado	Descripción del Resultado
RESULTADOS DE INNOVACIÓN	
Tipo de Impacto: Económico – Socioambiental	Descripción de las características de los impactos.

Fuente: Elaboración propia en función de los modelos propuesto por Iboroz et al. (2017) y Perkmann et al. (2011)

Para el análisis de la información se realizaron tablas con información cuali-cuantitativa y se trianguló la

información con los informes cualitativos de cada NACTs en análisis. Las entrevistas a los referentes de

NACTs fueron transcritas y se extrajeron fragmentos centrales en relación a la temática en estudio.

III. RESULTADOS

En el avance hacia la *caracterización institucional* y particularmente de la política de investigación surge que la UNICEN plantea como meta alcanzar el afianzamiento y la promoción de conocimientos científicos y las innovaciones tecnológicas transferibles. Para lograr esto, en los últimos años, la UNICEN ha transitado por un proceso de fortalecimiento de sus grupos de investigación, hecho que ha conducido a la conformación de Unidades Ejecutoras de doble y triple dependencia (con el Consejo Nacional de Investigaciones Científicas y Técnicas -CONICET- y la con la Comisión de Investigaciones Científicas de la Provincia de Buenos Aires -CICPBA-, respectivamente) y la creación del Centro Científico Tecnológico Tandil (CCT Tandil) también con el CONICET. Estos grupos han participado de diferentes convocatorias generadas desde la Universidad, a través de la Secretaría de Ciencia, Arte y

Tecnología (SECAT) a efectos de acceder a financiamiento que permita su desarrollo.

La SECAT se encuentra conformada internamente por la Subsecretaría de Ciencia, Arte y Tecnología y la Subsecretaría de Vinculación y Transferencia (SUBVyT) creada esta última en acuerdo con el CCT Tandil, a fin de promover, coordinar y supervisar todas las actividades y proyectos institucionales de Vinculación y Transferencia, dentro de los cuales se destaca el Fortalecimiento de la gestión de la Propiedad Intelectual (PI) a través del Acuerdo de Cooperación Institucional con el Instituto Nacional de la Propiedad Industrial (INPI). Otra división importante que remarca la trayectoria institucional de la UNICEN en relación a la vinculación con el medio es el Centro de Innovación y Creación de Empresas (CICE). Creado en el año 2009, bajo dependencia de la SECAT, su misión consiste en estimular procesos de creación de nuevos proyectos, emprendimientos y asistencia en organizaciones existentes, impulsando la innovación desde el ámbito de la UNICEN hacia toda la región. Los datos más relevantes se sintetizan en la Tabla N° 3.

Tabla N° 3: NACTs, Proyectos de I+D AgroTech y Fuente de Financiamiento CT del Proyecto I+D

CONTEXTO UNICEN				
960 docentes con categoría de investigadores. NACTs de doble y triple dependencia (UNICEN - CICPBA - CONICET). Centro Científico Tecnológico Tandil (CONICET). Subsecretaría de Vinculación y Transferencia con programa de Fortalecimiento de Propiedad Intelectual con convenio con Fortalecimiento de Propiedad Intelectual con convenio con INPI. Centro de Innovación y Creación de Empresas				
NACT (FACULTAD)	PROYECTOS I+D	TECNOLOGÍAS	INNOVACIÓN	FINANCIAMIENTO
BIOLAB (Agronomía)	Evaluación de la diversidad biológica y funcional de hongos provenientes de suelos agrícolas bajo un sistema agroecológico y un sistema de siembra directa en la zona Centro y Sur de PBA, Argentina.	s.e	s.e	UNICEN - ANPCYT
	Avances en el manejo sostenible de la sanidad en cultivos de flores y hortalizas del AMBA.	Biotec.	NSP	UBA
CEA (Económicas)	Mapeo de actores e identificación de grado de ajuste entre la oferta y la demanda tecnológica en el Ecosistema AgTech en la región de influencia de la UNICEN.	Datos Abiertos	SSI	UNICEN
CISAPA (Veterinarias)	Desarrollo científico integrado en salud animal.	s.e	Genética	CONICET - UNICEN
	Estudio de la suplementación con probióticos sobre la performance de crecimiento, la microbiota intestinal y la respuesta inmune de los cerdos.	Biotec.	NSP - Genética	UNL
	Identificación de péptidos inmunodominantes en cepas Escherichia coli productor de toxina Shiga aisladas de bovinos para el diseño de una quimera multiepitope.	Biotec.	Genética	ANPCYT - UNICEN
	Producción de carne de cerdo local, agregado de valor y desarrollo sostenible en pos de una Economía Circular.	s.e	PySIA	UNICEN
	Impacto de actividades ganaderas en la calidad microbiológica del agua. Un enfoque en la resistencia a antimicrobianos.	Biotec.	NSP	FONCYT ANPCYT
Estudios sobre la infección por el virus de la leucosis bovina (BLV) en células mamarias y su relación con Staphylococcus aureus	Biotec.	NSP - Genética	ANPCYT	

CRESCA (Agronomía)	Programa de Investigación y transferencia tecnológica: Cadena Agroalimentaria Espárrago: bajo un enfoque sistémico.	s.e	PySIA	UNICEN - UNSL - UCA
	Análisis de la integración agrícola-ganadera de sistemas mixtos del centro de la provincia de Buenos Aires	TICs - IA	NSP	UNICEN
	Efecto del cambio climático asociado a Fusarium graminearum y su potencial impacto sobre la calidad panadera del trigo	Biotec.	PySIA - Genética	FONCYT
	Revalorización de subproductos de la industria agroalimentaria como ingredientes funcionales saludables a base de cereales en el marco de la Economía Circular.	TL	PySIA - Bioenergía	UNLP - CIDCA - CONICET UNICEN
	Aportes ecosistémicos de la integración de la ganadería en planteos agrícolas.	TICs IA	NSP	
	Articulación e integración de campos experimentales y demostrativos en el sur de la provincia de Buenos Aires hacia una producción agropecuaria sustentable	TICs	NSP	INTA
FISFARVET (Veterinarias)	Desarrollo científico en salud animal	Biotec.	NSP	CONICET - UNICEN
	Dispositivos para identificación de enfermedades infecciosas en el cerdo: herramienta para la terapia de precisión	IoT - Robótica	Mecanización - BD y AP	UNICEN - CIC- CONICET-
	Evaluación del bienestar animal, caracterización productiva, genética y de la sostenibilidad de sistemas pecuarios en la región de influencia de la UNCPBA	TICs	PySIA - Genética	UNICEN
	Modelación productiva, económica y ambiental de sistemas modales de producción de carne de base pastoril de la cuenca del Salado Bs. As. y del norte de Santa Fe.	TICs	BD y AP	ANPCYT - UNICEN -CIC- CONICET
	Impacto del uso del orujo de oliva sobre la permeabilidad intestinal de cerdos	Biotec.	NSP	UNICEN
	Reducción del uso de antimicrobianos en el tratamiento de diarreas mediante el empleo de vacunas y manejo calostrado estratégico en lechones de granjas en Colombia	Biotec.	NSP	-
MEVET (Veterinarias)	Desarrollo y caracterización biomecánica de una bioprótesis de pericardio bovino	Biotec.	Mecanización	UNICEN
	Avances sobre la endocrinología de la reproducción en llamas (Lama glama): estudios sobre la funcionalidad del cuerpo lúteo y el reconocimiento materno de la preñez	Biotec.	Genética	ANPCYT
	Impacto de la restricción nutricional de ovejas durante la preñez sobre los tejidos reproductivos de hembras prepúberes.	Biotec.	NSP	UNICEN
IHLA (Rectorado)	Adaptación al cambio climático con aprendizaje automático: oportunidades para la producción de cultivos	TL	Genética	UNMDP
	Maíz en el centro-sudeste de la provincia de Buenos Aires: enfrentando escenarios climáticos actuales y futuro	Biotec.	s.e	UNMDP
	Modelos de apoyo a la toma de decisiones ambientales en base a Aprendizaje Profundo	TICs	s.e	UNICEN
	Proc.de salinización de aguas subterráneas y relación con suelos y vegetación en la Pampa Deprimida de BA.	TL	s.e	ANPCYT - UNICEN
NUCEVA (Agronomía)	Sensores remotos y SIG como herramienta para caracterizar de servicios ecosistémicos en la región pampeana.	IoT - Robótica	BD y AP	UNICEN
CIISAS (Agronomía)	Sistemas de compostaje de estiércol de feedlot: caracterización y valoración agronómica del producto final	s.e	Bioenergía	UNICEN -LIMA -YA UNICEN
	Alternativas de manejo de la nutrición de un cultivo bioenergético, para la reducción de uso de agroquímicos	Biotec.	Bioenergía	
	Desarrollo de la Agricultura Inteligente en relación con prácticas de trabajo y adecuado manejo del agua y del suelo	s.e	BD y AP	UNICEN
	Economía circular en la cadena de valor de la bioenergía: incorporación de Arundo donax en un sistema bioenergético de origen agropecuario.	TL	Bioenergía	UNICEN

	Integración de un cultivo energético de segunda generación, Arundo donax L., a la cadena de valor de la bioenergía.	TL	Bioenergía	UNICEN
	Resistencia a herbicidas en malezas de los sistemas agrícolas de la zona centro de la provincia de Buenos Aires.	TICs	Genética	UNICEN
TECSE (Ingeniería)	Calidad de granos, nuevas aplicaciones y alternativas tecnológicas	TICs	s.e	ANPCYT
	Estudio integral de los granos argentinos para potenciar su aprovechamiento industrial	s.e	s.e	ANPCYT
	Producción de Carne de Cerdo local, agregado de valor y desarrollo sostenible en pos de una Economía Circular	s.e	s.e	UNICEN
	Procesamiento de granos para la extracción de aceites y uso de los subproductos como fuente de ingredientes bioactivos: un enfoque sustentable.	TL	PySIA	ANPCYT
ISISTAN (Exactas)	Desarrollo de un aparejo móvil IoT basado en visión computacional e IA, para la determinación automática del grado de terminación y condición corporal de bovinos.	IoT - IA	Genética - SSI	FONCYT
	Expresión facial de las emociones en equinos sangre pura de carrera: base de datos propia, abierta, clasificación y análisis de mod.computacionales e indicadores de comportamiento.	Datos Abiertos	s.e	UNICEN
	Herramienta de software para productores ganaderos que utiliza Machine Visión para estimar el estado corporal y peso de los animales.	TICs - IA	SSI - Automatización	CONICET-UNICEN
	Sistema semi-automático de calificación biométrica de vacas lecheras y modernización de la plataforma de gestión de datos de A.C.H.A. mediante IA y computación móvil.	IA	SSI - Automatización	ANPCYT
	Desarrollo de un Sistema Automático de Evaluación Biométrica del Ganado Lechero: Vacas Funcionales para cada Sistema Productivo	IA	SSI - Automatización	UNICEN
PROANVET (Veterinarias)	Alternativas tecnológicas destinadas a mejorar la eficiencia de la transferencia de embriones en caprinos.	Biotec.	Genética	FONCYT INTA
	Evaluación del bienestar animal, caracterización productiva, genética y de sostenibilidad de sistemas pecuarios en la región de la UNCPBA	Biotec.	Genética	UNICEN
	Propuesta de indicadores de bienestar que contribuyan a la sostenibilidad en tambos de la Cuenca Mar y Sierras.	s.e	s.e	UNICEN
	Sustentabilidad de la producción ganadera bovina de pastizales naturales: mod.y detección de indicadores.	s.e	s.e	AUDEAS-CONADEV
	Desarrollo de un sistema de bajo costo para la cuantificación de gas metano proveniente de efluentes de producción ganadera intensiva.	TL - TICs	Automatización	UNICEN
	Programa Argentino de Prueba de Reproductores Bovinos de Leche (PROAR)	Biotec.	Genética - NSP	UNICEN - MAGyP
	Estrategias para la mejora productiva, agregado de valor y sostenibilidad de la producción Apícola	s.e	s.e	UNICEN
INTELYME C (Ingeniería)	Integración de un cultivo energético de segunda generación, Arundo donax L., a la cadena de valor de la bioenergía.	TL	Bioenergía	UNICEN
	Arundo donax L. como fuente de bioenergía para la sustitución de combustibles fósiles.	TL	Bioenergía	UNICEN

Fuente: Elaboración propia a partir de las Memorias Académicas de los NACTs (2020-2022)

En relación con identificación de *capacidades tecnológicas* de los NACTs de la UNICEN orientados al desarrollo de tecnologías para el sector AgroTech, se detallan 13 NACTs de diferentes unidades académicas de la UNICEN que llevan adelante 53 proyectos de I+D orientados al sector AgroTech. Estos proyectos (enumerados y detallados en la Tabla N° 3) son financiados por diferentes instituciones del Ministerio de

Ciencia, Tecnología e Innovación de Argentina, como la Agencia Nacional de Promoción Científica y Tecnológica, el CONICET, la Comisión de Investigaciones Científicas de la Provincia de Buenos Aires (CICPBA), y diferentes universidades nacionales públicas y privadas.

La Tabla N° 4 a continuación hace referencia a otras capacidades tecnológicas asociadas a la formación de recursos humanos, la producción científica, los premios obtenidos y la cantidad de citas de los NACTs. Al 2022 los NACTs estaban conformados en promedio por 12 doctores y 14 becarios de grado y posgrado. Se destaca la

producción científica realizada en el período así como la obtención de premios y menciones en el 77% de los NACTs. En cuanto a la cantidad de citas de los directores y codirectores de los Centros de I+D⁷, se evidencia mayor cantidad de citas en centros de Cs. Exactas (ISISTAN) y Cs. Veterinarias (FISFARVET).

Tabla N° 4: Capacidades Tecnológicas de los NACTs de la UNICEN

NACTs	RECURSOS HUMANOS		PRODUCCIÓN CIENTÍFICA				PREMIOS	CITACIÓN
	DOCTORES	BECARIOS	ARTÍCULOS	LIBROS	PARTES DE LIBROS	T. EN EVENTOS CT PUBLICADOS		
BIOLAB	8	7	X		X	X	0	s.d.
CEA	12	18	X			X	3	429
CISAPA	17	19	X			X	6	s.d.
CRESCA	10	22	X		X	X	8	81
FISFARVET	24	17	X		X	X	6	9069
IHLA	18	19	X	X		X	0	2553
MEVET	9	1	X			X	4	421
NUCEVA	7	9	X	X	X	X	0	s.d.
CIISAS	1	6	X	X	X	X	2	s.d.
TECSE	11	13	X		X	X	2	s.d.
ISISTAN	16	12	X		X	X	17	4148
PROANVET	15	9	X		X	X	3	596
INTELYMEC	9	26	X		X	X	3	2934

Fuente: Elaboración propia a partir de las Memorias Académicas de los NACTs (2020-2022)

Respecto a las *capacidades relacionales*, se pudieron identificar 5 NACTs que han formalizado sus vínculos con organizaciones por fuera del Sistema Científico-Tecnológico con el financiamiento de proyectos de I+D. La tabla N° 5 exhibe los NACTs, pertenecientes a las facultades de Agronomía, Cs. Veterinarias, Cs. Exactas e Ingeniería, los proyectos, el tipo de innovación y la tecnología trabajada, y las organizaciones que han financiado tales actividades. Estas organizaciones han sido de carácter privado, como empresas, y cooperativas, y otras entidades sin fines de lucro como cámaras, fundaciones y asociaciones específicas que se encuentran fuera del Sistema Científico-Tecnológico Nacional

⁷Es de destacar que este dato no pudo obtenerse en la totalidad de los NACTs debido a que en gran parte de éstos, los referentes de estos centros no cuentan con perfiles en Google Scholar.

