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THE IMPLEMENTATION OF IRRIGATION SYSTEM IN TANZANIA UNDER DEVELOPMENT AID PROJECT CONDITIONS

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Summary

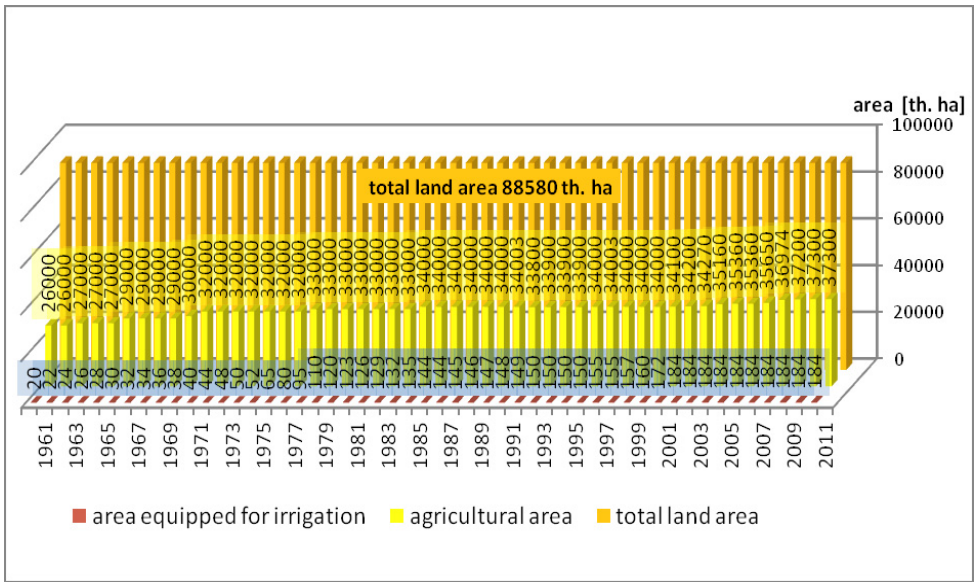
This paper presents the process and results of the implementation of the irrigation system on meadows in Tanzania. The irrigation system was implemented in 2010 and 2012 as an element of two development projects co-financed by Ministry of Foreign Affairs of the Republic of Poland under the Polish Development Programme. During the first phase (2010) the earth water reservoir and the canal carrying water on a meadow were built and the irrigation system based on Amirite sprinklers was installed. In 2012, the concrete water tanks were built, and two hose reel irrigators were bought and put in action. The implementation of the irrigation system allowed for a significant increase in the production of hay. In the analyzed time period (from 2008 to 2012) the increase in yields of hay from 34.7 tons to 237.3 tons was noticed. The resulting implementation of the irrigation project increase hay production should be considered valuable, especially under the conditions of advancing climate change and its potential impact on the reduction of agricultural production in Tanzania.

INTRODUCTION

The involvement in development actions is one of the marks of Polish participation in international policy. As a signatory of the Millennium Declaration, accepted by UN members states in 2000, Poland takes active part in initiatives aimed at implementing the Millennium Development Goals (*MDGs*). The level of supporting the processes and actions aimed at the socio-economic development and growth of global prosperity and the belief that such co-operation is an integral part of Polish foreign policy. It is also a Polish response to interna-

tional challenges and obligations declared in the documents regulating co-operation development, including the Treaty on the Functioning of the European Union (Articles 208 to 211), the Millennium Declaration, the Paris Declaration on Aid Effectiveness, the European Consensus on Development and the European Development Fund.

