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THE IRRI PROJECT OF IRRIGATION – EXAMPLE OF DEVELOPING EASTERN CROATIA

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ABSTARCT

"IRRI - The Irrigation Project" is by EU through IPA II Cross-Border Program Croatia – Bosnia and Herzegovina and implemented by the Municipality of Lovas on the Croatian side and Municipality of Odžak on the Bosnian and Herzegovina side together with project partners: Vukovar-Srijem County, Municipality of Tompojevci, Associations of Users of the Opatovac and Tompojevci Irrigation System, Municipality of Šamac and Association Independent Office for Development.

The project seeks to increase incomes by reducing the effects of droughts which in crossborder region occur once in three to five years. The average yield of primarily vegetables, fruit and other crops is low comparing to European Union countries. Also one of the major problems is lack of education, basic knowledge and training what leads to the fact that farmers are not involved in the growing global irrigation trend.

Therefore, the project is intended to develop demonstration irrigated fields through investments that are cost effective, environmentally and socially sound and beneficial to the rural poor. Special accent is put on education where conducted series of workshops and field trainings will enable the transfer of the latest knowledge and technologies in the field of irrigation and establish a number of experts in irrigation. All results of project activities are presented to the wider audience through events, presentation and demonstration fields.

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The aim of the assignment is to contribute to increase crop productions and raise farmers' incomes in the municipalities Lovas and Tompojevci through supporting of production of agriculture producers by introduction of the system for irrigation, enhancing of knowledge of farmers and expertise of technicians and increasing of cooperation and public awareness in irrigation.

Key words: *IRRI project, project of irrigation, irrigation technique, agricultural crops, irrigation conditions, expected irrigation effects*

SAŽETAK

"IRRI – Projekt navodnjavanja" financiran je iz Europske unije sredstvima IPA II Prekograničnog programa Hrvatska – Bosna i Hercegovina. Nositelj projekta je Općina Lovas, a projektni partneri su Općina Tompojevci, Vukovarsko-srijemska županija te udruge korisnika sustava za navodnjavanje iz Opatovca i Tompojevaca dok je od strane Bosne i Hercegovine za provedbu zadužena Općina Odžak sa partnerima Općinom Šamac i Udruženjem Nezavisni biro za razvoj.

Projekt teži povećanju prihoda smanjivanjem učinaka suša koje se u pograničnom području Hrvatske i Bosne i Hercegovine pojavljuju jednom u tri do pet godina. Prosječni prinos prvenstveno povrća, voća i drugih usjeva je mali u usporedbi sa zemljama Europske unije. Jedan od većih problema je i nedostatak obrazovanja i temeljnih znanja, što u konačnici dovodi do toga da poljoprivrednici nisu dovoljno uključeni u rastuće globalne trendove u navodnjavanju.

Projektom su postavljena demonstracijska polja kroz ulaganja koja su isplativa, ekološki i socijalno zdrava i korisna za ruralna područja. Poseban naglasak je stavljen na edukaciju te su održane radionice i obuka na terenu, omogućen je prijenos najnovijih znanja i tehnologija na području navodnjavanja, a obučen je i određeni broj stručnjaka za navodnjavanje. Svi rezultati projektnih aktivnosti predstavljaju se (projekt u tijeku) široj javnosti putem organiziranja raznih događanja, prezentacija i demonstracijskih polja.

Projektom se želi doprinijeti povećanju proizvodnje usjeva i povećanju prihoda poljoprivrednika u općinama Lovas i Tompojevci kroz poticanje proizvodnje poljoprivrednih proizvođača uvođenjem sustava za navodnjavanje u poljoprivredi, unaprjeđivanje znanja poljoprivrednika i stručnosti tehničara (trenera) i povećanjem suradnje i svijesti javnosti o navodnjavanju.

Ključne riječi: IRRI projekt, projekti navodnjavanja, tehnika navodnjavanja, poljoprivredne kulture, preduvjeti navodnjavanja, očekivani učinci navodnjavanja

1. Introduction

Climate changes, especially precipitation and temperature regimes, have often adverse influence on the quantity of field crop yields. Annual global temperatures have increased for approximately 0.4 °C since 1980, with even larger changes observed in several regions (IPCC, 2001). Lobell and Field (2007) estimated that approximately 30% variations of global average yields for the world's six most widely grown crops (wheat, rice, maize, soybeans, barley and sorghum) are result of growing season precipitation and temperature variations.