Tabla N° 5: Financiamiento de Proyectos de I+D fuera del sistema C-T

NACT (FACULTAD)	PROYECTOS I+D	TECNOLOGÍAS	INNOVACIÓN	FINANCIAMIENTO
CIISAS (Agronomía)	Economía circular en la cadena de valor de la bioenergía: incorporación de Arundo donax en un sistema bioenergético de origen agropecuario.	TL	Bioenergía	Bioeléctrica Gral Alvear S.A. (BGA)
	Integración del cultivo energético de seg. generación, Arundo donax L., a la cadena de valor de bioenergía.	TL	Bioenergía	Bioeléctrica Gral Alvear S.A. (BGA)
FISFARVET (Veterinarias)	Reducción del uso de antimicrobianos en el tratamiento de diarreas mediante el empleo de vacunas y manejo calostrado estratégico en lechones de granjas en Colombia	Biotech.	NSP	Centro Internacional para Soluciones a la Resistencia Antimicrobiana (ICARS)
INTELYMEC (Ingeniería)	Integración de un cultivo energético de segunda generación, Arundo donax L., a la cadena de valor de la bioenergía.	TL	Bioenergía	Bioeléctrica Gral Alvear S.A. (BGA)
ISISTAN (Exactas)	Desarrollo de un aparato móvil IoT (Internet de las Cosas) basado en visión computacional e inteligencia artificial, para la determinación automática del grado de terminación y condición corporal de bovinos.	IoT - IA	SSI - Genética	Asociación Criadores de Holando Argentino (ACHA)
	Herramienta de software para productores ganaderos que utiliza Machine Vision para estimar el estado corporal y peso de los animales.	TICs - IA	SSI - Automatización	Holy Data S.A.S. Fundación Sadosky
	Sistema semi-automático de calificación biométrica de vacas lecheras y modernización de la plataforma de gestión de datos de A.C.H.A. (Asociación Criadores de Holando Argentino) mediante inteligencia artificial y computación móvil.	IA	SSI - Automatización	Asociación Criadores de Holando Argentino (ACHA)
	Desarrollo de un Sistema Automático de Evaluación Biométrica del Ganado Lechero: Vacas Funcionales para cada Sistema Productivo	IA	SSI - Automatización	Asociación Criadores de Holando Argentino (ACHA)
TECSE (Ingeniería)	Producción de Carne de Cerdo local, agregado de valor y desarrollo sostenible en pos de una Economía Circular	s.e	s.e	Cagnoli S.A.
	Aportes tecnológicos para la generación de la cadena de valor de alpiste (<i>Phalaris canariensis</i> L.) apto para consumo humano	s.e	PySIA	Molino Olavarría S.A.

Fuente: Elaboración propia a partir de la lectura de las Memorias Académicas de los NACTs y de las entrevistas a investigadores

Existen vinculaciones entre los NACTs y organizaciones/empresas, las cuales pueden estar formalizadas o no, e incluso, pueden tener una contraprestación económica. En este sentido, se identifican 10 NACTs con indicadores de capacidades relacionales orientadas al sector AgroTech. Estos NACTs pertenecen a diferentes unidades académicas (Agronomía, Cs. Veterinarias, Cs. Exactas), de los cuales se destaca el PROANVET, el TECSE y el CIISAS con 15, 9 y 8 acciones de vinculación con organizaciones externas al Sistema Científico y Tecnológico Nacional, respectivamente. En general, las actividades de vinculación se encuentran formalizadas mediante acuerdos de colaboración o convenios específicos, aunque también algunas de ellas no son formalizadas por convenios. No se declaran en las

Memorias Académicas publicaciones conjuntas y tampoco la existencia de oficinas de vinculación tecnológicas propias de los NACTs analizados (Tabla N° 6).

Tabla N° 6: Capacidades Relacionales NACTs UNICEN

NACT	PUB. CONJ.	VINCULACIÓN		
		ORG. NO SCyT	FORMAL	TIPO
CIISAS	s.e	Asociación de Laboratorios Agrop. Privados (ALAP)	SI	C-T. Investigación y transferencia de cultivos proteicos (arveja proteica).
		Agustín Quattrochio e hijos SA.	NO	Investig. sobre Agricultura de Precisión.
		Verttech SRL	NO	Investig. sobre crecimiento y rendimiento de clones de Arundo donax por micropropagación.
		REDCAI - División de Microbiología Agrícola y Ambiental - AAM	SI	Grupo de trabajo de compost, abonos y enmiendas.
		Schang Agroveterinaria	NO	Cooperación Técnica para desarrollo de Agricultura de Precisión
		Cementos Avellaneda SA	SI	C-T Investigación sobre Arundo donax un cultivo lignocelulósico como fuente alternativa a los combustibles fósiles.
		Nievas SA	SI	Desarrollo de herramientas para la descompactación de suelos bajo siembra directa.
		Círculo de Ing. Agrónomos de Tandil (CIAT)	SI	Capacitación en temas de mecanización agrícola.
CEA	s.e.	ORBITA – Ministerio de Producción de la Provincia de Bs. As.	SI	Cooperación. Informe Industria 4.0 en sector metalmeccánico PBA.
CISAPA	s.e	Sanatorio Tandil - Hospital "Ramon Santamarina"	NO	Trabajos en colaboración. Análisis clínicos.
		Cooperativa Nuevo Amanecer - BioExt. S.A. - Inbio Highway	NO	Trabajos en colaboración. Controles y testeos de calidad.
CRESCA	s.e	AAPRESID	NO	Comportamiento de cultivos de servicios cuando son utilizados para pastoreo.
		Fundación Pro-Mendoza	SI	Asistencia Técnica a empresarios mendocinos a posicionar sus productos y servicios
		Ferticer Logística SRL - Agrotecnos SA - Sanatorio Azul SA - Transporte Ricardito - Agroservicios Senderos SA - Agronomía Olavarría	NO	Cooperación voluntaria para realizar aportes y dinamizar el sector agroindustrial.
		Chacras Experimentales de la Provincia de Buenos Aires	SI	Convenio Marco para el desarrollo de investigaciones y cultivos experimentales.
FISFARVET	s.e	Asociación Argentina de Producción Animal (AAPA)	SI	Membresía Individual.
		Pracma (Grupo Roemmers)	SI	Convenio I+D: Análisis de los compuestos presentes en el extracto de orujo de oliva que impacten potencialmente sobre la salud intestinal del cerdo.
		Cevesa S.A. - Bedson S.A.	SI	Servicios Tecnológicos de Alto Nivel
IHLLA		Redimec S.R.L.	SÍ	Desarrollo de herramientas para la identificación de enfermedades en los sistemas intensivos de producción porcina.
		PROMITEC Santander - "Asociación por Colombia" - ICARS (Asociación Internacional de Lucha contra la Resistencia Antibiótica)	SI	Asistencia Técnica a empresarios colombianos para mejorar sus sistemas intensivos de producción porcina.
IHLLA		Instituto Correntino del Agua y del Ambiente	SI	C-T Isotopic and hydrological assessment of groundwater-wetland ecohydrological relationships under climatic and land use changes. Case study: Esteros del Iberá.
		Oficina de Riesgo Agropecuario MAGyP	SI	Colaboración. Mapas de estrés hídrico.

TECSE	s.e	Institut Charles Viollette. (Francia)	SI	Trabajos en colaboración
		Laboratorium fur Auftragsanalytik (Alemania)	SI	Trabajos en colaboración
		Red Internacional Chía-Link	SI	C-T. Estudio físico-químico, nutricional y tecnológico de la contribución de subproductos de chia como nuevos ingredientes en Europa.
		Molino Olavarría S.A.	SI	Colaboración
		Advanta Semillas SAIC	SI	Transferencias de material y confidencialidad.
		Consorcio Ciruelas -Fundación Pro-Mendoza	SI	Transferencia sobre factibilidad técnica de obtención de ciruelas pasas de bajo contenido calórico.
		Monsanto Argentina	SI	Cooperación, complementación y asistencia técnica.
		Asociación Argentina de Grasas y Aceite (ASAGA)	SI	C-T. Trabajos referidos a calidad de aceite de oleaginosas, descascarado de girasol, etc.
		GUNDEL Hnos.	SI	C-T. Control, monitoreo y adquisición de datos del silo Piloto del Grupo de Investigación TECSE.
ISISTAN		Holy Data	s.e	s.e
PROANVET	s.e	Mesa Ovina Mar y Sierras	SI	Membresía individual
		Consejo de Profesionales del Agro, Alimentos y Agroindustria (CPIA)	SI	Membresía individual
		Sociedad Latinoamericana de Invest. en abejas	SI	Integrante Comisión Directiva representando a Argentina
		Consejo Nacional Apícola de MAGyP	SI	Membresía individual
		Comisión Promotora de la Asoc. Argentina de Sociología Rural.	SI	C-T Complejidad de lo agroalimentario en el espacio social: innovación, calidad y territorio.
		Sistema Integrado de Gestión de la Lechería Argentina - MAGyP	SI	Trabajos en colaboración del Laboratorio de Calidad de Leche
		Cluster Porcino Tandil	NO	s.e
		Red Argentina de Laboratorios Lácteos de Calidad Asegurada.	SI	Trabajos en colaboración
		Asociación Criadores de Holando Argentino (ACHA)	SI	Cooperación Técnica. Formación de recursos humanos y evaluación del potencial genético de 500.000 animales inscriptos en el Sistema Nacional de Control Lechero.
		MOST (CEPIT)	NO	Trabajos en colaboración. Soluciones Informáticas
		INTERBULL	SI	Membresía individual
		Asociación Argentina de Criadores de Hereford	SI	Convenio de Cooperación mutua. Evaluación de bovinos.
		Fundación La Paloma - Asociación Tandilense de Equinoterapia	NO	Asistencia Técnica.
		GRASSFED Argentina	SI	Membresía individual
Mesa Argentina de Carne	NO	Trabajos en colaboración.		
		Sustentable		
INTELYMEC	s.e	Bioeléctrica General Alvear S.A.	NO	Cooperación Técnica. Integración de Arundo Donax a la cadena de valor de la bioenergía.
		Cementos Avellaneda S.A.	NO	Cooperación Técnica. Desarrollo de bioenergías para la sustitución de combustibles fósiles.

Fuente: Elaboración propia a partir de las Memorias Académicas de los NACTs (2020-2022)

Las entrevistas realizadas a investigadores y referentes de NACTs que orientan sus actividades hacia el desarrollo de tecnologías AgroTechs han permitido identificar diferentes *modalidades de vinculación U-I* entre los NACTs y las organizaciones con las que

interactúan, las cuales conducen a resultados diversos en materia AgroTech. En este sentido, siguiendo la línea de vinculación U-I propuesta por Carattoli (2020), identificamos cinco modalidades de vinculación U-I: Tradicional, de Servicios estandarizados, de servicios

no estandarizados, Bidireccional (mayor intensidad de la relación y generalmente formalizadas) y Comercial (las universidades logran comercializar sus resultados de investigación - patentes, licencias de tecnología, spin-off, incubadoras, etc.- y obtener recursos).

En primer lugar, en relación a la modalidad tradicional, se identifican NACTs con capacidades tecnológicas y proyectos de I+D orientados al AgroTech, que no explicitan capacidades relacionales en sus memorias, ni vínculos con organizaciones públicas o privadas por fuera del sistema científico-tecnológico. Se asume, en este aspecto, que la modalidad de vinculación es tradicional, de carácter unidireccional, donde existe un trabajo del investigador de tipo intelectual, y orientado al desarrollo de publicaciones científicas, por sobre la vinculación con el medio y la transferencia de tecnología. Se destacan en este aspecto NACTs de la Unidad Académica de Agronomía, como el NUCEVA.

En relación a la modalidad de servicios, la misma se clasifica en servicios estandarizados y no estandarizados. Los servicios estandarizados, fueron identificados en NACTs de Agronomía y Medicina Veterinaria, los cuales se corresponden con ensayos rutinarios y/o experimentales en la producción de hortalizas y/o vegetales, como es el caso del BIOLAB en Agronomía; y también diversos servicios a terceros que se corresponden con análisis virológicos y toxicológicos en animales y también en humanos, por el NACT CISAPA, de Cs. Veterinarias y su rol activo en la detección de la presencia del genoma de SARS-CoV 2 durante la pandemia.

Con respecto a los servicios no estandarizados, se identificaron NACTs que prestaban servicios de baja complejidad y otros denominados STAN (servicios tecnológicos de alto nivel). Suelen ser consultorías, asistencia técnica y asesoramientos eventuales y específicos, para la resolución de problemas productivos o de gestión. En este sentido, se identificó esta modalidad en el PROANVET, en Cs. Veterinarias, a partir del asesoramiento en la producción de compost proveniente de residuos orgánicos equinos a una ONG, lo que luego derivó en la creación de un fertilizante orgánico. En relación a la modalidad de servicios no estandarizados, de alto nivel tecnológico, se destacan asociados a análisis de tratamiento de efluentes, en NACTs de Cs. Veterinarias como el CISAPA, otros desarrollos antibióticos en bovinos y cerdos por parte del FISFARVET, de la misma unidad académica.

Finalmente, se identifican tres NACTs que mantienen modalidades de vinculación bidireccional y comercial. Respecto de la modalidad bidireccional, la cual implica relaciones de largo plazo con organizaciones y/o empresas de la industria, se destaca el NACT PROANVET, de la Facultad de Cs. Veterinarias, y el lhlla, dependiente del área de Rectorado de

UNICEN. En el primer caso, destaca el vínculo ininterrumpido entre el PROANVET y la Asociación de Criadores de Holando Argentino, desde el año 1993 hasta la actualidad, donde se han avanzado en la realización de varios proyectos, siendo uno de los más importantes la aplicación móvil ACHA CIEL, una app de sistematización de datos de evaluación genética. En general, estas iniciativas han sido financiadas por fondos privados, en este caso provenientes de ACHA. Los entrevistados sostienen que se está buscando migrar este desarrollo tecnológico hacia el concepto de datos abiertos, lo que resulta a la fecha muy complejo por el alto costo que representa cambiar radicalmente el sistema.

Se resalta por otra parte, una modalidad de vinculación bi-direccional, dando lugar al consorcio de cooperación público-privado lhreda, el cual es conformado por el Instituto de Hidrología de Llanuras (lhlla), la empresa Redimec S.A y la Autoridad del Agua de la provincia de Buenos Aires. Este consorcio fue creado con la finalidad de realizar monitoreos meteorológicos e hidrológicos y desarrollar estaciones meteorológicas para prevenir las inundaciones y sequías, permitiendo a los productores agropecuarios tomar decisiones productivas en función de mediciones de humedad y otras variables ambientales. El consorcio ha sido creado a partir de un Fondo Argentino Sectorial (FONARSEC) y capitales públicos y privados.

Finalmente, en relación a la modalidad comercial de vinculación, se identifica la creación de un spin off desprendido del NACT FISFARVET, constituyendo una nueva empresa que desarrolla tecnologías orientadas al agro y con fines comerciales. Este es el caso de UNIAGRO S.A., spin off conformado por un grupo de docentes investigadores de campos interdisciplinarios (ingenieros agrónomos, veterinarios e ingenieros en sistemas) pertenecientes a distintos núcleos científico-tecnológicos de la UNICEN, el cual se orienta al desarrollo de tecnologías de ganadería de precisión. Si bien el spin-off fue creado en 2017, ha obtenido licencias por sus desarrollos tecnológicos así como premios y distinciones por ideas-proyectos relacionadas a la ganadería de precisión. Uno de los desarrollos es un producto denominado CControl. Ar, el cual es un prototipo hard-soft de una cámara que toma imágenes 3D de vacunos al paso y aplica algoritmos de Inteligencia Artificial para estimar la condición corporal del animal o su grado de terminación, el cual resultó premiado en categoría de prototipado, en el I Certamen de Agtech Ganadero de la Sociedad Rural Argentina en 2019.

UNIAGRO S.A. ha financiado sus resultados de innovación con fondos provenientes de fuentes públicas aunque los montos han permitido alcanzar un prototipo de productos pero no han alcanzado escalar hacia un producto mínimo viable, consideran como obstáculo las

limitaciones en la captación y retención de recursos humanos para llevar adelante las actividades, con restricciones de financiamiento para tal fin.

En términos de generación de *resultados de innovación*, los entrevistados coinciden que es posible

desarrollar productos que existen a nivel global a costos más accesibles y con prestaciones diferenciadas pero igualmente con alto componente tecnológico.