Tanzania is one of the highest aid recipients, with bilateral and multilateral donors assigning increasing aid amounts or proceeding with debt relief. In 1960-2007 period the United Kingdom (3120.74 million USD) has been on the top of the list of bilateral donors followed by Japan (2773.46 million USD), Sweden (2643.98 million USD) and Denmark (2113.19 million USD). In the group of multilateral donors World Bank (4977.43 million USD) followed by African Development Bank (1026.59 million USD) and International Monetary Fund (351.97 million USD) were the main aid providers to Tanzania in that period (Rotarou and Ueta, 2009). The country`s stable economic growth and transition to the market economy has prompted its characterization as one of the new African success stories. All this progress however cannot hide the fact that Tanzania is still one of the poorest countries in the world. In total aid inflow from all donors in the period 1973 - 2004 agriculture was one of main aid beneficiary sectors of Tanzanian economy (Mbiha et al., 2009). Agriculture plays an important role in the economy of Tanzania, contributing significantly to the country's GDP, accounting for 60 percent of export earnings and employing 84 percent of the rural population. Poor availability of water and pastures has been identified as the single most important factor constraining productivity of livestock in Tanzania (Rajabu, 2005). Irrigation has been found to be central in curbing food scarcity in many developing countries. It has been proved that continued reliability on rainfall in agriculture cannot sustain the increase in population. The potential implication of the current irrigation systems is that if irrigation is managed properly it may lead to sustainable increases in agricultural productivity and income, thus alleviating rural poverty (Mwakalila, 2006). However, the increase in irrigated area in Tanzania should be considered small, and certainly insufficient. In the period from 1961 to 2011, the share area equipped for irrigation in the agricultural area increased from 0.77 ‰ to 0.49 % and for the last 10 years is maintained at 184 thousand ha (Fig. 1).



Source: Results of own study based on the FAO statistic database (www.fao.org)

Figure 1. The changes of area equipped for irrigation versus the agricultural area and total land area in Tanzania

The story of the Faculty of Civil and Environmental Engineering of Warsaw University of Life Sciences involvement to support the activities of the humanitarian and development assistance is long. Since November 2005, when a cooperation agreement between WULS-SGGW and the Polish Humanitarian Action Foundation (PHA) was signed, the University scientists serve their knowledge and experience. The activities of PHA, associated with the carrying on the outreach around the world, are factually supported by the staff of the Faculty of Civil and Environmental Engineering in the drinking water treatment, environmental quality improvement and pollution reduction. Evaluation of Water Program conducted by the Polish Humanitarian Action in Chechnya, made in collaboration with the Faculty of Chemical and Process Engineering, Warsaw University of Technology, was carried out during the field researches in 2006. Recent advances of the Faculty in the field to develop poorer regions of the world was the development project financed by the Ministry of Foreign Affairs under the Polish Aid Program completed in 2009. The beneficiary of the project was LITA Tengeru - one of the Tanzanian training institutions. In 2010, next development project in Tanzania, funded by the Ministry of Foreign Affairs: "The proper water management as an increasing factor of agricultural production efficiency", which was also realized with the LITA Tengeru, was completed. One of the project`s goals was implementation of new irrigation techniques.

Some elements of the project was continued in 2012 under the Polish Aid project: "On the way to the University – ecological background of infrastructure development of LITA – Tengeru".