Josipović et al. (2014), in four-year investigation, were satisfied by grain yields of tested maize inbred lines in amount 1809 kg ha⁻¹ under N non-fertilized conditions which is an indication of the high level of natural soil fertility. Maize yield under more favorable weather

conditions of the 2006 growing season was about 3-fold higher (average 2450 kg ha⁻¹) in comparison of yield achieved under drought and the high air-temperature stress of 2007 (823 kg ha⁻¹). Maize yield under non-irrigated conditions was 1500 kg ha⁻¹. By two steps of irrigation yields of maize were lineary increased for 21% and 41%, respectively. Differences of the 4-year average yields among the maize genotypes were in range from 1259 to 2765 kg ha⁻¹.

Heat and drought-stress conditions very frequently have an impact on the quantity and quality of wheat production in the most regions of the world (Kovačević et al., 2014). Therefore, it is essential to improve drought and heat stress tolerance in wheat breeding programs (Reynolds et al. 2007; Shao et al. 2008; İlker et al. 2011). Many authors investigated a water deficit or drought stress impact on agricultural plant and reported that water deficit leads to the perturbation of all, or some of physiological and biochemical processes thus, consequently reduces plant growth and yield (Ingram and Bartels 1996; Denčić et al. 2000; Shao et al. 2005a, 2005b; Boutraa 2010; Akhkha et al. 2011) as well as the rate of photosynthesis in plant (Sharkey 1990; Cornic 2000; Lawlor 2002; Akhkha et al. 2011). Rational water use of plant cultivars can be a good indicator of plant production in water-limited conditions (Passioura, 1977; Reynolds et al., 2007; Araus et al., 2008; Blum 2009; Yong'an et al., 2010).

Building of water accumulations and increases of irrigated arable lands could be priorities, particularly with aim of application to high profitable activities as vegetable growing and seed production of the field crops (Kovačević and Josipović, 2013).

The project seeks to increase incomes by reducing the effects of droughts which in crossborder region occur once in three to five years. The average yield of primarily vegetables, fruit and other crops is low comparing to EU countries. Also one of the major problems is lack of education and training what leads to the fact that farmers are not involved in the growing global irrigation trend.

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Therefore, the project is intended to develop demonstration irrigated fields through investments that are cost effective, environmentally and socially sound and beneficial to the rural poor. Special accent was put on education where conducted series of workshops and field trainings was enabling the transfer of the latest knowledge and technologies in the field of irrigation and establish a number of experts in irrigation. All results of project activities were presented to the wider audience through events, presentation and demonstration fields.

The aim of the project is to contribute to increase crop productions and raise farmers' incomes in the municipalities Lovas and Tompojevci through supporting of production of agriculture producers by introduction of the system for irrigation, enhancing of knowledge of farmers and expertise of technicians and increasing of cooperation and public awareness in irrigation. In order to improve competences of target groups it is foreseen: a) conducting of research related to the irrigation management of current practice within targeted areas with developed irrigation practices register, b) setting up and following up demonstration plots on improved water management/farming practices in the project areas and conducting of research at experimental area over one production season, c) conducting of training of technicians to advice farmers on irrigation methods with developed manual on irrigation techniques, d) presentation of the results and study trips to established irrigation systems.

2. Material and methods

Under the requested services of the IRRI – irrigation project we have had three lots of services: 2.1. LOT 1 - Irrigation Development Expert, 2.2.; LOT 2 - Workshop Expert - Management and administration of irrigation systems and Irrigation System Design and 2.3. LOT 3 – Train the trainers course Irrigation specialist.

a. LOT 1 - Irrigation Development Expert

Support and facilitate the Contracting Authority in planning and implementation of small-scale irrigation schemes, with particular emphasis to promotion of highly efficient and modern small-scale irrigation techniques. Specific responsibilities of the Irrigation Development Expert will include the following:

A. Study research of current irrigation practice within Vukovar-Srijem County,

B. Identify and discuss feasible scenarios of investments in irrigation on up to 20 agriculture plots,

C. Design irrigation schemes on at least 8 selected pilot agriculture plots,

D. Conduct research at pilot agriculture plots over one production season.

b. LOT 2 - Workshop Expert - Management and administration of irrigation systems and Irrigation System Design

The expert will design and conduct two one-day workshops on following topics:

1. Management and administration of irrigation systems.

2. Irrigation system design. The expert should prepare training material. The course includes a certificate on completion.

c. LOT 3 - Train-the-trainers course Irrigation specialist

The expert will design and conduct 20-day train-the-trainers for at least 10 trainees. The objective is to provide a group of local technicians with appropriate level of skills for competent planning and installation of agricultural irrigation systems, as well as with ability to provide counsel to local growers on best management practices in irrigation of agricultural crops. The education is a combination of theory and practical work. The trainers should produce training manual. The course includes a certificate on completion. These Lot have had two parts:

- 1. Theoretical education and
- 2. Field practical training.