Tabla N° 7: Resultados de los NACTs

NACT	RESULTADO	ACTIVIDAD	DESCRIPCIÓN
BIOLAB	Servicio estandarizado	Laboratorio de Valoración de Calidad Industrial de Trigo.	Ensayos rutinarios y/o experimentales para determinar características de productos y/o componentes de productos. Producción vegetal-cereales
CEA	Servicio No Estandarizado	Estudios Tecnológicos Orientados: Industria 4.0.	Servicio eventual. Asesoramientos, consultorías y asistencias técnicas. Asesoramiento para la resolución de problemas productivos o de gestión.
CIISAS	Servicio Estandarizado	Intensificación sostenible de la producción de trigo, maíz y carne bovina.	Asesoramientos, consultorías y asistencias técnicas. Asesorar para la resolución de problemas productivos o de gestión.
CISAPA	Servicio Estandarizado	Determinación de la expresión de citoquinas bovinas	Ensayos rutinarios y/o experimentales. Objetivo: realizar la adaptación o estandarización de procesos, productos y/o técnicas. Producción animal.
	Servicio Estandarizado	Diagnóstico Viroológico	Servicios a terceros. Sanidad animal
	Servicio No Estandarizado	Análisis de efluentes en descomposición .	Servicio eventual. Asesoramientos, consultorías y asistencias técnicas. Asesoramiento para la resolución de problemas productivos o de gestión.
	Servicio Estandarizado	Detección, titulación y rango de hospedador de bacteriófagos sobre cepas de Escherichia coli.	Servicio eventual a terceros. Ensayos rutinarios y/o experimentales para determinar características de productos y/o componentes de productos. Servicios Tecnológicos de Alto Nivel.
	Servicio Estandarizado	Detección de la presencia del genoma SARS-CoV2	Servicios a terceros. Salud pública.
	Servicio No Estandarizado	Análisis de pastura para determinar el avance del quitridio en pastizales serranos.	Servicios a terceros. Conservación de biodiversidad. Servicios Tecnológicos de Alto Nivel.
	Servicio No Estandarizado	Determinación de la actividad antiviral de productos sintéticos o biosintéticos, químicos o físicos.	Servicio eventual a terceros. Ensayos rutinarios y/o experimentales para determinar características de productos y/o componentes de productos.
CRESCA	Servicio Estandarizado	Análisis de suelos, compost y fertilizantes.	Ensayos rutinarios y/o experimentales. Asesoramiento para la resolución de problemas productivos o de gestión.
FISFARVET	Producto	CControl.ar	Prototipo hard-soft de una cámara que toma imágenes 3D de vacunos al paso y aplica algoritmos de IA para estimar la condición corporal del animal o su grado de terminación. Premiado en categoría de prototipado, I Certamen de Agtech Ganadero de la Sociedad Rural Argentina 2019.
	Producto	Sensor de Temperatura - Sensor de Tos	Prototipos de herramientas para la identificación precoz de enfermedades infecciosas en el cerdo (fiebre y tos).
	Servicio No Estandarizado	Estudio de la suplementación dietaria de aceites esenciales en cerdos.	Ensayos rutinarios y/o experimentales para determinar características de productos y/o componentes de productos. Servicios Tecnológicos de Alto Nivel (STAN)
	Servicio No estandarizado	Desarrollo de formulaciones de ivermectina de larga acción en bovinos.	Determinar características de productos y/o componentes de productos.

	Servicio Estandarizado	Determinar residuos y establecer tiempos de retiro de antimicrobianos en el cerdo.	Ensayos rutinarios y/o experimentales para determinar características de productos y/o componentes de productos. Servicios Tecnológicos de Alto Nivel (STAN)
	Servicio Estandarizado	Asesoramiento y diagnóstico toxicológico.	Servicios a terceros. Sanidad animal
INTELYMEC	Producto	Arundo donax L como fuente de bioenergía	Evaluar condiciones para la producción, manipulación y acopio de Arundo donax L, las opciones tecnológicas que optimicen su rendimiento energético y como fuente de energía térmica.
MEVET	Producto	Prototipo de bioprótesis de pericardio bovino.	Prototipo con pericardio bovino, con el objetivo de lograr una bioprótesis diseñada y testeada para ser utilizada como injerto.
	Servicio No Estandarizado	Estudio de biodisponibilidad absoluta de zoledronato en cerdos.	Desarrollo farmacéutico. Realizar la evaluación de tecnologías. Servicios Tecnológicos de Alto Nivel (STAN).
PROANVET	Producto	ACHA SICEL	App que sistematiza información de 500 productores que operan en Control Lechero Oficial de sus animales, inscripción, genealogía y calificaciones morfológicas.
	Producto	Cápsulas de Metano SF6 - Tubos de acero inoxidable para recolección de aire	Junto con la Facultad de Ciencias Exactas se ha innovado en el desarrollo de dos herramientas de mediciones de metano, mejorando su material y eficiencia a la hora de la cuantificación del gas metano.
	Producto	Prototipo de sensor de bajo costo para cuantificación de gas metano	Desarrollo, en conjunto con la Facultad de Ingeniería, de un sensor de bajo para la medición de gas metano provenientes de efluentes de producción ganadera intensiva.
	Servicio No Estandarizado	Apoyo y asesoramiento a la elaboración de compost con los excrementos equinos	Determinar características de productos y/o componentes de productos.
TECSE	Servicio Estandarizado	Caracterización de oleaginosas y subproductos.	Ensayos rutinarios y/o experimentales para determinar características de productos y/o componentes de productos.
	Servicio No Estandarizado	Estudio de pre-factibilidad agrícola e industrial.	Servicio eventual. Realizar la evaluación de tecnologías. Asesoría, investigación, consultoría.

Fuente: Elaboración Propia a Partir de las Memorias Académicas de los NACTs (2020-2022)

En relación con el análisis de *impacts*, el caso de los servicios estandarizados, como informes de consultoría, ensayos o asistencias técnicas, los impactos se materializan en brindar diagnósticos específicos e información para la toma de decisiones a la organización vinculada, y por ejemplo, si esa organización es una institución pública, pueden ser de utilidad para la determinación de políticas públicas que contribuyan a dinamizar al sector o una vertical AgroTech.

En relación a los servicios no estandarizados, si la vinculación se mantiene en el tiempo puede conducir a un desarrollo tecnológico que suponga una mejora para el sector en términos productivos o socioambientales.

En relación a los productos desarrollados en el período, existen algunos en fase de prototipo y otros ya operando en el sector. Aquellos como CControl. Ar (FISFARVET) supone impactos productivos para los

productores ganaderos pero cuenta con un obstáculo para el desarrollo a escala del producto, asociado a la falta de recursos humanos para trabajar en la actividad y al financiamiento disponible. La App desarrollada por PROANVET aporta a la trazabilidad del ganado vacuno Holando Argentino y facilita la toma de decisiones de los productores que operan en el Control Lechero Oficial.

El consorcio lhreda a través de la realización del desarrollo de estaciones meteorológicas para prevenir las inundaciones y sequías, permite a los productores agropecuarios tomar decisiones productivas con impacto económico positivos y por la naturaleza del aporte contribuye en los impactos ambientales.

En tanto que el producto desarrollado por INTELYMEC supone impactos socioambientales importantes para el sector, vinculado a la posibilidad de

sustituir energía proveniente de combustibles fósiles por fuentes alternativas renovables como la caña de azúcar, y la implicancia de esta sustitución energética en industrias vinculadas como la cementicia.

IV. CONCLUSIÓN

Este trabajo resulta un avance en la investigación cuyo propósito es mapear la oferta y demanda de tecnología para el Ecosistema Agrotech e identificar el grado de acople entre oferta y demanda en la región de influencia de la UNICEN.

Tomando como base aportes de la literatura que estudia la relación U-I, se expone una propuesta de operacionalización de las variables de capacidades (tecnológicas y relacionales), resultados e impactos para el análisis de los núcleos científico-tecnológicos orientados al desarrollo de tecnologías para el sector AgroTech.

En términos generales se identifica la explicitación de una política institucional con estructuras específicas para la vinculación y transferencia de tecnologías. Además se pudo identificar NACTs con capacidades tecnológicas desarrolladas desde estándares globales y con acciones que dan cuenta de capacidades relacionales que permitirían el planteo de hipótesis acerca de la permanencia y profundidad del vínculo.

Los resultados de este estudio resultan limitados al análisis de la información declarada en las Memorias Académicas del último trienio de 13 Núcleos de Actividades Científico-Tecnológicas (en adelante NACTs) de la UNICEN, y a la realización de entrevistas en profundidad a diez investigadores de NACTs con resultados significativos en AgroTech.

Emerge como cuestión recurrente la dificultad para encontrar información completa documentada de las actividades de vinculación. En los casos en los que se profundizó el análisis mediante entrevistas a los referentes de los NACTs se pudieron identificar acciones de vinculación no declaradas a priori en los informes de la Memoria. Esto resultaría un obstáculo al momento de contar con información actualizada que permita contribuir a desarrollar futuros vínculos que contribuyan a dinamizar el ecosistema.

A partir de los hallazgos encontrados y expuestos en este trabajo, se plantea la necesidad de continuar con la búsqueda de información de tipo cualitativa a través de otras entrevistas en profundidad, lo que permitiría avanzar en brindar mayores especificidades a fin de brindar una medida de cuán acoplada/desacoplada está la oferta y la demanda tecnológica en la región en análisis. Por otra parte, a partir de los hallazgos encontrados mediante el análisis de la información primaria recolectada se presentarán propuestas para que la sistematización de la

información solicitada en las Memorias permitan dar cuenta a futuro, de una mayor especificidad del nivel de capacidades relacionales desarrolladas por los centros de investigación.

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Production of Rape (*Brassica Napus L*) Under Diaper Waste-Moisture Conservation Field Technology

By Chikwanha S. M., Tungwarara M. K., Mutibura E. R., Ncube K. & Mazula A.

Midlands State University

Abstract- The purpose of this study was to test the effectiveness of growing vegetables under diaper waste moisture conservation technology and to incentivise diaper waste management in a way which reduces its ecological footprint through water and plant nutrients harvesting and conservation in agriculture. Due to poor refuse collection in Chitungwiza which has encouraged improper disposal of diaper waste, people resorted to the dumping of used disposable diapers at various dumping sites that have sprouted in most residential areas in the urban areas of Zimbabwe. Diaper wastes currently not properly managed in a manner which adds value to the food chain while they contain significant amounts of nutrients coupled with their water holding capacity which is not being utilised to address challenges induced by climate change in the agricultural sector pertaining food security and climate resilience in urban agriculture hence the need to undertake this study. An experiment to compare growth of vegetables under diaper waste treatment and a control without diapers was conducted. Vegetable growth rate and soil moisture loss were monitored over 10 weeks.

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I. INTRODUCTION

Disposable baby diapers have almost become indispensable in the list of baby care products as their use has been increasing steadily over the years [12]. Although disposable baby diapers were used traditionally for their convenience especially when travelling, nowadays they are generally used in many parts of the developed and developing world as a replacement for cloth diapers. In the developed world approximately between 90% and 95% of diapers used are disposable [23]. In a study done in Ottawa, Canada, disposable diapers were used by 82.3% parents and only 2% used cloth diapers. The developing world is adopting the use of disposal diapers because of their perceived advantages over the cloth diapers. It is

therefore apparent that, the advent of disposable diapers has somehow resulted in the death of the napkin culture. [20] Claims that disposable diapers have become highly commoditized as they are regarded as an epitome of modernization. They have in actual fact become a necessity rather than a luxury in fast paced lives.

The increased use of disposable diapers is associated with a number of environmental health challenges. The soiled diapers litter public spaces where they are an aesthetic nuisance [2]; [18]. Unlike in the developed countries where the disposal of waste is more developed, with separation at the source, developing countries such as Zimbabwe still use traditional methods of mixing waste and sometimes the diapers are dumped at illegals dumpsites [11]. Attributes this to inefficiencies by local authorities to manage solid waste. The refuse collection and disposal systems are inadequate and it is common to find refuse containing human waste such as disposable diapers mixed with other domestic waste. This negligent disposal of soiled disposable diapers therefore increases the chances of environmental pollution by waste which will otherwise be used in an ecological sustainable manner. It also exposes people who deal with solid waste such as municipal employees and waste scavengers to contaminants which could cause serious illnesses as they may handle raw faecal matter in the process of handling of soiled disposable diapers. The challenge of improper diaper disposal is affecting many towns and cities in the world and Chitungwiza town is not an exception.

However, diaper waste can be recycled into scientifically proven use which can contribute significantly in waste management, nutrient recycling and moisture conservation for agricultural use. A model around these elements can be developed to in order to proffer solutions around use of diapers in a more sustainable manner and addressing climate change and irrigation water scarcity problems. Originally, diapers relied on the absorbency of cotton, paper and sponges to hold the liquid in place. Unfortunately, those materials could only hold about 20 times their weight in water. However, today there is a much better situation. The use of super absorbent polymer materials such as sodium polyacrylate has dramatically increased the liquid holding capacity of diapers. Sodium polyacrylate was originally developed as an agricultural product which

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could be spread over crop fields to absorb moisture when it's plenty and release it when needed. It is a super-absorbing polymer that can hold up to 800 times its weight in water. When water is added to the soil, the polymer will absorb and hold some water. As the soil dries, the polymer releases its water keeping the soil moist. These properties can be harnessed in a bid to conserve water for irrigation whilst addressing the challenge diaper waste management.

a) *Problem Statement*

The non-collection of refuse in Chitungwiza has encouraged improper disposal of diaper waste. Generally, people resort to the dumping of used disposable diapers at various dumping sites that have sprouted in most residential areas in the urban areas of Zimbabwe. This is because, responsible authorities fail to collect refuse on a regular basis. Walking through Chitungwiza one can observe soiled diapers that are disposed near residences and along the roads. Diapers that are recklessly dumped at illegal dump sites are usually ravished by stray dogs thereby exposing faecal matter which attracts the huge green flies. It takes 500 years for disposable diapers to decompose [15]. There is acute water scarcity late alone water for irrigation. This study seeks to find out if hydrogels contained in diapers would make a significant difference in conserving water and retaining the moisture as well as supplying nutrients in the soil in a vegetable garden.

b) *Justification*

This study explores the subject of diapers, which are an iconic environmental problem associated with child rearing. It is generally regarded that waste management is the sole duty and responsibility of local authorities, and that the public is not expected to contribute. Contrary to this statement however, there is need for community involvement and participation in decisions regarding proper disposal of waste material to maintain a health and safe environment. In Zimbabwe, as in many developing countries, it appears that little information is available regarding handling and the proper disposal of disposable diapers despite a significant rise in usage of such during the last decade by women of child bearing age. Proper disposal of diapers reduces incidences of contamination of drainage water, which can subsequently lead to diarrheal diseases. There are a lot of diapers which are a nuisance and threat to environmental health around urban areas. Diaper wastes currently not properly managed in a manner which adds value to the food chain while they contain significant amounts of nutrients coupled with their water holding capacity which is not being utilised to address challenges induced by climate change in the agricultural sector pertaining food security and climate resilience in urban agriculture hence the need to undertake this study.

c) *Objectives*

i. *General Objective*

To incentivise diaper waste management in a way which reduces its ecological footprint through water and plant nutrients harvesting and conservation in agriculture.

ii. *Specific Objectives*

1. To establish diaper waste handling practices in Chitungwiza.
2. To compare growth rates of *Brassica Napus L* under diaper waste moisture conservation technology and the conventional farming method.
3. To determine the effectiveness of diaper waste-moisture conservation technology in moisture conservation.

d) *Research Questions*

1. What are the waste handling practices in Chitungwiza residential area?
2. What is the plant growth rate of *Brassica Napus L* under the conservation conditions?
3. How effective is diaper waste-moisture conservation technology in moisture conservation?

e) *Definition of Terms*

Diaper Waste Moisture Conservation Technology – a technique used to conserve moisture and harvest nutrients from soiled diapers for small scale agricultural purposes.

II. MATERIALS AND METHODS

a) *Study Site Description*

Chitungwiza City is located about 20km South East of Harare Main Post Office, covering 49km². It shares boundaries with Harare City and Mashonaland East Province. Chitungwiza town has an estimated population of about 354,472 according to the 2012 census. It is popularly known for a hospital named Chitungwiza Central Hospital, Aquatic complex, Town Centre complex and its Delta Chibuku super plant, Chitungwiza came into existence in the late 1970s.