THE STUDY AREA

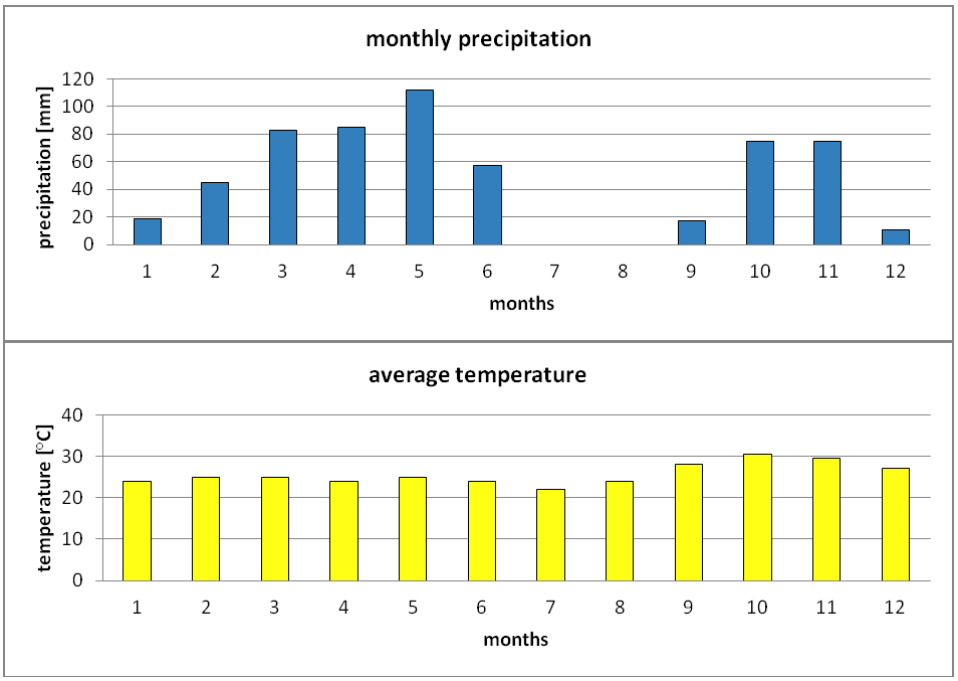
The Livestock Training Agency (former LITA) Tengeru located in north-east Tanzania at the lower slopes of Mount Meru, about 14 km from Arusha, is one of the training institutions under the research, training and extension directorate of the Ministry of Livestock Development and Fisheries of Tanzania. Agency was established in 1952 after the departure of the Polish refugees at the end of the Second World War. The Agency holds remarkable history for being the Headquarters of the East African Community from 1967 to 1977. Currently, the Agency has 450 students in their first and second year of their studies. LITA`s vision is to be a centre of excellence in practical training in livestock skills aimed at producing competitive personnel and competent farmers.

The project area is arable pasture belonging to LITA Tengeru, located in the southeastern part of the Agency campus. The field in the structure of land LITA described as "Block O" with an area of □□approximately 40 hectares has a shape of an elongated triangle oriented from north-west (top) to south-east (base). The boundaries of the study area are two roads (south-east, south-west) and the Malala River (north-east).

The analyzed field is overgrown with Rhodes grass (*Chloris gayana*) grown for hay to feed cattle. *Chloris gayana* is one of the major tropical forage grasses, originating from Africa, but widely grown and naturalized throughout the tropics and subtropics. Grass is a valuable feed resource, suited for use under various conditions in tropical areas (Ponsensb et al., 2010).

The climate in Tanzania varies from tropical on the coast to temperate in the highlands. There are two predominant precipitation regimes in the country with an average annual rainfall of 600–800 mm. Only a few areas in Tanzania receive 1000 mm precipitation annually. In the northern parts, one finds a bi-modal precipitation regime with long-duration rains generally occurring between March and May and the short-duration rains experienced from October to December. The rest of the country generally experiences rain from December to May (ICID, 2013). In Tengeru, the main wet season occurs during March to May, while there is a less distinct precipitation peak during October to December. The period from June to September is generally dry, and the January to February period yields some rain, but less than during the wet seasons.

Meteorological data (rainfall [mm], temperature [°C]) were measured on Tengeru Meteorological Station. Station no 9336035 is located at a latitude 3:23:00 S, longitude 36: 52 E, and altitude 1280 m. Monthly values of precipitation and air temperature measured in 2011 are shown in Fig. 2.



Source: Results of own study based on data received from LITA Tengeru.

Figure 2. Monthly precipitation and average air temperature measured on meteorological station Tengeru in 2011

PROJECT IMPLEMENTATION

The implementation of the irrigation system on meadows belonging to LITA began in 2010 and was continued in 2012. The irrigation system was established during the implementation of the two projects co-financed by the Ministry of Foreign Affairs of Republic of Poland under the Polish Development Programme.

Both projects were financed independently and were not formally the whole. The specificity of the projects under the scheme of Polish Development Programme allow for the financing and implementation for only one year period. In practice, however, due to the availability of financing, the time is limited to about seven months. This is because spending of public funds requires using the provisions of the Public Procurement Act, which, with limited time, makes it difficult to carry out the work. The amount of available funds in comparison with other European aid programs is relatively low, which usually does not let the action in full required dimension.