3. Results and discussion

On the basis of tasks mentioned in the material and methods we realized tasks LOT by LOT. Because we have relatively short time to realize planed program of the IRRI- irrigation project, Agricultural Institute Osijek, who was the responsibility and sign the contract with municipality of Lovas, organized expert team which one by one prepared his specialties.

First of all, we take the TOR - term of reference and one by one part solved.

In connection with the project coordinator, Anica Panenić, we organized the meeting with all interested farmers, as potential applicants for irrigation project. Total amount from Lovas and Tompojevci municipality was eighteen. We visiting the farmers, one by one, and on the bases of 12 parameters made a decision who will be applicant of the project. The mentioned parameters were: 1) soil suitability for irrigation, 2) necessity for irrigation – climate criteria, 3) waters sources and water quality for irrigation, 4) quantity of water for irrigation, 5) mark of the user, 6) experience and practice of the user, 7) crop and benefit from crop, 8) market of

the produced crop, 9) registered family farm - OPG subject ("obiteljsko poljoprivredno gospodarstvo"), 10) cost benefit effect, 11) water protected area and 12) expert estimated value. Each parameters had mark from 1 to 5 (from bad = 1 to excellent = 5).

After we made rang list and chose the users (6 from Lovas and 7 from Tompojevci), we started with projecting of the irrigation systems. For each user we prepared the irrigation project with necessity details.

d. LOT 1 - Irrigation Development Expert

Under the plan of LOT 1 we planning and implementing the small-scale irrigation schemes, with particular emphasis to promotion of highly efficient and modern small-scale irrigation techniques. Specific responsibilities of the Irrigation Development Expert include the following:

A. In the "Study research of current irrigation practice within Vukovar-Srijem County" we made report (80 pages) and wright actual situation about the political, legal and economic management model, barriers and potentials in irrigation in Croatia, Vukovasko-srijemska county and Lovas and Tompojevci municipalities.

B. We identify and discuss feasible scenarios of investments in irrigation on 18 agriculture plots: a) we visited field to municipalities of Tompojevci and Lovas to the proposed agriculture plots to assess their irrigation potential, b) assess the technical potential for construction or improvement of short listed potential irrigation agriculture plots, technical and cost-benefit analysis, c) recommend the correct irrigation regime with emphasis on maximizing water use efficiency, d) identify, suggest and discuss feasible scenarios of investments in irrigation.

C. We design irrigation schemes on 13 selected pilot agriculture plots: a) planed, designed and specified irrigation equipment for the selected agriculture plots, b) support and facilitate the Contracting Authority in development tender documents, designs and technical specifications, c) supervised implementation, operated and maintenance of irrigation systems on the selected agriculture plots, d) in drilling wells, used the hydrogeological data to determine the location of drilling.

D. We conduct research at pilot agriculture plots during this (year 2014) production season: a) collecting field data from pilot plots to deliver proof for irrigation necessity, b) developed and conducted irrigation site visit program, c) organize at least four events to demonstrate results to wider public (including one-day irrigation site visit).

e. LOT 2 - Workshop Expert - Management and administration of irrigation systems and Irrigation System Design

The experts were designed and conducted four one-day workshops (plan was two) on following topics:

- 3.2.1. Management and administration of irrigation systems were done in two days (one in Lovas and one in Šamac). Through this introductory course users might learn the basics of irrigation installation. Topics that will be also covered included: introduction to irrigation and product identification and terminology.
- 3.2.2. Irrigation system design was done in two days education, also (one day in Orašje -BiH and one in Tompojevci - Croatia). Course was made on basic principles and techniques for designing irrigation systems within industry guidelines. Topics that will be also covered included: techniques in installation and system set-up and fine tuning.

Training offered to all interested farmers. The expert produced training material (paper and computer presentation). The course included a certificate on completion.

3.3. LOT 3 - Train-the-trainers course Irrigation specialist

The expert designed and conducted 16-day train-the-trainers for at least 12 trainees. The objective was to provide a group of local technicians with appropriate level of skills for competent planning and installation of agricultural irrigation systems, as well as with ability to provide counsel to local growers on best management practices in irrigation of agricultural crops. The education was a combination of theory and practical work. The trainers produced training manual which have basic lectures for trainers. The course included a certificate on completion.

A. Theoretical education involved the following subjects:

Theme 1. Introduction in the irrigation systems and basic of irrigation: Irrigation – part of the hydro-technical amelioration; methods and manners of irrigation; soil drought; crop water supplies; water balance; irrigation rate; irrigation distance; time off irrigation and hydromodul of irrigation.