The town has four administrative districts, namely Seke North, Seke South, Zengeza and St Mary's as shown in the map below. The oldest of the suburbs is St Mary's which is divided into two sections, Manyame Park (New St Mary's) and Old St Mary's. St Mary's is popularly known for being the oldest suburb in Chitungwiza town. Zengeza is divided into 5 sections i.e. Zengeza 1, 2, 3, 4 and 5. Zengeza 4 being relatively the largest section. Seke is another suburb and it is divided into many sections i.e. Unit A up to Unit P.

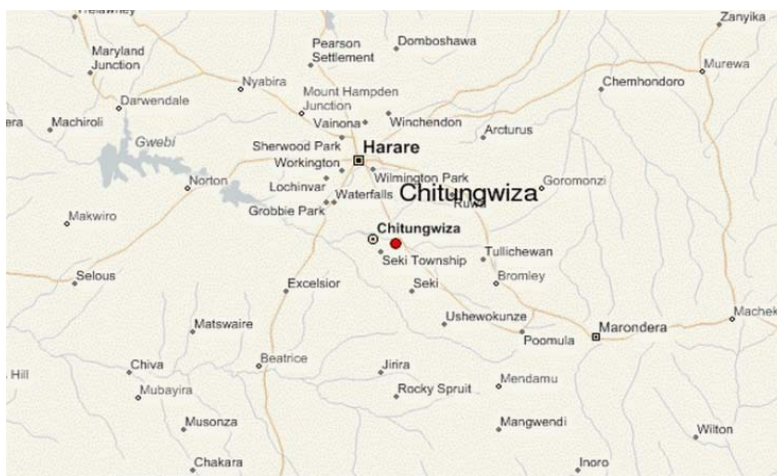


Figure 2.1: Showing Location of Chitungwiza

Some of the popular shopping centers in Chitungwiza include Chikwanha, PaGomba, Pazvido, PaJambanja, Chigovanyika, PaDaddy, unit j shopping Centre, Zengeza 2 shopping Centre.

b) Study Area

The study was conducted in Old St Mary's Chitungwiza, ward 5 lying on coordinates 17°59'51''S 31°2'35''E. It is bounded by other wards in Chitungwiza, namely in the North by Manyame park, on the North

West by Zengeza 2 and on the South Zengeza 5. It is characterised by a continental temperate climate and it has a rocky geology which is characterised by big granite rocks.

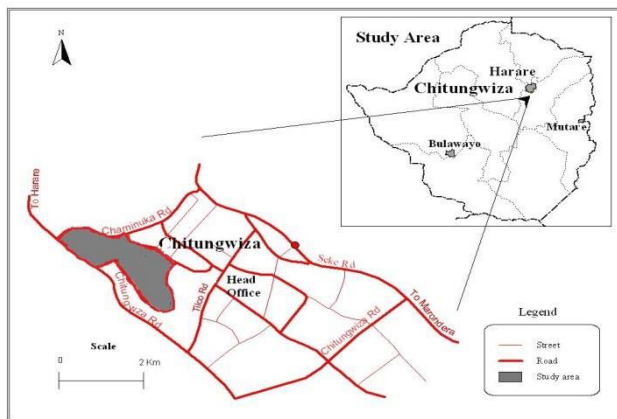


Figure 2.2: Study Area Map

c) Research Design

A cross sectional case study on the assessment of improper solid waste collection, handling and disposal practices among residents of Old St Mary's, Chitungwiza. The case study was appropriate for the researcher because it allowed an in depth study of aspects of the problem within a limited time scale. Hand administered questionnaires, interviews and observations were used for the study.[7] Defines research design as a deliberately planned arrangement of conditions for analysis and collection of data in a manner that aims to combine relevance to research purpose with the environmental procedure. The two common types of research design are the case study and the descriptive research and in this particular study the Case study method will be used. A descriptive case

study research design was used in order to achieve the research objectives. A descriptive case study research design helps in gaining adequate insight and an in-depth analysis of occupational noise at the organization. Due to the case study approach that was used the research was confined to the mentioned area of study.

This is a cross sectional research that will use both mixed research method methodology involving the use of both quantitative and qualitative research methods. Observational check list and structured interviews with the selected respondents will be employed. Experiments to assess the feasibility of utilizing soiled diapers in vegetable beds will also be conducted.

d) *Sampling Frame/Population*

The target population of the study are caregivers of infants and toddlers who are still using diapers and environmental health promoters. The study will be conducted in two residential areas of Chitungwiza town namely St Marys and Manyame Low Density. Twenty mothers with children below the age of two years will be interviewed from each of the above mentioned suburbs and they will be randomly selected.

e) *Method of Data Collection*

The study will also look at the municipal solid waste disposal site as it is the destination of disposal sites that were collected in the town. This study will triangulate a number of qualitative techniques in gathering data including interview guide and observation guide. The use of qualitative methods enable the study to have access to the perspectives of the people in sampled areas on their views and handling practices of disposable diapers. The use of qualitative techniques will enable the research observe the social life of women using diapers and where the diapers are being utilised. This will provide the study with a deeper appreciation of what is going on with regards the use of diapers.

i. *Questionnaires Surveys*

40 questionnaires were self-administered systematically selected households (target population) to collect adequate information to determine household that use disposable diapers and the method of disposal, to establish the amount of disposable diaper as a proportion of the total waste, assess the effectiveness of current strategies used in managing the disposal of diapers and assesses the environmental impacts of improper disposal of diapers. The questionnaires keep away from interviewer bias, guiding the areas that can impact the legitimacy and reliability of data collection. They comprised of closed type questions whereby answers to the questions were availed and open ended type questions which gave room for respondents to explain and describe their feelings about the issues requiring clarification. Open ended questions allowed the respondents to formulate their own answers. Closed ended questions entailed the respondents to choose answers from given options. The questionnaires are of critical importance in research since the research study can be swiftly done and data analysis can begin right away and they are a less costly way of reaching people. Questionnaires allowed responses to be gathered in a standardized way and in this case the questionnaires will be more objective.

This research adopted a mixed method approach and hence the nature of data collected and analysed was both qualitative and quantitative. A questionnaire with semi structured questions were used in the study because questionnaires allow the recording of both qualitative and quantitative data and this is

important for this study because it adopted a mixed method [5]. A questionnaire also promotes high validity and reliability than other instruments. The data collected through questionnaires is easily quantifiable especially through the use of software packages such as SPSS and Excel which were also utilised in this study. This instrument was used because it is flexible and allows in-depth understanding of issues under study and a greater exploration of the issues [5]. Furthermore questionnaires can be analysed more scientifically and objectively than other instruments. A questionnaire has its own shortfalls that include its inability to allow interaction or discussions during data collection [10].

ii. *Field Observations/ Reconnaissance*

This is non-verbal way of collecting data was used by the researcher. It emphasizes on discovering the meanings of the reactions exhibited by people towards actions of other people or change of situations. It allows the researcher to look at people's actions and situations' noting what is going on without asking questions. In the case of the research under study, observations assisted the researcher to view day to day disposable baby diaper waste management activities that are being undertaken by residents in Chitungwiza. The observations are aimed at allowing the study to obtain firsthand information through purposeful, systematic and selective way of watching the state of diaper handling and disposal at the illegal dump sites. The researcher will also participate in the municipal assessment of solid waste generation rates and waste characteristics, specifically focusing on data on soiled disposable diapers.

iii. *Experimental Method*

A piece of land to which measures approximately 1.5 m² was used to run the experimental gardening under the soil moisture conservation technique. Soil was excavated from an area which measures 1.5m x 1m up to a depth of 0.5m. The hydrated super absorbent polymer will come from used biodegradable diapers which are usually soaked in urine rich nitrates which are required for optimum plant growth. These were in the ratio of 1:1 by weight. Overland flow filled in the depression during rainy season such that water was harvested and stored for future use. Short maturity variety will be growth and growth performance measured. Soil moisture was determined weakly during the short maturity plant growing season using a soil tensiometer. A tensiometer measures soil water suction (negative pressure), which is usually expressed as tension. This suction is equivalent to the force or energy that a plant must exert to extract water from the soil. The instrument must be installed properly so that the porous tip is in good contact with the soil, ensuring that the soil-water suction is in equilibrium with the water suction in the tip. The suction force in the porous tip is transmitted through the

water column inside the tube and displayed as a tension reading on the vacuum gauge.

The researcher used two vegetable beds. The control and variable was set up as follows:

Control A: Include diapers and watered after every seven days. Moisture was measured on a daily basis. Plant growth was measured on a weekly basis.

Control B: No diapers included in the vegetable bed and watered after every seven days. Moisture was measured on a daily basis. Plant growth was measured on a weekly basis.

vi. *Materials*

- Watering cans
- Tape measure
- Used diapers
- Recording chart
- Rape seeds (*Brassica Napus L*)
- Tensiometer

f) *Data Presentation and Analysis*

The collected data has been presented in different forms through the use of tables, graphs and

figures. The data was then critically analysed through assessing trends, increases, decreases and consistencies. The data was also analysed using statistical tools such as SPSS Kersim 20 and Microsoft Excel.

III. RESULTS AND DISCUSSIONS

This section presents the findings of the study. Results shown in this chapter show the diaper waste handling practices in Chitungwiza, growth rate of *Brassica Napus. L* and the effectiveness of the moisture conservation technology. The results are presented in various forms such as tables, bar graphs and pie charts which can be easily interpreted and understood. The data was then critically analysed and interpreted.

a) *The Number of Diapers used Per Day.*

The responses to this question are shown in table 3.1. The responses to this question were gathered from all those who still have babies that are still using diapers within the targeted population of Chitungwiza.

Table 3.1: Daily Diaper Usage

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	>2	5	12.5	12.5
	2-5	33	82.5	95.0
	6-8	2	5.0	100.0
Total	40	100.0	100.0	

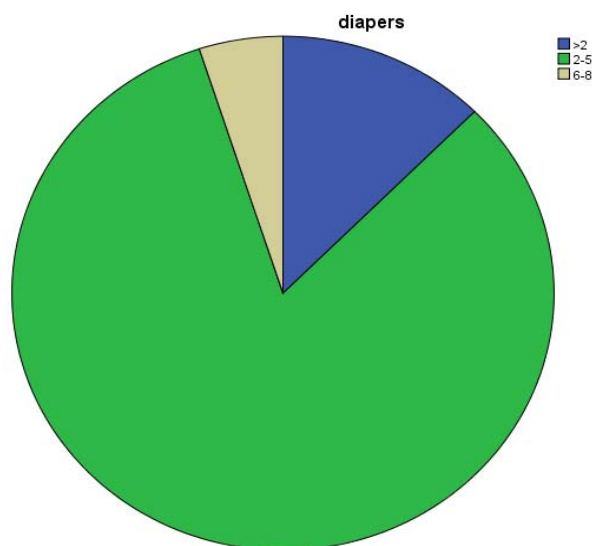


Figure 3.1: Showing the Number of Diapers used by Mothers Per Day

Table 3.1 and Fig 3.1 above show the total percentages of diapers used per day. Out of the total population surveyed, 12.5% of the sample uses less than 2 diapers per day. 82.5% uses 2-5 diapers per day

and only 5% uses a minimum of 6-8 diapers per day. The results show that the average usage of diapers per day is 2-5 diapers.

b) Age up to Which Diapers are Used

Table 3.2: Age

	Frequency	Percent	Valid Percent	Cumulative Percent
2	27	67.5	67.5	67.5
Valid 3	11	27.5	27.5	95.0
4	2	5.0	5.0	100.0
Total	40	100.0	100.0	

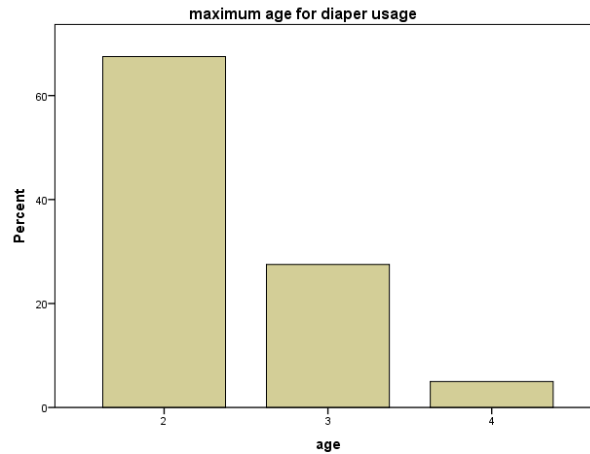


Fig 3.2: Variation of Diaper usage with Age Groups

Table 3.2 and Fig 3.2 shows the age group of children which uses diapers the most. The bar graph shows that 67.5% of the children that uses diapers the most are 2 years old followed by 27.5% which are 3 year old babies and the least being the 4 year old children with 5%.

Used Diapers Handling Practices

Table 3.3: Used diapers

	Frequency	Percent	Valid Percent	Cumulative Percent
Burn	9	22.5	22.5	22.5
Dumpsite	10	25.0	25.0	47.5
Valid Bin	8	20.0	20.0	67.5
Burry	13	32.5	32.5	100.0
Total	40	100.0	100.0	

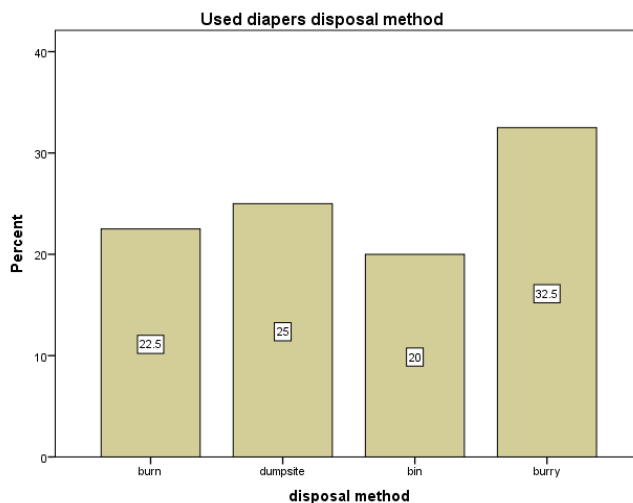


Fig 3.3: How Mothers Manage their used Diapers in Chitungwiza

Table 3.3 and Fig 3.3 show results on how mothers manage used diapers in Chitungwiza. The various methods used for disposal include Burning, Throwing diapers at illegal dumpsites, Waste bins and Burying them. The bar graph shows that 32.5% of the targeted population burry their soiled diapers. 25% of the population dispose of their diapers at illegal dumpsites. This was mainly attributed by poor municipality services which have led to open dumping. Out of the 40 respondents 22.5% burn the diapers, however, burning of diaper waste by residence is mainly attributed to ignorance and also irregular waste collection by the municipality. The open burning practices reduce the volumes of diaper waste but it also actually promotes health hazards to the public through inhalation of smoke and odour. Hazardous toxins like furan and dioxin are

also produced when there is incomplete combustion on diaper waste. Residents tend to use paraffin, methylated spirit and diesel as catalyst to burn diapers because it is difficult to burn in their wet condition with faeces. Therefore, burning of paraffin and other fuel increase the number of greenhouse gases in the atmosphere leading to global warming. Moreover, dioxin and furan are the deadliest toxins that can be produced when there is incomplete combustion. [4] Also commented that carbon monoxide and chlorine are the greenhouse gasses generated when disposable diapers are incinerated and open burning of refuse pose health risk of inhalation of smoke and odour. Ashes may be leached to the ground or dispersed by wind which results in respiratory problems and water contamination by toxics. Lastly 20% dispose the diapers in waste bins.

c) Why do you Prefer Diapers to Nappies

Table 3.4: Diapers vs Cloth Nappies

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Easy	22	55.0	55.0
	Affordable	7	17.5	72.5
	Saves water	11	27.5	100.0
	Total	40	100.0	100.0



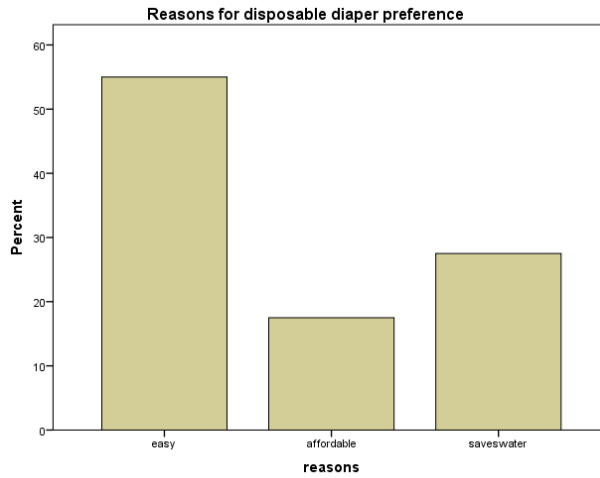


Fig 3.4: Showing Why Mothers Prefer using Disposable Diapers to Cloth Nappies

Table 3.4 and Fig 3.4 show results on why mothers prefer using diapers to nappies. 55% of the targeted population uses disposable diapers because they are easy to use. 27.5% suggest that they save water whilst 17.5% pointed out that disposable diapers are affordable. These results show that disposable diaper use is dominant in Chitungwiza as most women revealed that diapers are convenient in saving time than traditional reusable nappies which are difficult to handle

and require a lot of laundry. In actual fact cloth diapers are difficult to deal with as they require a lot of water and unavailability of water up to four days worsens the situation, power shortage also initiates women to use disposable diapers since cloth diaper require ironing before use. The research conducted by Mutowo (2015) established that 78% women are in use of disposable diapers and the reasons cited were convenience 70% and cost 30%.

d) What Can Be Done to Improve Diaper Waste Management?

