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# Production and Perception of Agricultural Reuse in a Rural Community

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ABSTRACT

There is a growing competition among the various sectors of society in the world for the use of water where agriculture stands out as a major consumer. Since it is carried out in a controlled manner, irrigation with effluents from a Sewage Treatment Plant (STP) is a very attractive practice, as it allows a greater supply of water for nobler purposes. This work had the general objective of evaluating the perception of a rural community in the municipality of Pesqueira, Pernambuco, Brasil, in terms of consumption and production of products cultivated with the practice of agricultural reuse. The local population showed acceptance for the cultivation and consumption of products through agricultural reuse, above all, with reliable information on the appropriate quality of the effluents used for irrigation. In the estimated data, the same community had a potential of production of corn, beans and cotton in the order of 19.8 tons, 3.4 tons and 7.7 tons respectively, with the use of treated sewage in irrigation.

Keywords: sewage, agricultural reuse, semi-arid

## Introduction

The growing demand for potable water, as a result of the growing world population, has intensified at the global level. As a result, conflicts and disputes between different segments of society tend to emerge significantly through access to this natural resource. In the arid and semi-arid regions, water scarcity has become a limiting factor for urban, industrial and agricultural development. Even areas with abundant water resources, but insufficient to meet the high demands, experience conflicts of use and suffer consumption restrictions that affect economic development and quality of life (LIRA et al., 2015; HESPANHOL, 2003).

The applications of water and fertilizers show greater efficiency and control, considering the development of agriculture, the intensity of the crops, the economic aspect, the shortage of labor and mainly the lack of water in some regions (ALMEIDA et al., 2016).

Against this backdrop, there is a need for demand control, aiming at reducing pressure on water resources, and seeking complementary resources. Water resources management, however, becomes a major challenge in maintaining the balance between users' needs and water availability.

The reuse of water in activities such as agriculture, industry, public cleaning, aquaculture, among others, which do not require a high degree of quality is a way of minimizing the problem of the scarcity of this natural resource. The reuse of water for non-potable purposes has intensified throughout the world in the last decades, due to the increasing difficulty of meeting this demand, for urban centers and some localities in rural areas, due to the growing scarcity of water sources near Points of consumption and / or of adequate quality for supply after conventional treatment (MUFFAREG, 2003; SCHAER-BARBOSA et al., 2014).

The use of domestic sewage treated in the soil with the purpose of providing nutrients for agriculture, for example, is a little used practice in Brazil, mainly in a controlled way, but very old in many countries of Southeast Asia, the Middle East and the African continent . The first European cities to adopt this practice were Bunzlau in Germany in 1531 and

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Edinburgh in Scotland in 1650 (TRENTIN, 2005; BARBOSA, 2008).

In terms of river basin planning, reuse must be present in the list of water resource managers, and it is an important tool in the control of the quality of water bodies (MANCUSO, 1992; LEITE, 2003).

According to Leme (2010), the perception of people in terms of sustainable water use is not always positive, however much they know the importance of natural resources and the need to survive in the face of the water scarcity problem that we are experiencing today.

In this way, the objective of this study is to evaluate the perception of a rural community in relation to basic sanitation and agricultural reuse, as well as the potential of agricultural reuse of a rural community in a municipality inserted in the semi-arid region, considering the Local basic sanitation services.

## Material and Methods

The research was carried out in the district of Mutuca, in the municipality of Pesqueira, located 22 km from the municipal head office and presents a climate that, according to the Koppen classification, is very hot semi-arid steppe type, subject to torrential rains and marked irregularity in the pluviometric regime, With a rainy season varying from four to five months in duration (March to July), annual average temperature around 27 ° C, relative air humidity of 73% and average wind speed of 2.5 m / s, with precipitation Average of 670 mm (MOLINIER et al., 1994). It has about 600 residences in the urban area and 500 in the rural area, corresponding to a population of approximately 3,000 inhabitants in the urban area and 2,500 in the rural area (COSTA, 2009).

The district of Mutuca has a pilot reuse unit with an area of 4,078 m², consisting of a sewage treatment unit and reuse of the effluent and a meteorological station (Class A tank, thermo-hygrograph, rain gauge and data collection platform ). The Sewage Treatment Plant (STP) is comprised of three sedimentation tanks in series, with a total accumulation capacity of approximately 360 m³ and a UASB (Upflow Anaerobic Sludge Blanket), in order to carry out the secondary effluent treatment.