In 2010, as a part of the work and activities prior to the start of earthworks associated with the construction of water reservoir, several studies and field research were conducted. Their goals were to determine the ground water conditions at the place of the planned investment. The analyze of the first occurrence of contingencies in the ground permeable layers of soil and soil compaction makes possible the feasibility of forming the building blocks of reservoir embankments. In the case of unfavorable conditions newly created reservoir could not perform its function (accumulated water could percolate into the soil profile) or the embankments could be destroyed by the pressure of water gathered on them. Prior to earthworks it was necessary to construct the drainage ditch that intercepted water from a neighboring area. The area was then cleaned from the overlying vegetation of grass, shrubs and trees. Excavation works were carried out under the supervision of project partners from the WULS - SGGW, using the services of a Tanzanian company contracted to this purpose. As a result - an earth construction water reservoir with dimensions of 82 x 67 meters was constructed for irrigation. Assuming an average depth of 2 m, the volume of stored water is around 10 th. m^3 is necessary to its fill. Water for filling the reservoir comes from underground sources and neighboring precipitation period, the rainy season. Very important factor which should be taken into account in designing the rules of water management in terms of deficit is the need to address the needs of the existing customers. In the case of the African failure it may lead very easily to social unrest, sometimes with very violent progress. Quite often stalling natural rivers or streams and building the water reservoirs is being seen as an attempt to appropriation of water.

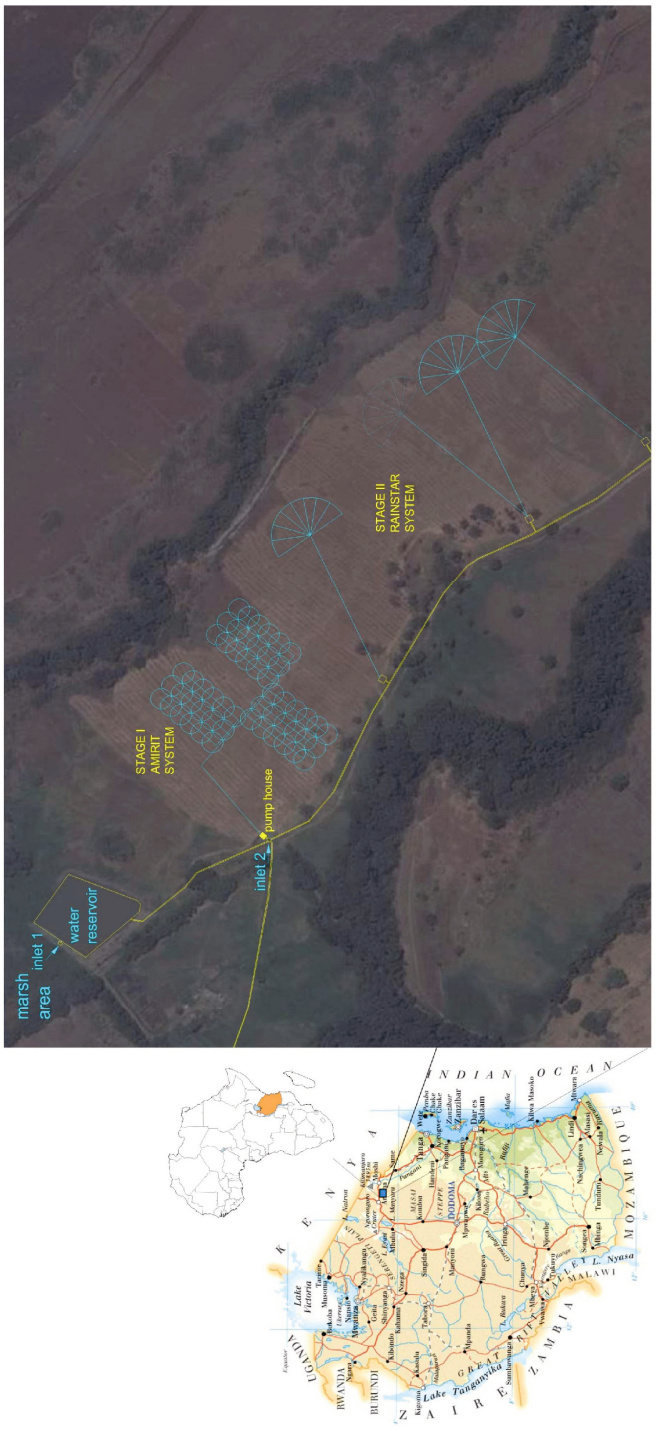
Water accumulated in the reservoir was used for irrigation of meadow during dry season. Second source of water for irrigation was a small reservoir on forest stream, localized about 0.6 km from meadows. Water from that source is transported to the field by small canal (Figs. 3, 4). Trapezoidal-shaped channel with the maximum total flow field of 0.26 m^2 was originally made from rectangular concrete panels of 5 cm thickness, sealed by concrete plastering. The walls of many, often long, stretches of concrete canal lining were completely or partially destroyed. As the result, it was found that the irrigation canal wasnot used for many years and its condition did not allow for the life restoration without the required repair and reconstruction project. Along almost the entire length the channel was overgrown with grass and bush vegetation. In the opinion of WULS-SGGW supervisors the destruction of irrigation canal reached about 30% of total length. After inventory completing and plan set-out to the cleaning the canal embankment and removal of vegetation, soil and debris from the canal begun to flow. These activities were made by employees of LITA Tengeru. In consultation and with the assistance of the Beneficiary (LITA Tengeru Principal