Table 3.5: Waste Management

	Frequency	Percent	Valid Percent	Cumulative Percent
Burn	14	35.0	35.0	35.0
Burry	5	12.5	12.5	47.5
Valid Gardening	7	17.5	17.5	65.0
Education/awareness	12	30.0	30.0	95.0
Recycling	2	5.0	5.0	100.0
Total	40	100.0	100.0	



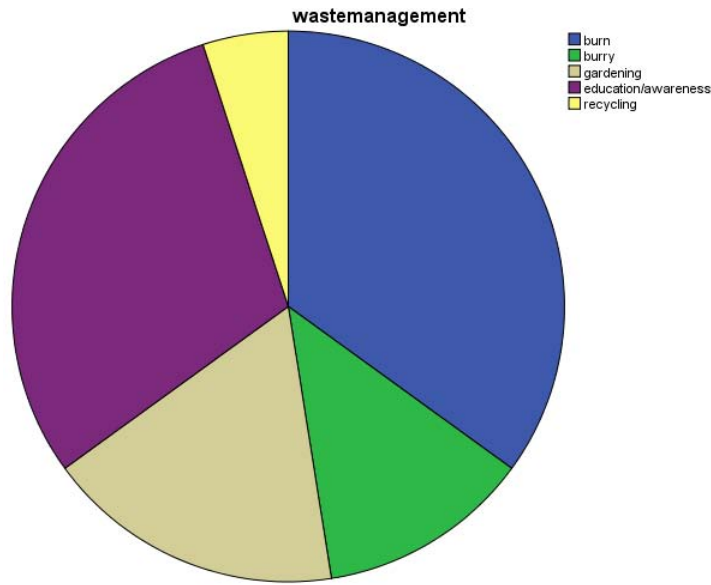


Fig 3.5: Showing How Waste Management Can be Improved

Table 3.5 and Fig 3.5 show the responses on how waste management can be improved in Chitungwiza. 35% suggests that diapers should be burned, 30% suggests that there should be education and awareness on how to properly dispose these diapers. This is supported by the only sure method to get people to change their habits is through education and

creating awareness. 17.5% of the targeted population suggests that soiled diapers should be used for small scale gardening. Out of the 40 respondents 12.5% suggests that soiled diapers should be buried whilst 5% suggests that they should be recycled in order to improve waste management practices in Chitungwiza.

e) *The Growth Rates of Brassica Napus L under Diaper Waste Moisture Conservation Technology and the Conventional Farming Methods*

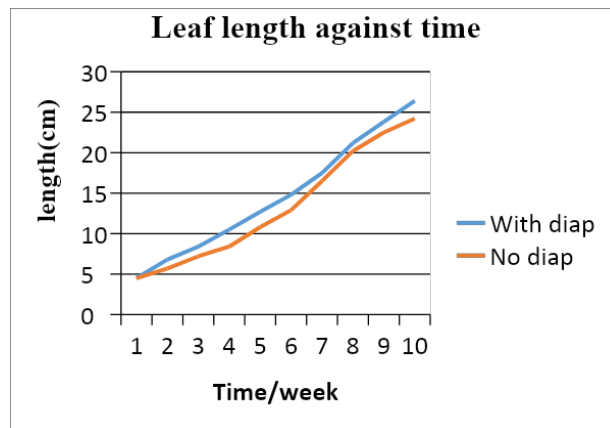


Fig 3.6: Showing the Growth of Leaf Length Against Time

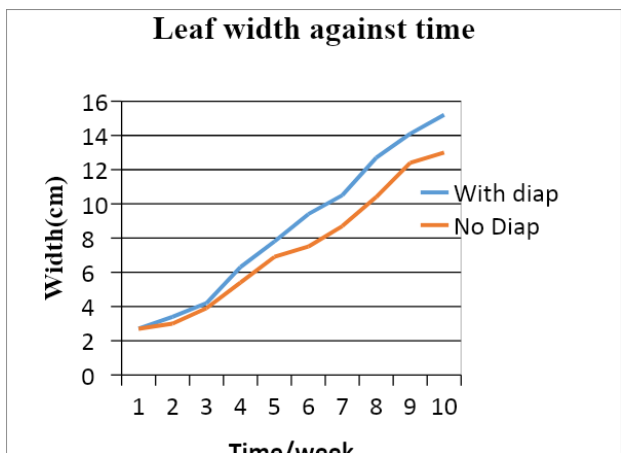


Fig 3.7: Showing the Growth of Leaf Width Against Time

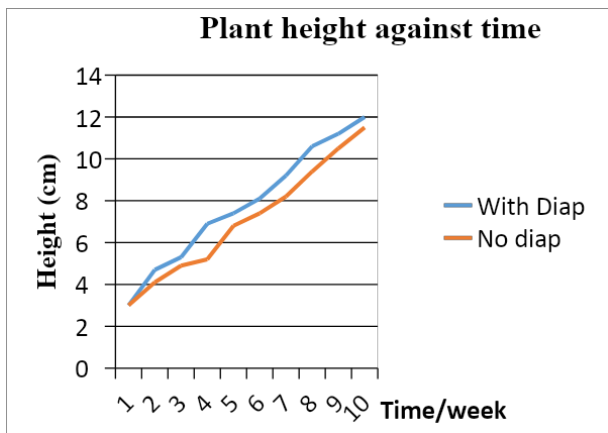


Fig 3.8: Showing the Growth of Plant Height Against Time

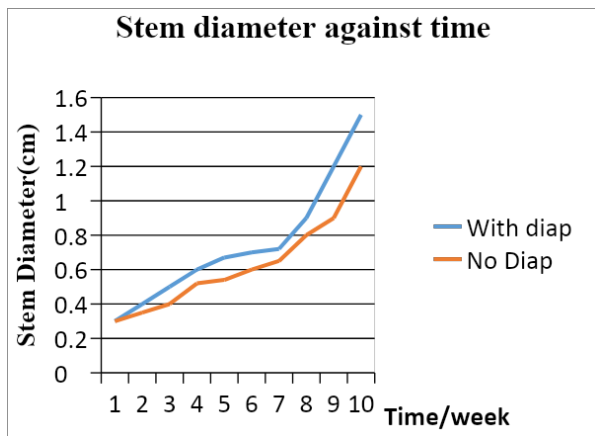


Fig 3.9: Showing the Growth of the Stem Diameter Against Time

The above diagrams show the growth rate of *Brassica Napus L*. The results were extracted from two different vegetable beds thus one with diapers and the other one without diapers. The growth measurements were taken from the growth of the stem diameter, leaf length, leaf width and plant height. The above results therefore show that the vegetables grow on a faster rate under the diaper waste moisture conservation technology.

f) *The Effectiveness of Diaper Waste-Moisture Conservation Technology In Moisture Conservation*

The results shown in Fig 3.10 show the measurements of moisture taken from Control A and Control B.

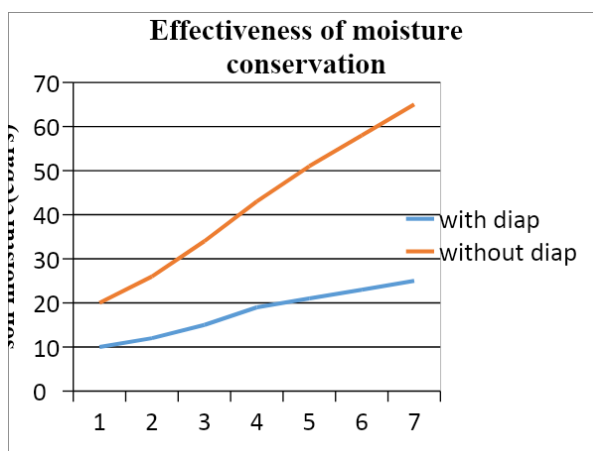


Fig 3.10: Showing Moisture Conservation

The measurements were taken from a depth of 10cm-15cm. According to the graph in Fig 3.10, 10cb (centibars) corresponds to the saturation for loam soils which were used in this study. As a rule of thumb the tensiometer is installed in the plant row, where roots are concentrated, and taking up the most water. The operation of the tensiometer represents suction force needed to draw water from the soil is such that the higher the measurement the less the moisture. The tensiometer used measures from 0-85 cb with 0 indicating saturation point and 85 showing dry soil conditions. Around 60cb the crops begin to wilt. The moisture content is inversely proportional to the tensiometer centibars reading. The trend on the graph therefore shows that under diaper treated soils moisture decreased by a factor of 15 cb whilst under the control it decreased by a factor of 45 cb. This result shows less moisture loss rate under the treatment than the control. This demonstrates capacity of diaper hydrogels to conserve water. The results clearly show that diapers are highly effective in conserving moisture when compared to the control of the experiment.

IV. CONCLUSION AND RECOMMENDATIONS

a) Conclusion

From the findings of the study it can be concluded that there is improper diaper waste handling in the study area. The most common diaper waste disposal methods used are illegal dumping, burying and dumping. This cause for concern and an environmental health risk is looming. Majority of babies consume between 2-5 diapers per day. It was also established that diaper waste generation is most to babies 2 years and below and the conclusion is that as child grow diaper consumption decreases. The major reason why disposable diapers are preferred to cloth diapers is that disposable diapers are easy to use. It can also be concluded that there is environmental illiteracy calling for the need for environmental awareness and educational programs as indicted by the public misconception that

burning of diaper waste could improve waste management yet this causes air pollution. The comparison between the growth of *Brassica Napus L* under the moisture conservation technology and the control showed that the technology is effective in improving plant growth. It can also be concluded that the technology is an effective moisture conservation technique as evidenced by the less moisture loss rate under the treatment than the control after irrigation. This shows that irrigation scheduling or irrigation frequency can be reduced when the moisture conservation technology is applied due to the water holding capacity of diapers.

b) Recommendations

- To use the diaper waste moisture conservation technology in small scale farming
- Marketers to insert disposable plastic papers inside the diapers,
- Regular refuse collection,
- Health promotion awareness on proper disposal of diapers
- Manufacturers to include information leaflets in diapers packs on proper disposal of disposal diapers
- To keep abreast with current trends in waste management, the local authorities should invest in resources to promote proper disposal of refuse.
- Diaper waste disposal awareness campaigns should be carried out in tandem with Family Health Care Services at Clinics and social gathering so that maximum numbers of mothers are reached.
- Communities to be empowered through Community Based Organization to manage their own refuse instead of relying on the local authorities, who are facing financial constraints.
- Solid waste management authorities should invest more effort in upgrading waste collection capacity and improve disposal mechanism which in turn shall help to reduce the environmental burden and to treat hazardous wastes like soiled diapers

economically and eco-friendly through developing community based composting facilities for disposable diapers and others at least per each sub city.

- As disposable diapers are the choices of almost all diaper users in the current situation, the demand is expected to increase in the future. So, government should support and encourage importing companies in tax related issues so as to import biodegradable and eco-friendly diapers.

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Replacement of Fish Meal with Soybean Meal on Growth Performance of Monosex Nile Tilapia (*Oreochromis Niloticus*) Fish Diet

By Sonu Kandel, Mina Mahatara, Ram Bhajan Mandal & Jay Dev Bista
Tribhuvan University

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Keywords: growth performance, fish meal, soybean meal.

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Replacement of Fish Meal with Soybean Meal on Growth Performance of Monosex Nile Tilapia (*Oreochromis Niloticus*) Fish Diet

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Abstract- Fish meal (FM) has excellent protein and lipid profile. However, FM is losing its acceptability and substituted with plant protein due to high price, high demand, and sustainability issues in global aquaculture production. In this study, experimental diets were prepared by substituting FM with soybean meal (SM) to assess the effects on growth performance. The study was carried out by rearing 240 *Oreochromis niloticus* fries (0.1g) in 12 hapa in earthen pond for 65 days in Kathar, Chitwan. The fishes were fed with four isonitrogenous (27% protein) and isocaloric experimental diets viz. Treatment T₁ (100% fish meal protein), Treatment T₂ (50% fishmeal protein and 50% soybean meal protein), Treatment T₃ (25% fishmeal protein and 75% soybean meal protein) and Treatment T₄ (100% soybean meal protein). Among the treatments the weight gain, mean harvest weight, specific growth rate was obtained with no significant difference (p>0.05) was observed between treatment T₁, T₂ and T₃ but shows statistically significance difference with treatment T₄. Treatment T₃ (1.35) have higher B: C ratio than other treatment implies to economical farming composition. All water quality parameters like temperature, dissolved oxygen, pH, turbidity and ammonia etc. measured during the experimental period were found at the desired level. So, the study concludes that fish meal protein can be replaced upto 75% by soybean meal protein in the diet of *O. niloticus* without affecting the growth performance.

Keywords: growth performance, fish meal, soybean meal.

I. INTRODUCTION

Feed are highest cost occupied material in fish farming. Fish meal constitutes the major protein source used in commercial feeds. Fish meal has traditionally been used as the main feed ingredient in preparation of aqua feeds, due to high protein content and balanced amino acids profile (Mahmoud *et al.*, 2014). Because of its recent sparseness in global production, coupled with increased demand and competition for its use in livestock and poultry feeds, its prices have become unaffordable (Poudel *et al.*, 2020). As fishmeal is a scarce source, sole used of fish meal in

aquaculture feed can lead to scarcity. So, for the sustainability in aquaculture feed system, alternative plant by product can be used as protein source. Past researches such as Al-kenway, Naggar and Zead (2008) and Shiau *et al.* (1990) have suggested to use plant protein sources to partially or completely replaced fish meal without reducing the growth performance on Tilapia (Agbo *et al.*, 2011).

Tilapia (*Oreochromis niloticus*) is important aquaculture species in South Asia and is consumed regularly by locals when available (Shrestha *et al.*, 2018). Tilapia belongs to Cichlidae family, it is warm water fish species. Because of its fast growth, tolerance to wide range of environmental condition, ready market, resistance to disease and stress, admissible to artificial feed, and ability to reproduce in captivity and short regeneration time all those aspects make it highly embrace by farmer in their farm.

Monosex tilapia *O. niloticus* does not breed/multiply, which makes it easy for fish farmers to avoid uncontrolled breeding in their farms.

The shortage of the fishmeal resource has posed to develop some substitute protein sources to diminish feed cost and meet the protein necessitate of fish as well. Plant-based protein diet can be alternative to fishmeal as they are locally and readily available and cheaper in cost. Since aquaculture sector uses 2–5 times more fishmeal to feed farmed species than what is supplied by the farmed product, study can prove beneficial to formulate fish diet to reduce fishmeal reliance and substitute it with widely available soyabean meal (Ogunji, 2004). However, deficiency or imbalance of some essential amino acids, as well as the existence of anti-nutritional factors in soyabean (such as trypsin inhibitors, phytic acid and tannins) can have pernicious effects on fish growth performance, intestinal health and immune response (Tadele, 2015). Tilapia are omnivorous fish feeding on wide range of natural food available in pond, and also aggressively feed on formulated feed. Fish are fed with 24-26% CP feed @ 2% body weight daily on monoculture system (Abdel-Aziz *et al.*, 2021). So, feed occupies major portion in cost of production (COP). Poor budgetary plan, not proper management strategies and lack of quality fish feed are major problem of Nepalese fish sector (Karki, 2016).