According to information provided by health agents working in the district, the urban nucleus of Mutuca has 75 families served with a sewage collection network, characterizing the basin of the sewage contribution that feeds the STP of the experimental unit. The flow directed to the experimental area was estimated considering a population of 300 inhabitants in the contribution basin, whose total urban population is 2,534 inhabitants, and per capita water consumption of 75.15 L / inhab.day, according to the SNIS (BRAZIL , 2010), and a reference coefficient of return of 70%, because it is a rural community (PEREIRA and SOARES, 2006).

To evaluate the potential of local cultivation, corn and caupi-beans crops were used (Vigna unguiculata (L.) Walp.), which are the most produced crops in the region, and the cotton crop, as an alternative production. The reference for water demand of each crop followed the values quoted by EMBRAPA (EMBRAPA, 2010, EMBRAPA, 2003, EMBRAPA, 2006), as shown in Table 1.

Table 1 – Reference values to evaluate the agricultural reuse potential in the District of Mutuca, considering corn, beans and cotton crops. (Author, 2011).

| Crops | Water Demand | Cycle |
|---|---|---|
| Corn | 600 mm | 120 days |
| Besns | 400 mm | 90 days |
| Cotton | 700 mm | 150 days |

To evaluate the potential of agricultural reuse, two specific scenarios were considered: Scenario 01: sewage produced by the urban population served by the district (300 inhabitants); Scenario 02: sewage produced by the total urban population of the district (2,534 inhabitants).

In order to better understand the perception of the local population regarding basic sanitation and the acceptance of the consumption of products irrigated with treated domestic sewage, a questionnaire was elaborated based on the methodology of Trentin (2005). The questionnaires were applied through visits to all residences (75 houses) inserted in the basin of the sewage contribution, in the urban nucleus of the district of Mutuca. The residences were duly identified by the health agents of the Municipality of Pesqueira.

## Results and Discussion

**Production Estimate with Agricultural Reuse**

For the district of Mutuca, it was estimated a daily sewage production of approximately 15.8 m³, considering a population of 300 inhabitants, per capita water consumption of 75.15 L / hab.day and reference return coefficient 0.7, Which pass through the existing treatment system, before being disposed in the receiving body, Mutuca reservoir. The potential related to the agricultural reuse of the sewage treatment and sewage treatment system is estimated in Table 2.

Every agricultural reuse system implemented in Mutuca has a useful area of 0.36 hectares and is therefore compatible with the volumes of sewage produced by the population served by the sanitary sewage system, and can produce, under adequate sanitary conditions of the STP effluent, respectively 2.4 tons, 0.4 tons and 0.92 tons of corn, beans and cotton. However, when there is an expansion of the sewage collection and treatment system, an area of 2.67 hectares should be increased, producing up to 19.8 tons of corn, 3.4 tons of beans and 7.7 tons of cotton.

According to the Municipal Department of Agriculture of Pesqueira and the Pernambuco Company of Agricultural Research - IPA, every region of the district of Mutuca produced in 2010, 3,120 kg of maize and 4,700 kg of beans, where, in terms of local reuse potential , Could consider an increase in corn production of more than 76% and beans around 10%,

considering only one crop cycle, as well as encouraging cotton production in the region, since there is no record of its cultivation.

According to the IBGE, 2015, the municipality of Pesqueira produced in the year 2015, 415 tons of corn and 330 tons of beans, where, in terms of potential for local reuse, it could consider an increase in corn production of more than 4.7% And of beans around 1%, considering only one crop cycle, as well as encouraging cotton production in the region, since there is no record of its cultivation.

According to EMBRAPA (2010), the average yield of corn under dry conditions in Brazil is 3,175 kg ha-1. Nascimento et al. (2003) studied 12 corn crops (hybrids and varieties), and found productivity values ranging from 4,215 to 4,938 kg ha-1.

According to IPA, irrigated corn yields in the state of Pernambuco registered values of around 3,600 kg ha-1 (PERNAMBUCO, 2008b), while Reami (2008), considering irrigation with treated domestic sewage, found a productivity of 7,420 kg ha- 1.

According to EMBRAPA (2003), for the production of beans stands out caupi-beans, corda-beans, macassar-beans (Vigna unguiculata (L.) Walp. as an excellent source of proteins (23-25% in Average), presenting all the essential amino acids, carbohydrates (62% on average), vitamins and minerals, besides having large amount of dietary fibers, low amount of fat Oil of 2%, on average) and does not contain cholesterol, representing a staple food for the low-income populations of the Brazilian Northeast, which produces 303.5 kg ha-1 in rainfed cultivation.

Santos et al. (2007) found a maximum productivity value of 1,321 kg ha-1, using a liquid biofertilizer applied to the leaves of the plants. According to Silva (2007), irrigation with treated domestic sewage can lead to a yield of feijão-caupi of 1,138.80 kg ha-1.