and Local Coordinator of the Project) the recognition of the local market of suppliers of building materials has been made. The construction and reconstruction of the channel, launched under the supervision of WULS-SGGW partners, was the basis of the plan works, supplied by the materials and the staff provided by LITA Tengeru to perform the work.

The construction work was carried out partially throughout 1-km canal. According to the recommendations of the WULS-SGGW staff the trees adjacent to the course of the channel (mostly *Eucalyptus*) were cut off, because of the high probability of destroying the channel by the roots or fallen trunks. The supporting works consisted of the sitting of unblocking culverts under the road and driveways on the fields, building a small (20 m^3) concrete water reservoir and rebuilding the valves controlling the flow of water distribution points. As a result, the channel carrying water for flood irrigation of arable meadow was activated. The water channel is also an alternative source for the sprinkler irrigation system. The effect of the works allowed bringing water for flood irrigation of meadow lands of □□approximately 30 hectares.

At the next project step the overhead sprinkler irrigation system was designed and - after the purchase of its components - has been installed on a grassland meadow - Rhodes grass (*Chloris gayana*) on the area near the ground water reservoir. The system (Amirat, designed by Naan) is based on the movable Naan 5035 overhead sprinklers (plastic, impact) with 3.5 mm nozzle, installed on lightweight irrigation stands, height 1.70 m and spaced 15 meters. The sprinklers on the stands are connected by quick connectors to PE 50 mm pipe sections. The PE sections (rows of three) are connected to the main PVC pipe with diameter 110 mm installed permanently underground.

During the first stage small building for the controlling equipment and a diesel pump pumping water from the nearby built small concrete reservoir were built. Scheme of sprinkler irrigation system (stage I) is presented in Fig. 3. The effect of the work carried out in the project allowed for the possibility of sprinkling irrigation for an about 10-ha meadow land area. In accordance with the project the commissioning and operations of sprinkler irrigation system have helped to reduce the deficit of water in the soil profile and to ensure favorable conditions for plant growth, which leads to an increase in yield of hay per hectare gained from both the yield and unit growth in the number of hay cuts. Technical staff from LITA Tengeru has been trained in the operating of irrigation system. The effect of the works in 2010 allowed to bring water for flood irrigation of meadow land of □□approximately 30 hectares and sprinkler irrigation of 10 hectares.