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Therefore, the study can prove to be beneficial to gain understanding of proportion of soybean meal that can be integrated in fishmeal-based diet without reducing growth and development of fish. The study also provides insight on economic benefit of the plant-based feed.

II. MATERIALS AND METHODS

a) Location

The experiment was conducted at Centre for Aquaculture-Agriculture Research and Production Pvt. Ltd. (CAARP), Khairahani-10, Kathar, Chitwan for 65 days (from July 2021 to Sept 2021). The site is located 30 km east from Narayanghat. The latitude is 27.529° N and longitude is 83.3542° E.

The center has necessary infrastructure as large sized earthen pond and equipment's as breeding hapa, aerators, feeders etc. Fry was raised within the center which was economical and also ensure only healthy fries were used for research. Feed material required was easily available and economical in Chitwan district as it is one of the large producers of fisheries.

b) Experimental Design

The experiment was conducted in 12 hapa of 1m×1m×1m with 20 fries in each hapa. The experiment was conducted in completely randomized design (CRD) having four treatments and three replications.

c) Research Set up

Necessary facilities like inlet, outlet, screening mesh, outlet valve etc. were cleaned and managed in

pond and water level maintained as per requirement. In pond, water depth was maintained at 30cm.

d) Experimental Fish

Already prepared monosex tilapia fry on an average 0.1±0.01 gram from hatchery was used for the research.

e) Experimental Diet Preparation

Four different types of experimental diets were formulated for feeding to tilapia fry during experiment. Shrimp fish were crushed into fine powered. Step in soybean meal preparation:

1. At first, soybean was cleaned by removing waste material present in it.
2. Soybean was roasted (heat treatment) to remove antinutritional factor (trypsin inhibitor, phytase inhibitor) present in it.
3. Finally, small size fine powder was made by crushing in the mincer.

While preparing the diets, dry ingredients of maize flour, rice flour and mustard oil cake was first grounded to a small fine size and mixed thoroughly according to calculated percent of each ingredient as shown in the table 1 to make required crude percent for each treatment. Four diets with same levels of dietary protein 27% for Nile tilapia fry were formulated. Composition of experimental diet is shown in Table 1.

f) Packaging and Storage of Feed

Prepared experimental feeds were packed in air tight plastic bags of capacity of 1 kg and stored in a refrigerator at 4°C.

Table 1: Ingredients and Composition (%) of the Experimental Diets

Ingredients	100% FM (T1)	50% FM+ 50% SM (T2)	25% FM +75% SM (T3)	100% SM (T4)
Shrimp meal	45	30	20	0
Soya full roasted	0	30	50	65
Maize flour	15	15	12.5	2.5
Rice bran	15	15	12.5	2.5
Mustard oilcake	25	10	5	30

g) Hapa Preparation

Hapa was set at 30 cm above water surface. Water was enriched with organic and chemical fertilizer. Each hapa was set at distance of 15 cm from each other. Bamboo was used for staking and support. Stone was placed at the edge of hapa for the settlement of hapa.

h) Feeding

In 1st week = Feeding rate 20% of body weight and frequency was 5 times (6 AM, 9 AM, 12 noon, 3 PM, 6 PM)

2nd week= Feeding rate 15% of body weight and frequency 4 times (6 AM, 10 AM, 2 PM and 6 PM)

3rd week and then onwards= Feeding rate 10% of body weight and frequency 3 times (6 AM, 2 PM and 6 PM).

i) Stocking

Altogether 240 tilapia fries of 0.1g size were procured from CAARP for stocking in hapa. Fries were stocked at a density of 20fries/1m³ early in the morning at 7.00 am.

j) Sampling

Sampling was done fortnightly. Random sampling of 10% population of stocked fry was done from each hapa and weighted (Digital pocket weighing machine) and growth measurements were recorded and required measurement was performed. Behavior of

tilapia was regularly observed especially after feeding in the morning and in the evening to determine their conditions such as movement, infection, colorations and diseases. Sampling was continued until harvest.

k) *Final Harvesting*

Final harvesting of tilapia was done by draining each hapa completely on Oct 6, 2021. Weight of 20% population of stocked fry were measured using digital pocket weighing machine. Fish were counted and, their batch weight was recorded.

l) *Proximate Analysis of Experimental Diet*

Quadrant sampling of prepared diets was done to draw representatives for proximate analysis. Proximate analysis of each experimental diet was done at National Animal Nutrition Research Centre, Khumaltar, Lalitpur. Proximate composition (dry matter, crude fiber, crude protein, crude fat, total ash, gross energy cal/g) of four treatment diet was calculated.

m) *Water Quality Analysis*

Temperature, pH, and Dissolved oxygen (DO) were recorded in daily basis (6 am, 2 pm, 6 pm) in pond. Temperature and dissolve oxygen were measured by using dissolve oxygen meter (Hanna HI 9147 DO meter) and pH was measured by Hanna HI 98128. While ammonia, were measured fortnightly by using instrument called Hach Ammonia test kit of pond between 7:00 to 7:30 am. Five ml sample in the vial with the help of 5 ml syringe was taken and 1 drop Ammonia Reagent I in the Vial sample was added and shake. Then 3 drops of Ammonia Reagent II were added and finally the observed color was immediately compared with Ammonia color chart. Turbidity was measured fortnightly by Secchi disk.

n) *Economic Analysis*

Economic analysis was conducted to determine economic returns of the four treatments tested during the experiments. The economic analysis was based on

the farm gate price for the harvested fish and current local market prices for the all-other inputs. The benefit cost ratios of the different treatments were calculated by using following formula;

$$\text{Total cost} = \sum \text{Cost of feeds} + \text{labor cost}$$

$$\text{Labor cost} = \text{Hapa preparation and installment}$$

$$\text{Total Income} = \text{Total number of monosex fingerlings production} \times \text{Price of monosex fingerlings (NRs/individuals)}$$

$$\text{B: C ratio} = (\text{Total Income}) / (\text{Total Cost})$$

The economic analysis was mainly based on farm gate price for the stocked and harvested fish and current local market prices for all other inputs in Nepal.

o) *Statistical Analysis*

The data was collected during the course of time and statistical analysis of data was carried out with Gen-Stat 15th edition. Effect of treatment was carried out using one-way analysis of variance (ANOVA), followed by a post hoc Duncan's multiple range tests. Differences were considered significant at the 95% confidence level ($p < 0.05$). All means were given with \pm standard error (S.E.).

III. RESULTS AND DISCUSSION

a) *Proximate Analysis of Experimental Diet*

Proximate analysis of experimental diet is shown in Table 3. Fresh Dry matter percentage was highest in 100% Soybean meal-based diet followed by 75% Soybean meal+ 25% Fishmeal, 50% Fishmeal + 50% Soybean meal and 100% Fishmeal. Fish meal-based diet had the highest crude protein (27.07%) than the other treatments. Highest ash percentage and crude protein was found in 100% Fishmeal. Similarly, Energy was highest in 75% Soybean meal followed by other treatments.

Table 2: Proximate Analysis of Experimental Diets

Constituents	Fresh Dry Matter (%)	Crude Protein (%)	Ash (%)	Crude fiber (%)	Energy (cal/g)
T ₁	88.55	27.07	14.46	7.44	30961.9
T ₂	88.64	26.9	10.04	5.57	40445.7
T ₃	90.39	26.3	7.43	7.26	42195.3
T ₄	91.29	26.3	4.89	6.72	40856.2

T₁= control diet, Diet-1; T₂= 50% replacement of fishmeal by soybean meal (SBM), Diet-2; T₃= 75% replacement of fishmeal by soybean meal, Diet-3 and T₄= 100% replacement of fishmeal by soybean meal, Diet-4.

b) *Growth Parameter*

A mean weight of about 0.1g size fry were stocked at the beginning of the experiment in all treatments which were not significantly different ($p > 0.05$) with each other. The analysis of variance indicated that there was no significant difference in weight gain among T₁, T₂, T₃ and lowest was found in

T₄. Up to 75% replacement, methionine is supplied by fishmeal. Replacement by soybean meal (100%) may have drastically reduced methionine content in diet. Insufficient dietary methionine reduced the growth performance and protein utilization (Sveier *et al.*, 2001). Low growth in complete replaced fishmeal diet with soybean meal could also due to increase in carbohydrate component (Chou *et al.*, 2004).

There was no significantly different in specific growth rate of Tilapia between T₁, T₂, and T₃ and lower specific growth rate was obtained in T₄. The data are also supported by other authors. Sharda *et al.* (2017) have also found significant difference on specific growth rate when fishmeal was completely replaced by soybean on Tilapia fish. Studies shows that replaced proportions of feed can be used for tilapia production.

Similarly, there was no significant difference in survival rate ($p > 0.05$) with each other. Jahan *et al.*

(2007) reported that 75% fishmeal protein in the diet of Tilapia fingerlings could be replaced by defatted soybean meal without any significant reduction in growth. Davies *et al.* (1989) suggested that commercial soybean meal could be replaced up to 75% of fishmeal protein in diet of tilapia with no significant reduction of average final weight. Shiau *et al.* (1990) also observed that defatted or full fat soybean meal could be used to replace 30 % fishmeal protein in a diet for tilapia (Jahan *et al.*, 2007).

Table 3: Mean Value of Growth Parameters of Nile Tilapia Fry during the Experimental Period of 65 Days

Treatments	Initial weight (g)	Weight gain (g)	Survival	Survival (%)	Specific growth rate
T ₁	0.1±0.00 ^a	12.16±1.52 ^a	17.33±0.88 ^a	86.67±4.41 ^a	7.37±0.18 ^a
T ₂	0.1±0.00 ^a	11.54±1.90 ^a	16.00±1.00 ^a	80.00±5.00 ^a	7.28±0.24 ^a
T ₃	0.01±0.00 ^a	9.78±1.83 ^a	17.67±1.45 ^a	88.33±7.26 ^a	7.01±0.28 ^a
T ₄	0.1±0.00 ^a	5.1±0.74 ^b	17.33±1.20 ^a	86.67±6.00 ^a	6.05±0.21 ^b
F-test		*			*

T₁= control diet, Diet-1; T₂= 50% replacement of Fishmeal by Soybean meal, Diet-2; T₃= 75% replacement of Fishmeal by Soybean meal, Diet-3 and T₄= 100 % replacement of Fishmeal by Soybean meal, Diet-4

Mean value with a different superscript letter within same row are significantly different at $p < 0.05$

* Indicates significant at 5% level of significance

c) *FCR, PER, Feed efficiency, Condition Factor*

The result show that analysis of variance indicated no significant difference on FCR, Feed efficiency and condition factor among the different treatment means (Table 6).

The data also supported by other articles. Yanti *et al.* (2019) in his research in Lates Calcarifer shows that feed conversion ratio and feed efficiency were not significantly different ($p > 0.05$) between the treatment.

In the case of protein efficiency ratio, the lowest PER was seen in 100% SBM (T₄) and highest was seen in 50% FM+50% SBM (T₂) which was significantly different ($p < 0.05$) with each other. Protease inhibitors and Phytic acid in soyabean reduce protein digestibility by inhibiting protease activity and destroying the structure of the intestinal mucosa, leading to the low availability of dietary protein (Kuba *et al.*, 2005; Francis *et al.*, 2001)

Table 2: Mean Value of FCR, PER, FE and CF of Nile Tilapia Fish during 65 Days

Treatments	Food Conversion Ratio (FCR)	Protein Efficiency Ratio (PER)	Feed Efficiency	Condition Factor (CF)
T ₁	0.43±0.03 ^a	0.42±0.05 ^{ab}	0.71±0.08 ^a	1.50±0.23 ^a
T ₂	0.37±0.11 ^a	0.44±0.07 ^a	0.64±0.10 ^a	1.28±0.24 ^a
T ₃	0.32±0.12 ^a	0.37±0.06 ^{ab}	0.54±0.10 ^a	1.09±0.17 ^a
T ₄	0.30±0.02 ^a	0.19±0.02 ^b	0.64±0.09 ^a	1.78±0.04 ^a
F-test		*		

T₁= control diet, Diet-1; T₂= 50% replacement of Fishmeal by Soybean meal, Diet-2; T₃= 75% replacement of Fishmeal by Soybean meal, Diet-3 and T₄= 100 % replacement of Fishmeal by Soybean meal, Diet-4

Mean value with a different superscript letter within same row are significantly different at $p < 0.05$

* Indicates significant at 5% level of significance

d) *Water Quality*

Mean temperature, dissolved oxygen of the water was measured daily in morning, noon and afternoon, pH, turbidity and ammonia were measured fortnightly are shown in the following figures:

the gastrointestinal tract, and store excess energy (Makori *et al.*, 2017).

e) *Temperature*

Temperature play role in fish metabolic rate and thus their energy balance and behavior, including locomotor and feeding behavior. Temperature strengths the ability of the fish to obtain food, and how they process food through digestion, absorb nutrients within

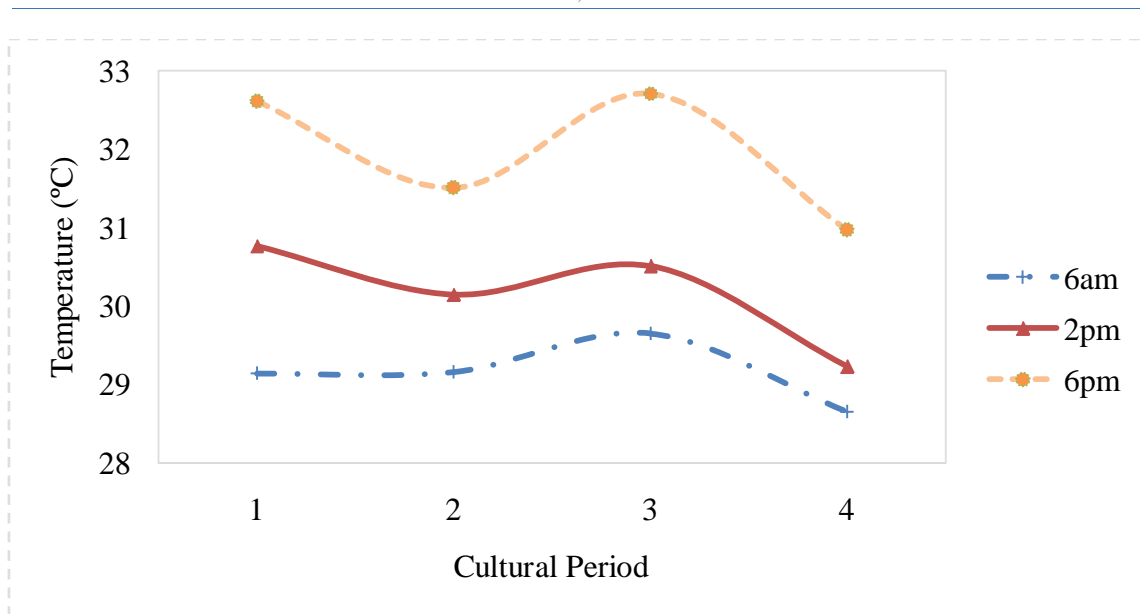


Figure 1: Fortnightly Mean Temperature (°C) during Experimental Period

Figure 1 shows that mean temperature at morning, afternoon and evening in pond which was in desirable range. Average temperature requirement for tilapia culture is in range of 20- 32°C. Makori *et al.* (2017) give a range of between 20 and 35 °C as ideal for tilapia culture.

f) Dissolved Oxygen

Dissolved oxygen (DO) is a critical environmental indicator in aquaculture. Depleted DO is the leading cause of fish kills, and fish farmers know that low-oxygen conditions are their worst enemy.