Regarding the herbaceous cotton crop, its dryland yield is around 844.5 kg ha-1 of cotton seed (EMBRAPA, 2006a). According to EMBRAPA (2004), in a study of the BRS Safira variety, under rainfed conditions, the average productivity was 1,915 kg ha-1; Under irrigated conditions, the same variety can obtain yields greater than 3,500 kg ha-1.

The productivity of irrigated cotton in Pernambuco, according to the IPA, the recommended cultivars (CNPA 7 H, CNPA 8 H and CNPA Precoce 2) have a genetic potential to produce above 3,000 kg ha-1 of cotton seed (PERNAMBUCO, 2008a) . Ferreira et al., (2005), says the yield of herbaceous cotton irrigated with treated sewage, is of 3,000 kg ha-1. Miranda (2010), evaluating the variation of irrigation slides with treated sewage of Mutuca, found a maximum productivity of 2,700 kg ha-1.

It is important to emphasize that the conduction of any crop with wastewater in Mutuca should adopt an effective and continuous monitoring of the effluents generated in its STP, with a view to meeting at least the guidelines suggested by PROSAB and in consideration of CONAMA Resolution No. 430, as well as CNRH Resolution No. 121.

**Perception for Reuse**

In order to evaluate the perception of the population served by the collecting network of Mutuca, a questionnaire was applied addressing issues on sanitation and water reuse. The sample had 81% of female respondents, most of them between 31 and 50 years old, in relation to family income, 62% have income of up to one minimum wage and 39% did not complete elementary education. When asked if they know or have heard of basic sanitation, 55% show total ignorance of the issue in question, although all respondents said they had access to at least one of the services related to basic sanitation, such as public cleaning, water supply, Collection of garbage and sewage.

Some agricultural reuse projects have been developed since 2007, with a partnership between the Federal University of Pernambuco (UFPE), Federal Rural University of Pernambuco (UFRPE) and the Secretaria de Recersos Hídricos e Energeticos (SRHE-PE). However, 58% of the interviewees do not know The operation of STP - Mutuca; And 66% attributed the responsibility of the management of the system to the Municipality of Pesqueira. Regardless of this, 96% stated that sewage collection was of great importance and all believe that proper sewage collection and treatment in a community can have major implications for improving the health of the population.

In regards to the aspects related to agricultural reuse, 92% do not practice irrigated agriculture, only of dry land, a very common situation, especially in any area under study. Regarding the reuse theme, 91% do not know what water reuse is, however 96% believe that when treated, sewage can be used for irrigation and 71% favored this practice, but 53% would not buy products From cultivated areas irrigated with treated sewage. The main concern for non-acceptance was the health aspect associated with the potential risks of disease transmission. According to Trentin (2005), in a study carried out with the population living in areas near STP's, in the outskirts of Curitiba-PR, it was identified that 74.3% of the respondents are favorable to the use of wastewater. The same author verified that 71.3% would buy products irrigated with wastewater.

When the population was questioned about the safety of consuming the products from agricultural reuse, if the treatment of the sewage presented good efficiency, allowing satisfactory sanitary quality, for its use in agricultural irrigation, 83% of the interviewees were favorable to the consumption of these products.

Table 2. Estimation of sewage generation and agricultural reuse production in the district of Mutuca, using corn, beans and cotton crops as reference. (Author, 2015).

| MUTUCA | Sewage (1) (m³/day) | Corn | | Beans | | Cotton | |
|---|---|---|---|---|---|---|---|
| | | Area (ha) | Prod. (2) (kg) | Area (ha) | Prod. (3) (kg) | Area (ha) | Prod. (4) (kg) |
| SCENARIO01 | 15,78 | 0,32 | 2.374 | 0,36 | 410 | 0,34 | 918 |
| SCENARIO02 | 133,30 | 2,67 | 19.811 | 3,03 | 3.451 | 2,85 | 7.695 |

Scenario 01: sewage produced by the urban population served by the district; Scenario 02: sewage produced by the total urban population of the district; 1: Estimate in relation to the population served with sanitary sewage. 2: Production per cycle, considering productivity found by Reami (2008). 3: Production per cycle, considering productivity found by Silva (2007). 4: Production per cycle, considering productivity found by Miranda (2010).

## Conclusions

The district of Mutuca presented an important potential for the local production with the agricultural reuse, being able to be extended with the implantation of collecting network in all urban nucleus. However, the existing sewage treatment system does not have rigorous control through the monitoring of its effluents, compromising its use for irrigation, which must, at least, meet the guidelines proposed by PROSAB (BASTOS AND BEVILACQUA, 2006).