Source: Results of own study based on Internet sources.

Figure 3. Localization and scheme of irrigation project implemented in Tengeru

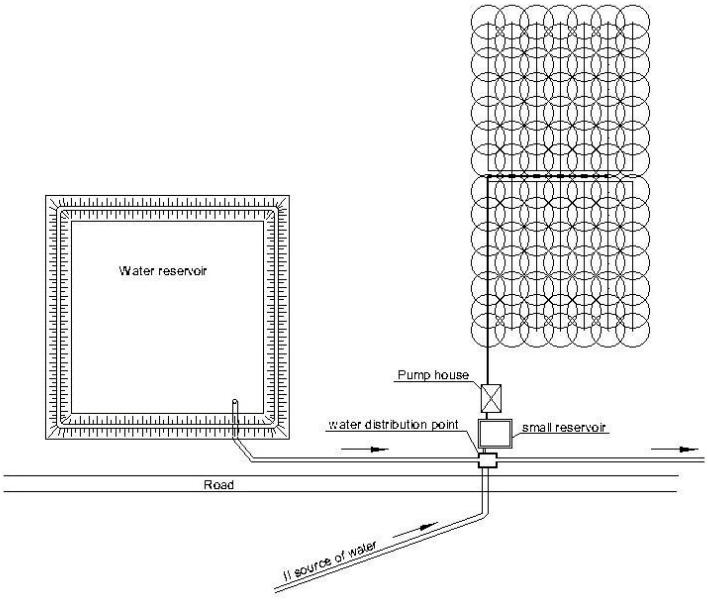


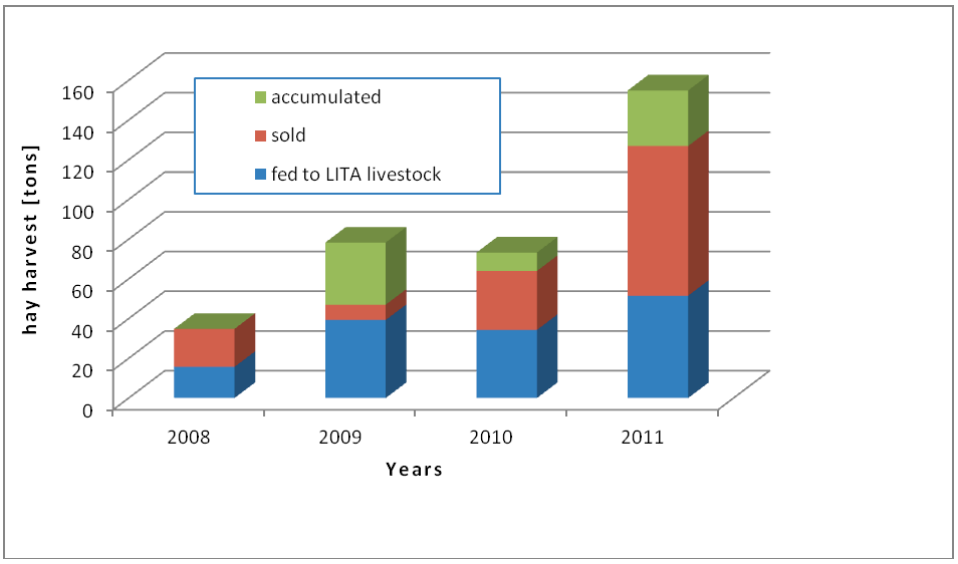
Figure 4. The scheme of main elements of irrigation system implemented in LITA Tengeru

Photo 1. Basic elements of II stage of implemented irrigation project (water reservoir, tractor operated pump and hose reel irrigator)