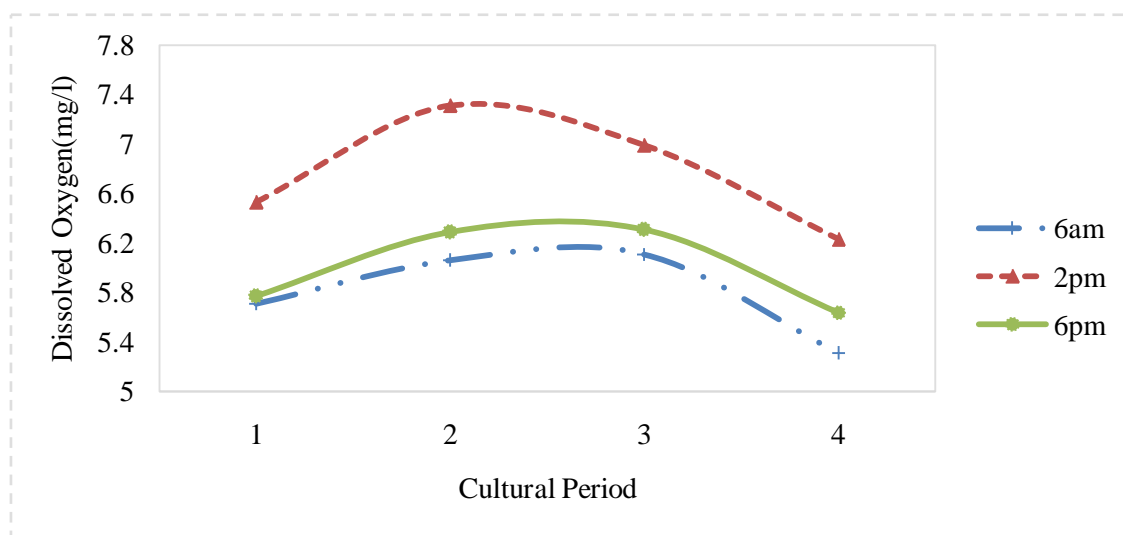


Figure 2: Fortnightly Dissolved Oxygen of Pond during Experimental Period

Figure 2 shows that dissolved oxygen level was at desirable range throughout the culture period. Makori *et al.* (2017) in his research found that tilapia can grow best in level of 5mg/l. Generally, fish growth and yields are greater in ponds with higher DO concentration (Bartholomew, 2010).

pH

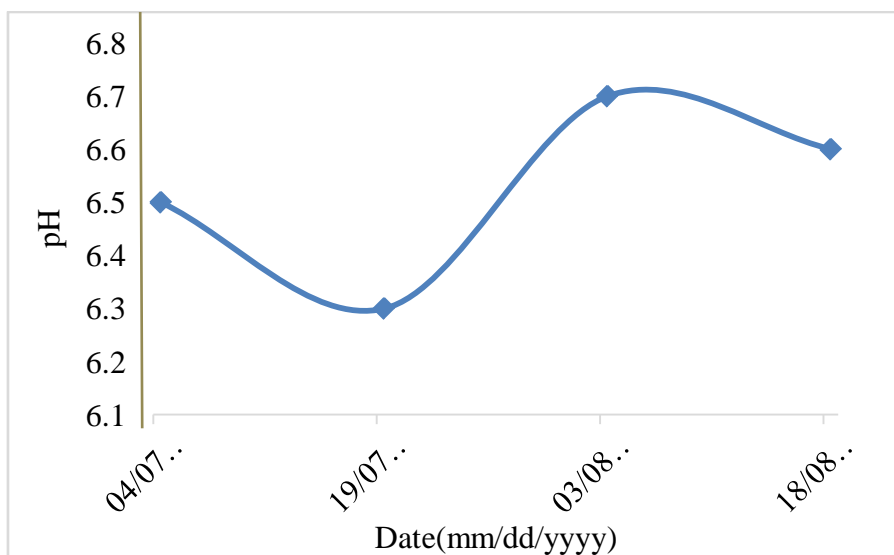


Figure 3: Fortnightly Mean pH of Pond during Experimental Period

Figure 3 shows that pH range was favorable during the entire research period. Bryan *et al.* (2011) concurs that most fish would do better in ponds with a *Ammonia*

pH near 7.0 and that ponds with a pH less than 6.0 may result in stunting or reduced fish production.

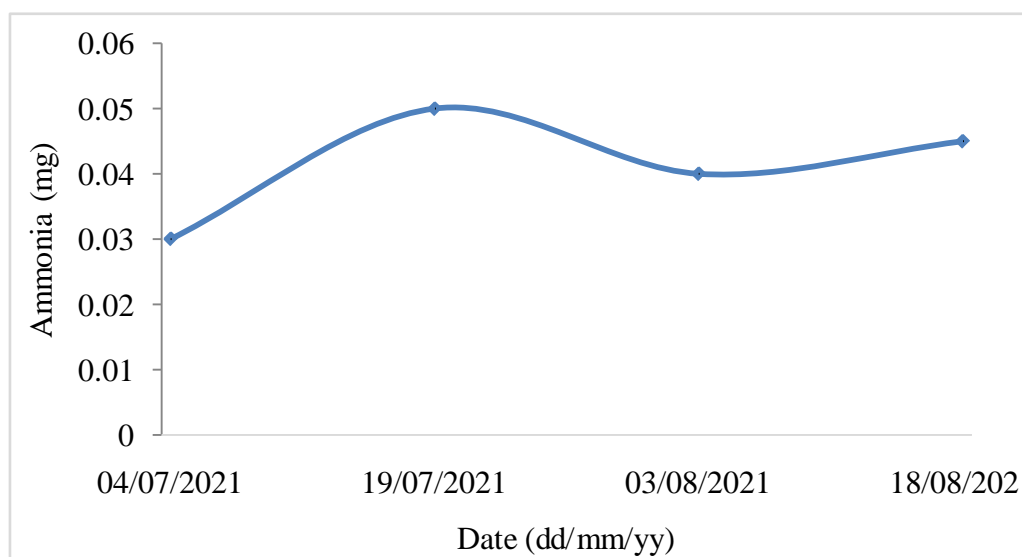


Figure 4: Fortnightly Ammonia of Pond during Experimental Period

Figure 4 shows that ammonia level was in desirable range during the research period. Tumwesigye *et al.* (2022) The concentration of Ammonia was higher than the 0.6 mg/L reported to kill fish at short exposure and cause damage to gills and kidney cells on chronic exposure. The high concentration of Ammonia in pond could be associated with over-feeding of the fish, irregular de-silting of ponds, and nutrient enrichment from agricultural fields (runoff).

Turbidity

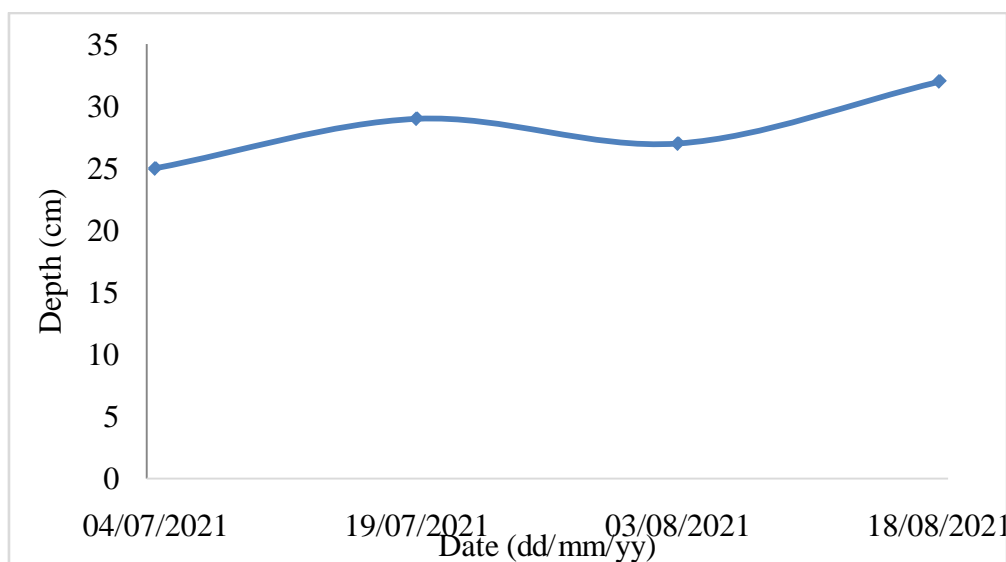


Figure 5: Fortnightly Turbidity Level of Water in Experimental Period

Figure 5 shows the turbidity level of water during experimental period. The number of feeding attempts made by tilapia was not affected by turbidity, suggesting that its propensity to initiate feeding may be higher in turbid water while its overall foraging success may be unaffected (Wing et al., 2021).

g) Economic Analysis

Analysis of variance on Benefit cost ratio indicated significant difference ($p < 0.05$) among the different treatment means. The higher B: C ratio (1.350 ± 0.11) of feed was recorded in T3 followed by T1

and T2. Along with it, relatively lower B: C ratio was found in treatment four. Poot-López and Gasca-Leyva (2009) when fed meal by partially substituting meal with *O. niloticus* with tree spinach (*Cnidoscolus chayamansa*) also found substantial reduction in cost of management and operating costs without any negative effect on growth of fish. Subedi et al. (2019) states that in tropical fish production food constitute major expense, so replacement of fishmeal by soyabean based meal would minimize the cost of production by optimizing the cost benefit ratio while scaling up the production.

Table 3: Economic Analysis of Benefit-Cost Ratio of Different Treatments at the End of the Experiment

Treatment	B: C Ratio
T1	1.323 ± 0.06^b
T2	1.31 ± 0.09^b
T3	1.350 ± 0.11^a
T4	1.30 ± 0.07^c

IV. CONCLUSION

The findings of the present study concluded that there was no significant difference in weight gain by replacing fish meal up to 75% and lowest weight gain was obtained by 100 % fish meal replacement. The total feed cost was minimized by replacing soybean meal in fish meal diet. It can be concluded that fish meal can be replaced upto 75% soybean meal in the diets without decreasing the growth performance and survivability at low cost. Soybean grain should be roasted and dehulled before feeding to inactivate the negative effect of different phytoestrogen activity present in it.

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Conflicts of Interest

There are no conflicts of interest.

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FELLOW OF SCIENCE FRONTIER RESEARCH COUNCIL is the most prestigious membership of Global Journals. It is an award and membership granted to individuals that the Open Association of Research Society judges to have made a 'substantial contribution to the improvement of computer science, technology, and electronics engineering.

The primary objective is to recognize the leaders in research and scientific fields of the current era with a global perspective and to create a channel between them and other researchers for better exposure and knowledge sharing. Members are most eminent scientists, engineers, and technologists from all across the world. Fellows are elected for life through a peer review process on the basis of excellence in the respective domain. There is no limit on the number of new nominations made in any year. Each year, the Open Association of Research Society elect up to 12 new Fellow Members.



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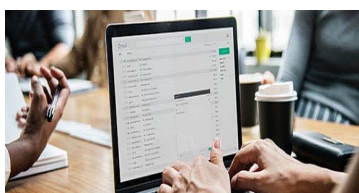


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<p>\$4800 lifetime designation</p> <hr/> <p>Certificate, LoR and Momento 2 discounted publishing/year Gradation of Research 10 research contacts/day 1 GB Cloud Storage GJ Community Access</p>	<p>\$6800 lifetime designation</p> <hr/> <p>Certificate, LoR and Momento Unlimited discounted publishing/year Gradation of Research Unlimited research contacts/day 5 GB Cloud Storage Online Presense Assistance GJ Community Access</p>	<p>\$12500.00 organizational</p> <hr/> <p>Certificates, LoRs and Momentos Unlimited free publishing/year Gradation of Research Unlimited research contacts/day Unlimited Cloud Storage Online Presense Assistance GJ Community Access</p>	<p>APC per article</p> <hr/> <p>GJ Community Access</p>



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Authors should submit their complete paper/article, including text illustrations, graphics, conclusions, artwork, and tables. Authors who are not able to submit manuscript using the form above can email the manuscript department at submit@globaljournals.org or get in touch with chiefeditor@globaljournals.org if they wish to send the abstract before submission.

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Authors must ensure the information provided during the submission of a paper is authentic. Please go through the following checklist before submitting:

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2. Authors must accept the privacy policy, terms, and conditions of Global Journals.
3. Ensure corresponding author's email address and postal address are accurate and reachable.
4. Manuscript to be submitted must include keywords, an abstract, a paper title, co-author(s) names and details (email address, name, phone number, and institution), figures and illustrations in vector format including appropriate captions, tables, including titles and footnotes, a conclusion, results, acknowledgments and references.
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Plagiarized content will not be considered for publication. We reserve the right to inform authors' institutions about plagiarism detected either before or after publication. If plagiarism is identified, we will follow COPE guidelines:

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- Findings
- Writings
- Diagrams
- Graphs
- Illustrations
- Lectures



- Printed material
- Graphic representations
- Computer programs
- Electronic material
- Any other original work

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2. Drafting the paper and revising it critically regarding important academic content.
3. Final approval of the version of the paper to be published.

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The corresponding author should mention the name and complete details of all co-authors during submission and in manuscript. We support addition, rearrangement, manipulation, and deletions in authors list till the early view publication of the journal. We expect that corresponding author will notify all co-authors of submission. We follow COPE guidelines for changes in authorship.

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Unless specified in the notification, the Editorial Board's decision on publication of the paper is final and cannot be appealed before making the major change in the manuscript.

Acknowledgments

Contributors to the research other than authors credited should be mentioned in Acknowledgments. The source of funding for the research can be included. Suppliers of resources may be mentioned along with their addresses.

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Authors can submit papers and articles in an acceptable file format: MS Word (doc, docx), LaTeX (.tex, .zip or .rar including all of your files), Adobe PDF (.pdf), rich text format (.rtf), simple text document (.txt), Open Document Text (.odt), and Apple Pages (.pages). Our professional layout editors will format the entire paper according to our official guidelines. This is one of the highlights of publishing with Global Journals—authors should not be concerned about the formatting of their paper. Global Journals accepts articles and manuscripts in every major language, be it Spanish, Chinese, Japanese, Portuguese, Russian, French, German, Dutch, Italian, Greek, or any other national language, but the title, subtitle, and abstract should be in English. This will facilitate indexing and the pre-peer review process.

The following is the official style and template developed for publication of a research paper. Authors are not required to follow this style during the submission of the paper. It is just for reference purposes.



Manuscript Style Instruction (Optional)

- Microsoft Word Document Setting Instructions.
- Font type of all text should be Swis721 Lt BT.
- Page size: 8.27" x 11", left margin: 0.65, right margin: 0.65, bottom margin: 0.75.
- Paper title should be in one column of font size 24.
- Author name in font size of 11 in one column.
- Abstract: font size 9 with the word "Abstract" in bold italics.
- Main text: font size 10 with two justified columns.
- Two columns with equal column width of 3.38 and spacing of 0.2.
- First character must be three lines drop-capped.
- The paragraph before spacing of 1 pt and after of 0 pt.
- Line spacing of 1 pt.
- Large images must be in one column.
- The names of first main headings (Heading 1) must be in Roman font, capital letters, and font size of 10.
- The names of second main headings (Heading 2) must not include numbers and must be in italics with a font size of 10.

Structure and Format of Manuscript

The recommended size of an original research paper is under 15,000 words and review papers under 7,000 words. Research articles should be less than 10,000 words. Research papers are usually longer than review papers. Review papers are reports of significant research (typically less than 7,000 words, including tables, figures, and references)

A research paper must include:

- a) A title which should be relevant to the theme of the paper.
- b) A summary, known as an abstract (less than 150 words), containing the major results and conclusions.
- c) Up to 10 keywords that precisely identify the paper's subject, purpose, and focus.
- d) An introduction, giving fundamental background objectives.
- e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition, sources of information must be given, and numerical methods must be specified by reference.
- f) Results which should be presented concisely by well-designed tables and figures.
- g) Suitable statistical data should also be given.
- h) All data must have been gathered with attention to numerical detail in the planning stage.

Design has been recognized to be essential to experiments for a considerable time, and the editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned unrefereed.

- i) Discussion should cover implications and consequences and not just recapitulate the results; conclusions should also be summarized.
- j) There should be brief acknowledgments.
- k) There ought to be references in the conventional format. Global Journals recommends APA format.

Authors should carefully consider the preparation of papers to ensure that they communicate effectively. Papers are much more likely to be accepted if they are carefully designed and laid out, contain few or no errors, are summarizing, and follow instructions. They will also be published with much fewer delays than those that require much technical and editorial correction.

The Editorial Board reserves the right to make literary corrections and suggestions to improve brevity.



FORMAT STRUCTURE

It is necessary that authors take care in submitting a manuscript that is written in simple language and adheres to published guidelines.