In the district of Mutuca the perception of its inhabitants, in relation to basic sanitation, is variable: the majority are unaware of the theme; For the practice of the agricultural reuse the population thinks feasible, in spite of affirming that they would not consume the products. However, in the certainty of an efficient sewage treatment process, they showed an interest in production and consumption..

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## References

ALMEIDA, A. N.; COSTA, J. O.; GRECCO K. L.; ALVES, B. A.; MARQUES, P. A. A. Modelo computacional para manejo da fertirrigação em sistemas de microirrigação. Revista Geama, Recife, v. 4, n. 1, 2016.

BARBOSA, J. E. de L. Uso e reuso da água em sistemas de produção animal. ZOOTEC 2008, João Pessoa, PB. Anais... João Pessoa, PB: Associação Brasileira de Zootecnistas: Universidade Federal da Paraíba, 2008. Disponível em: <http://www.abz.org.br/publicacoes-tecnicas/anais-zootec/palestras/4257-Uso-Reuso-gua-Sistemas-Produo-Animal.html>. Acesso em: 19 jul. 2010.

BASTOS, R. K. X.; BEVILACQUA, P. D. Normas e critérios de qualidade para reúso da água. In: SANTOS, M. L. F. (Coord.). Tratamento e utilização de esgotos sanitários. Rio de Janeiro: Associação Brasileira de Engenharia Sanitária e Ambiental, 2006. p. 17-61. Programa de Pesquisa em Saneamento Básico (PROSAB).

BRASIL. Resolução CNRH nº 121, de 16 de dezembro de 2010. Estabelece diretrizes e critérios para a prática de reúso direto não potável de água na modalidade agrícola e florestal, definida na Resolução CNRH no 54, de 28 de novembro de 2005. Disponível em: <URL: http://www.cnrh.gov.br/sitio/index.php?option=com_content&view=article&id=14>. Acesso em: 16 mai. 2011.

BRASIL, Resolução CONAMA nº 430, de 13 de maio de 2011. Condições e padrões de lançamento de efluentes, complementa e altera a Resolução no 357, de 17 de março de 2005. Publicado no D.O.U.
BRASIL. Ministério das Cidades/SNSA. Sistema Nacional de Informações sobre Saneamento - SNIS. Diagnóstico dos Serviços de Água e Esgotos - 2008. Brasília, março de 2010.

COSTA, M. R. da. Avaliação das estratégias de convivência com o semiárido. 2009. 190 f. Tese (Doutorado em Tecnologia Ambiental e Recursos Hídricos). Universidade Federal de Pernambuco. Recife, 2009.

EMBRAPA, 2010. Empresa Brasileira de Pesquisa Agropecuária - Semiárido. Cultivo do milho. Embrapa Milho e Sorgo. Sistema de Produção, 1 ISSN 1679-012X Versão Eletrônica - 6ª edição Set./2010. Disponível em: < URL: http://sistemasdeproducao.cnptia.embrapa.br/FontesHTML/Milho/CultivodoMilho_6ed/imanejo.htm >. Acesso em: 19 abr. 2011.
EMBRAPA, 2006. Empresa Brasileira de Pesquisa Agropecuária - Semiárido. Cultivo do algodão

irrigado. Embrapa Algodão. Sistemas de Produção, 3 - 2a. edição ISSN 1678-8710 Versão Eletrônica Set/2006. Disponível em: < URL: http://sistemasdeproducao.cnptia.embrapa.br/FontesHTML/Algodao/AlgodaoIrrigado_2ed/irrigacao.html>. Acesso em: 19 abr. 2011.

EMBRAPA, 2003. Empresa Brasileira de Pesquisa Agropecuária - Semiárido. Cultivo de feijão caupi. Embrapa Meio-Norte. Sistemas de Produção, 2 ISSN 1678-8818 Versão Eletrônica. Jan/2003. Disponível em: < URL: http://sistemasdeproducao.cnptia.embrapa.br/FontesHTML/Feijao/FeijaoCaupi/index.htm>. Acesso em: 24 mai. 2011.

FERREIRA, O. E.; BELTRÃO, N. E. M.; KONIG, A. Efeitos da aplicação de água residuária e nitrogênio sobre o crescimento e produção do algodão herbáceo. Rev. bras. ol. fibros., Campina Grande, v.9, n.1/3, p.893-902, jan./dez. 2005.

HESPANHOL, I. Potencial de reúso de água no Brasil: agricultura, indústria, município e recarga de aqüíferos. In: MANCUSO, P. C. S.; SANTOS, H. F. Reúso de água. Barueri: Manole, 2003. p.37-95.