The sprinkler irrigation system implemented under the project in 2012 was the continuation of previous activities carried out in 2010. As part of the project, implemented in 2012, two hose reel irrigators made by Bauer company - smaller model Rainstar A3, and bigger model Rainstar T41, with supplying them an engine driven tractor water pump were purchased and installed. The hose reel irrigators are supplied with water stored in small concrete reservoirs. Four square, concrete water reservoirs with a capacity of 50 m^3 each and one reservoir of circular cross section and a capacity of 80 m^3 were constructed as the part of the project. Small water reservoirs are supplied with water from a large earth construction reservoir, built in 2010. Small reservoirs construction was co-financed by the Ministry of Foreign Affairs RP and LITA Tengeru. The effect of the work carried out in the project made sprinkling irrigation for the meadow land area of about 30 hectares possible. In accordance with the project the commissioning and operations of sprinkler irrigation system have helped to reduce the deficit of water in the soil profile and to ensure favorable conditions for plant growth, which have led to increase in field of hay per hectare gained from both the field and unit growth in the number of hay cuts. The LITA Tengeru staff has been trained in the use of irrigation system. The implementation of the task allowed for obligatory inclusion of any additional operation rules of that kind of system to the teaching program conducted in LITA Tengeru.

RESULTS AND DISSCUSION

As a result of two development projects implemented in Tengeru in 2010 and 2012 the mobile irrigation system for irrigating about 35 ha of grasslands was designed, built and set in. The implementation of the irrigation system allowed for a significant increase in the production of hay. In the analyzed time period (from 2008 to 2012) the increase in yields of hay from 34.7 tons to 237.3 tons was noticed. It also managed to get an increase in the number of cuts from one in 2008 to three in next year. The increase in harvested crop of hay helped to meet the needs of LITA in animal feeding, accumulation of feed and the sale of surplus hay in the coming years. Total yield of harvested hay, taking into account and accumulation of sale, is shown in Fig. 5. The resulting implementation of the irrigation project increase in hay production should be considered valuable, especially in the conditions of advancing climate change and its potential impact on the reduction of agricultural production in Tanzania (Rowhania et al., 2011).



Source: Results of own study based on data received from LITA Tengeru.

Figure 5. Hay harvested in Tengeru in period 2008-2012

CONCLUSIONS

1. The implementation of development projects characterized by their specificity, regarding the implementation of logistics operations, reduced lead time and financing.
2. Agriculture Sub-Saharan Africa is closely dependent on rainfall. The deficiency may be supplemented by irrigation.
3. As a result of two development Projects, implemented in Tengeru in 2010 and 2012, the mobile irrigation system for irrigating about 35 ha of grass-lands was designed, built and set in.
4. In the analyzed time period (from 2008 to 2012) an increase in yields of hay from 34.7 tons to 237.3 tons was noticed. It also managed to get an increase in the number of cuts from one in 2008 to three next year.

REFERENCES

ICID. Tanzania country profile. Available online at: http://www.icid.org 2013.

Mbiha E. Aid Dependence and poverty alleviation effects of alternative aid programs The case of Tanzania. The Global Development Network, New Delhi, India, 2009, pp.:80.

Mwakalila S. Socio-economic impact of irrigated agriculture in Mbarali District of south-west Tanzania. Physics and chemistry of the Earth. 31 (2006), pp.: 876-884.

Rajabu K. The role of participatory problem analysis in performance improvement and sustainable management of rainwater harvesting (RWH) systems: A case study of Makanya village,Tanzania. Physics and Chemistry of the Earth, vol. 30, 2005, pp.: 832–839.

Rotarou E. Ueta K. Foreign Aid and Economic Development: Tanzania`s Experience with ODA. The Kyoto Economic Review 78 (2), 2009. pp.:157-189.

Rowhania P. Lobellb D. Lindermanc M. Ramankuttya N. Climate variability and crop production in Tanzania. Agricultural and Forest Meteorology vol. 151, 2011, pp.: 449–460.

Ponsensb J. Hansona J. Schellbergb J. Moeselerb B.M. Characterization of phenotypic diversity, yield and response to drought stress in a collection of Rhodes grass (Chloris gayana Kunth) accessions. Field Crops Research vol. 118, 2010, pp.: 57–72.

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