All manuscripts submitted to Global Journals should include:

Title

The title page must carry an informative title that reflects the content, a running title (less than 45 characters together with spaces), names of the authors and co-authors, and the place(s) where the work was carried out.

Author details

The full postal address of any related author(s) must be specified.

Abstract

The abstract is the foundation of the research paper. It should be clear and concise and must contain the objective of the paper and inferences drawn. It is advised to not include big mathematical equations or complicated jargon.

Many researchers searching for information online will use search engines such as Google, Yahoo or others. By optimizing your paper for search engines, you will amplify the chance of someone finding it. In turn, this will make it more likely to be viewed and cited in further works. Global Journals has compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

Keywords

A major lynchpin of research work for the writing of research papers is the keyword search, which one will employ to find both library and internet resources. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining, and indexing.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy: planning of a list of possible keywords and phrases to try.

Choice of the main keywords is the first tool of writing a research paper. Research paper writing is an art. Keyword search should be as strategic as possible.

One should start brainstorming lists of potential keywords before even beginning searching. Think about the most important concepts related to research work. Ask, "What words would a source have to include to be truly valuable in a research paper?" Then consider synonyms for the important words.

It may take the discovery of only one important paper to steer in the right keyword direction because, in most databases, the keywords under which a research paper is abstracted are listed with the paper.

Numerical Methods

Numerical methods used should be transparent and, where appropriate, supported by references.

Abbreviations

Authors must list all the abbreviations used in the paper at the end of the paper or in a separate table before using them.

Formulas and equations

Authors are advised to submit any mathematical equation using either MathJax, KaTeX, or LaTeX, or in a very high-quality image.

Tables, Figures, and Figure Legends

Tables: Tables should be cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g., Table 4, a self-explanatory caption, and be on a separate sheet. Authors must submit tables in an editable format and not as images. References to these tables (if any) must be mentioned accurately.



Figures

Figures are supposed to be submitted as separate files. Always include a citation in the text for each figure using Arabic numbers, e.g., Fig. 4. Artwork must be submitted online in vector electronic form or by emailing it.

PREPARATION OF ELETRONIC FIGURES FOR PUBLICATION

Although low-quality images are sufficient for review purposes, print publication requires high-quality images to prevent the final product being blurred or fuzzy. Submit (possibly by e-mail) EPS (line art) or TIFF (halftone/ photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Avoid using pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings). Please give the data for figures in black and white or submit a Color Work Agreement form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

For scanned images, the scanning resolution at final image size ought to be as follows to ensure good reproduction: line art: >650 dpi; halftones (including gel photographs): >350 dpi; figures containing both halftone and line images: >650 dpi.

Color charges: Authors are advised to pay the full cost for the reproduction of their color artwork. Hence, please note that if there is color artwork in your manuscript when it is accepted for publication, we would require you to complete and return a Color Work Agreement form before your paper can be published. Also, you can email your editor to remove the color fee after acceptance of the paper.

TIPS FOR WRITING A GOOD QUALITY SCIENCE FRONTIER RESEARCH PAPER

Techniques for writing a good quality Science Frontier Research paper:

1. Choosing the topic: In most cases, the topic is selected by the interests of the author, but it can also be suggested by the guides. You can have several topics, and then judge which you are most comfortable with. This may be done by asking several questions of yourself, like "Will I be able to carry out a search in this area? Will I find all necessary resources to accomplish the search? Will I be able to find all information in this field area?" If the answer to this type of question is "yes," then you ought to choose that topic. In most cases, you may have to conduct surveys and visit several places. Also, you might have to do a lot of work to find all the rises and falls of the various data on that subject. Sometimes, detailed information plays a vital role, instead of short information. Evaluators are human: The first thing to remember is that evaluators are also human beings. They are not only meant for rejecting a paper. They are here to evaluate your paper. So present your best aspect.

2. Think like evaluators: If you are in confusion or getting demotivated because your paper may not be accepted by the evaluators, then think, and try to evaluate your paper like an evaluator. Try to understand what an evaluator wants in your research paper, and you will automatically have your answer. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

3. Ask your guides: If you are having any difficulty with your research, then do not hesitate to share your difficulty with your guide (if you have one). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work, then ask your supervisor to help you with an alternative. He or she might also provide you with a list of essential readings.

4. Use of computer is recommended: As you are doing research in the field of science frontier then this point is quite obvious. Use right software: Always use good quality software packages. If you are not capable of judging good software, then you can lose the quality of your paper unknowingly. There are various programs available to help you which you can get through the internet.

5. Use the internet for help: An excellent start for your paper is using Google. It is a wondrous search engine, where you can have your doubts resolved. You may also read some answers for the frequent question of how to write your research paper or find a model research paper. You can download books from the internet. If you have all the required books, place importance on reading, selecting, and analyzing the specified information. Then sketch out your research paper. Use big pictures: You may use encyclopedias like Wikipedia to get pictures with the best resolution. At Global Journals, you should strictly follow here.



6. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right? It is a good habit which helps to not lose your continuity. You should always use bookmarks while searching on the internet also, which will make your search easier.

7. Revise what you wrote: When you write anything, always read it, summarize it, and then finalize it.

8. Make every effort: Make every effort to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in the introduction—what is the need for a particular research paper. Polish your work with good writing skills and always give an evaluator what he wants. Make backups: When you are going to do any important thing like making a research paper, you should always have backup copies of it either on your computer or on paper. This protects you from losing any portion of your important data.

9. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several unnecessary diagrams will degrade the quality of your paper by creating a hodgepodge. So always try to include diagrams which were made by you to improve the readability of your paper. Use of direct quotes: When you do research relevant to literature, history, or current affairs, then use of quotes becomes essential, but if the study is relevant to science, use of quotes is not preferable.

10. Use proper verb tense: Use proper verb tenses in your paper. Use past tense to present those events that have happened. Use present tense to indicate events that are going on. Use future tense to indicate events that will happen in the future. Use of wrong tenses will confuse the evaluator. Avoid sentences that are incomplete.

11. Pick a good study spot: Always try to pick a spot for your research which is quiet. Not every spot is good for studying.

12. Know what you know: Always try to know what you know by making objectives, otherwise you will be confused and unable to achieve your target.

13. Use good grammar: Always use good grammar and words that will have a positive impact on the evaluator; use of good vocabulary does not mean using tough words which the evaluator has to find in a dictionary. Do not fragment sentences. Eliminate one-word sentences. Do not ever use a big word when a smaller one would suffice.

Verbs have to be in agreement with their subjects. In a research paper, do not start sentences with conjunctions or finish them with prepositions. When writing formally, it is advisable to never split an infinitive because someone will (wrongly) complain. Avoid clichés like a disease. Always shun irritating alliteration. Use language which is simple and straightforward. Put together a neat summary.

14. Arrangement of information: Each section of the main body should start with an opening sentence, and there should be a changeover at the end of the section. Give only valid and powerful arguments for your topic. You may also maintain your arguments with records.

15. Never start at the last minute: Always allow enough time for research work. Leaving everything to the last minute will degrade your paper and spoil your work.

16. Multitasking in research is not good: Doing several things at the same time is a bad habit in the case of research activity. Research is an area where everything has a particular time slot. Divide your research work into parts, and do a particular part in a particular time slot.

17. Never copy others' work: Never copy others' work and give it your name because if the evaluator has seen it anywhere, you will be in trouble. Take proper rest and food: No matter how many hours you spend on your research activity, if you are not taking care of your health, then all your efforts will have been in vain. For quality research, take proper rest and food.

18. Go to seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

19. Refresh your mind after intervals: Try to give your mind a rest by listening to soft music or sleeping in intervals. This will also improve your memory. Acquire colleagues: Always try to acquire colleagues. No matter how sharp you are, if you acquire colleagues, they can give you ideas which will be helpful to your research.



20. Think technically: Always think technically. If anything happens, search for its reasons, benefits, and demerits. Think and then print: When you go to print your paper, check that tables are not split, headings are not detached from their descriptions, and page sequence is maintained.

21. Adding unnecessary information: Do not add unnecessary information like "I have used MS Excel to draw graphs." Irrelevant and inappropriate material is superfluous. Foreign terminology and phrases are not apropos. One should never take a broad view. Analogy is like feathers on a snake. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Never oversimplify: When adding material to your research paper, never go for oversimplification; this will definitely irritate the evaluator. Be specific. Never use rhythmic redundancies. Contractions shouldn't be used in a research paper. Comparisons are as terrible as clichés. Give up ampersands, abbreviations, and so on. Remove commas that are not necessary. Parenthetical words should be between brackets or commas. Understatement is always the best way to put forward earth-shaking thoughts. Give a detailed literary review.

22. Report concluded results: Use concluded results. From raw data, filter the results, and then conclude your studies based on measurements and observations taken. An appropriate number of decimal places should be used. Parenthetical remarks are prohibited here. Proofread carefully at the final stage. At the end, give an outline to your arguments. Spot perspectives of further study of the subject. Justify your conclusion at the bottom sufficiently, which will probably include examples.

23. Upon conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium through which your research is going to be in print for the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects of your research.

INFORMAL GUIDELINES OF RESEARCH PAPER WRITING

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form which is presented in the guidelines using the template.
- Please note the criteria peer reviewers will use for grading the final paper.

Final points:

One purpose of organizing a research paper is to let people interpret your efforts selectively. The journal requires the following sections, submitted in the order listed, with each section starting on a new page:

The introduction: This will be compiled from reference matter and reflect the design processes or outline of basis that directed you to make a study. As you carry out the process of study, the method and process section will be constructed like that. The results segment will show related statistics in nearly sequential order and direct reviewers to similar intellectual paths throughout the data that you gathered to carry out your study.

The discussion section:

This will provide understanding of the data and projections as to the implications of the results. The use of good quality references throughout the paper will give the effort trustworthiness by representing an alertness to prior workings.

Writing a research paper is not an easy job, no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record-keeping are the only means to make straightforward progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear: Adhere to recommended page limits.



Mistakes to avoid:

- Insertion of a title at the foot of a page with subsequent text on the next page.
- Separating a table, chart, or figure—confine each to a single page.
- Submitting a manuscript with pages out of sequence.
- In every section of your document, use standard writing style, including articles ("a" and "the").
- Keep paying attention to the topic of the paper.
- Use paragraphs to split each significant point (excluding the abstract).
- Align the primary line of each section.
- Present your points in sound order.
- Use present tense to report well-accepted matters.
- Use past tense to describe specific results.
- Do not use familiar wording; don't address the reviewer directly. Don't use slang or superlatives.
- Avoid use of extra pictures—include only those figures essential to presenting results.

Title page:

Choose a revealing title. It should be short and include the name(s) and address(es) of all authors. It should not have acronyms or abbreviations or exceed two printed lines.

Abstract: This summary should be two hundred words or less. It should clearly and briefly explain the key findings reported in the manuscript and must have precise statistics. It should not have acronyms or abbreviations. It should be logical in itself. Do not cite references at this point.

An abstract is a brief, distinct paragraph summary of finished work or work in development. In a minute or less, a reviewer can be taught the foundation behind the study, common approaches to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Use comprehensive sentences, and do not sacrifice readability for brevity; you can maintain it succinctly by phrasing sentences so that they provide more than a lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study with the subsequent elements in any summary. Try to limit the initial two items to no more than one line each.

Reason for writing the article—theory, overall issue, purpose.

- Fundamental goal.
- To-the-point depiction of the research.
- Consequences, including definite statistics—if the consequences are quantitative in nature, account for this; results of any numerical analysis should be reported. Significant conclusions or questions that emerge from the research.

Approach:

- Single section and succinct.
- An outline of the job done is always written in past tense.
- Concentrate on shortening results—limit background information to a verdict or two.
- Exact spelling, clarity of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else.

Introduction:

The introduction should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable of comprehending and calculating the purpose of your study without having to refer to other works. The basis for the study should be offered. Give the most important references, but avoid making a comprehensive appraisal of the topic. Describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will give no attention to your results. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here.



The following approach can create a valuable beginning:

- Explain the value (significance) of the study.
- Defend the model—why did you employ this particular system or method? What is its compensation? Remark upon its appropriateness from an abstract point of view as well as pointing out sensible reasons for using it.
- Present a justification. State your particular theory(-ies) or aim(s), and describe the logic that led you to choose them.
- Briefly explain the study's tentative purpose and how it meets the declared objectives.

Approach:

Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done. Sort out your thoughts; manufacture one key point for every section. If you make the four points listed above, you will need at least four paragraphs. Present surrounding information only when it is necessary to support a situation. The reviewer does not desire to read everything you know about a topic. Shape the theory specifically—do not take a broad view.

As always, give awareness to spelling, simplicity, and correctness of sentences and phrases.

Procedures (methods and materials):

This part is supposed to be the easiest to carve if you have good skills. A soundly written procedures segment allows a capable scientist to replicate your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order, but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt to give the least amount of information that would permit another capable scientist to replicate your outcome, but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section.

When a technique is used that has been well-described in another section, mention the specific item describing the way, but draw the basic principle while stating the situation. The purpose is to show all particular resources and broad procedures so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step-by-step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

Materials may be reported in part of a section or else they may be recognized along with your measures.

Methods:

- Report the method and not the particulars of each process that engaged the same methodology.
- Describe the method entirely.
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures.
- Simplify—detail how procedures were completed, not how they were performed on a particular day.
- If well-known procedures were used, account for the procedure by name, possibly with a reference, and that's all.

Approach:

It is embarrassing to use vigorous voice when documenting methods without using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result, when writing up the methods, most authors use third person passive voice.

Use standard style in this and every other part of the paper—avoid familiar lists, and use full sentences.

What to keep away from:

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings—save it for the argument.
- Leave out information that is immaterial to a third party.



Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part as entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Use statistics and tables, if suitable, to present consequences most efficiently.

You must clearly differentiate material which would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matters should not be submitted at all except if requested by the instructor.

Content:

- Sum up your conclusions in text and demonstrate them, if suitable, with figures and tables.
- In the manuscript, explain each of your consequences, and point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation of an exacting study.
- Explain results of control experiments and give remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or manuscript.

What to stay away from:

- Do not discuss or infer your outcome, report surrounding information, or try to explain anything.
- Do not include raw data or intermediate calculations in a research manuscript.
- Do not present similar data more than once.
- A manuscript should complement any figures or tables, not duplicate information.
- Never confuse figures with tables—there is a difference.

Approach:

As always, use past tense when you submit your results, and put the whole thing in a reasonable order.

Put figures and tables, appropriately numbered, in order at the end of the report.

If you desire, you may place your figures and tables properly within the text of your results section.

Figures and tables:

If you put figures and tables at the end of some details, make certain that they are visibly distinguished from any attached appendix materials, such as raw facts. Whatever the position, each table must be titled, numbered one after the other, and include a heading. All figures and tables must be divided from the text.

Discussion:

The discussion is expected to be the trickiest segment to write. A lot of papers submitted to the journal are discarded based on problems with the discussion. There is no rule for how long an argument should be.

Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implications of the study. The purpose here is to offer an understanding of your results and support all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of results should be fully described.

Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact, you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved the prospect, and let it drop at that. Make a decision as to whether each premise is supported or discarded or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."



Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work.

- You may propose future guidelines, such as how an experiment might be personalized to accomplish a new idea.
- Give details of all of your remarks as much as possible, focusing on mechanisms.
- Make a decision as to whether the tentative design sufficiently addressed the theory and whether or not it was correctly restricted. Try to present substitute explanations if they are sensible alternatives.
- One piece of research will not counter an overall question, so maintain the large picture in mind. Where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

When you refer to information, differentiate data generated by your own studies from other available information. Present work done by specific persons (including you) in past tense.

Describe generally acknowledged facts and main beliefs in present tense.

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	A-B	C-D	E-F
<i>Abstract</i>	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
<i>Introduction</i>	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
<i>Methods and Procedures</i>	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
<i>Result</i>	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
<i>Discussion</i>	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
<i>References</i>	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring



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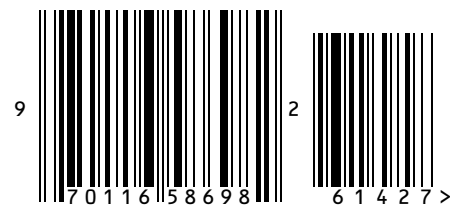
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