IBGE, 2015. Instituto Brasileiro de Geografia e Estatística. Produção agrícola municipal 2015. Rio de Janeiro: IBGE, 2015.

LEITE A. M. F. Reúso de água na gestão integrada de recursos hídricos. 2003. 120 f. Dissertação (Mestrado em Planejamento e Gestão Ambiental) - Universidade Católica de Brasília, Brasília, 2003.

LEME, T. N. Os municípios e política nacional do meio ambiente. Planejamento e politicas públicas. IPEA. Brasília. v.1, n. 35, p. 26–50, jul/dez. 2010.

LIRA, R. M.; SANTOS, A. N.; SILVA, J. S.; BARNABÉ, J. M. C.; BARROS, M. S.; SOARES, H. R. The use of lower quality water in irrigated agriculture. Revista Geama, Recife, v. 3, n. 1, 2015.

MANCUSO, P. C. S. O reúso de água e sua possibilidade na região metropolitana de São Paulo. 1992. 132 f. Tese (Doutorado em Saúde Pública) – Universidade de São Paulo, Faculdade de Saúde Pública, São Paulo, 1992.

MIRANDA, R. J. A. Lâminas de irrigação com água residuária e adubação orgânica na cultura do algodão BRS safira. 2010. 76 f. Tese (Doutorado em Engenharia de Irrigação e Drenagem) - Universidade Federal de Campina Grande, Campina Grande, PB.

MOLINIER, M.; ALBUQUERQUE, C.H.C.; CARDIER, E. Análise de pluviometria e isoietas homogeneizadas do nordeste brasileiro. Recife: Sudene, 1994. (Hidrologia, 32).

MUFFAREG, M. R. Análise e discussão dos conceitos e legislação sobre reúso de águas residuárias. 2003. 72 f. Dissertação (Mestrado em Ciências na Área de Saúde Pública) - Fundação Oswaldo Cruz, Escola Nacional de Saúde Pública, Rio de Janeiro, 2003.

NASCIMENTO, M. M. A.; TABOSA, J. N.; FILHO, J. J. T. Avaliação de cultivares de milho no agreste semiárido de Pernambuco. Revista Brasileira de Engenharia Agrícola e Ambiental, Campina Grande, PB, v. 7, n. 1, p. 53 – 56. 2003.

PEREIRA, J. A. R.; SOARES, J. M. Rede coletora de esgoto sanitário: projeto, construção e operação. Belém: Núcleo de Meio Ambiente/UFPA, 2006.

PERNAMBUCO. Instituto Agronômico de Pernambuco. Cultivo de milho irrigado no semiárido de Pernambuco. Recife, 2008. Disponível em: < http://www.ipa.br/resp59.php>. Acesso em: 24 mai. 2011.

REAMI, L. Avaliação de produtividade agrícola e de concentrações de metais nos grãos, de cultura de milho irrigada com efluente anaeróbio. 2008. 125 f. Dissertação (Mestrado em Saneamento e Ambiente) - Universidade Estadual de Campinas, Campinas, 2008.

SANTOS, J. F.; LEMOS, J. N. R.; NÓBREGA, J. Q.; GRANGEIRO, J. I. T.; BRITO, L. M. P.; OLIVEIRA, M. E. C. Produtividade de feijão caupi utilizando biofertilizante e uréia. Tecnol. & Ciên. Agropec., João Pessoa, v.1, n.1, p.25-29, set. 2007. Disponível em:<http://www.emepa.org.br/revista/volumes/tca_v1_n1/tca05_feijao_vigna.pdf>. Acesso em: 30 mai. 2011.

SILVA, V, de P. Efeitos da fertirrigação com efluente de lagoa de polimento nos atributos do solo e na produção de feijão caupi (Vigna unguiculata (L.) Walp). 2007. 128 f. Tese (Doutorado em Tecnologia Ambiental e Recursos Hídricos) - Universidade Federal de Pernambuco, Recife.

SCHAER-BARBOSA, M.; PEREIRA DOS SANTOS, M. E.; DANTAS P. M. Y. "Viabilidade do reúso de água como elemento mitigador dos efeitos da seca no semiárido da Bahia". Ambiente & Sociedade XVII, 17-32, 2014.

TRENTIN, C. V. Diagnóstico voltado ao planejamento do uso de águas residuárias para irrigação nos cinturões verdes da região metropolitana de Curitiba – PR. 2005. 129 f. Dissertação (Mestrado em Ciência do Solo) - Universidade Federal do Paraná, Curitiba, 2005