Theme 2. CROPWT program for irrigation – application: Introduction; reference evapotranspiration; crop water requirement; month evapotranspiration and rainfall amount; crop data; crop water supplies; irrigation supplies; optimal irrigation; irrigation schedule; irrigation practice.

Theme 3. Legal regulation for water and irrigation: Introduction; legality regulative; national irrigation program; developing of irrigation projects.

Theme 4. Agronomic irrigation basis: Introduction; basic pedology and soil irrigation properties.

Theme 5. Others agronomy basis for irrigation: Introduction; water in the soil; implement of crop rotation in irrigation; actual cropping structure; planed cropping structure; total growing season; planning water supplies.

Theme 6. Impact of irrigation on the crops: Irrigation impact on the vegetable; irrigation of fruit plants; grape wine irrigation impact; irrigation in indoor farming - green house's; autumn tomato production – experience of the farmer Ljikar Željko.

Theme 7. Hydrologic and meteorological basis for irrigation: hydrologic and meteorological parameters; hydrologic drought; basis for irrigation; irrigation equipment parts; hydraulic calculation.

Theme 8. Water sources and water quality for irrigation; irrigation water sources; irrigation water quality.

Theme 9. Crop fertilization importance in agriculture production in irrigation: Introduction; soil as a source of crop fertilizers; content of biogenic elements in plants; soil measure of soil fixing – fertilization and liming; mineral fertilization.

Theme 10. Basis of current fruit production in irrigation conditions: Introduction; agro ecological growing conditions; soil cultivation for planting; growing system and plant number; planting and production area organization; soil fertility maintenance; waste production worthy.

Theme 11. Problems and consequences of non-proper irrigation: Problems of nonprofessional irrigation; environment irrigation impact.

Theme 12. Specific notes of used equipment: 12.1. Basic notes of meteorological station, "Pinova"; 12.2. Basic notes of soil water equipment control - Gato automatika d.o.o.; 12.3. Irrigation equipment specificity on the IRRI project - "Pšeno d.o.o.".

During the 8 working days experts presented mentioned themes and trainers got each presentation and published "book for irrigation practice on the IRRI - irrigation project".

B. Field practical training

Themes made in to two parts, the first one was during the summer time in year 2013 and second during the May and July in 2014.

B1. On-the spot knowledge implementation during implementation of pilot irrigation schemes (8 days). According the plan and program, 8 themes were made in the field directly with prepared data: name of presenter, date, time and place were presentation will be.

1. Pedology basis for irrigation practice – practical part:

Showing in situ basis of pedological equipment for soil sampling; practical showing two soil pedology profiles (sampling and soil description, in peach orchard).

2. Irrigation and heating system indoors (green house):

Production of vegetable for replanting and producing paper and tomato – basic technology; water sources was deep well; parts of heating and irrigation system; crop water requirement; soil water content (in OPG Ljikar Željko, Mikluševci).

3. Irrigation system on the potato seed production:

Self-propelled traveling irrigator (tifon); storing potato seed; irrigation system in red paper; parts of the system; specific of production; water source; crop water requirement; soil water control; yields and its specificity in 2013.

4. Irrigation system in pears and apple orchards:

Water sources reservoir 5000 l and pipeline; distribution pipeline with compensation drip irrigation system; distribution pipeline with micro irrigation system; distribution pipeline with drip irrigation system; distribution pipeline, drip irrigation system on the wire above the soil; (in pear and apple orchards).

5. a) Irrigation system in the plum orchard:

Water sources pipeline; drip irrigation system on the soil surface; Chlorine as a problem in pipeline water source in crop production; growing season specificity for plum production (practice in the plum orchard),

5. b) Irrigation system on the vegetable production:

Water sources is pipeline; specific of vegetable production in the year 2013 growing season; parts of the irrigation system,

5. c) Irrigation system on the grape for vine:

Water source is pipeline; parts of the irrigation system; specific of the 2013 growing season.

6. Device for soil moisture control; meteorological station "Pinova" and bore holing wells.

7. a) Irrigation system in the peach orchard:

Water source is reservoir 5000 l; drip irrigation system on the soil surface; specific of the irrigation system and the growing season.

7. b) Irrigation system in the peach orchard:

Drip irrigation system on the soil surface; water source is deep well; peach production specific in growing season.

8. Sustainable irrigation in orchards:

Production in orchards; practical lectures in apple, peach and pear orchards; fertilization; cutting; irrigation.

B2. Demonstrate results of the pilot agriculture plots over one growing season 2014 to wider public; presentation of the results (brochures; open).

During the growing season 2014, were set trials with all crops in the irrigation project planed: plums, pears, peach, apple, grape for vine, vegetables, potato for seed, red paper. Treatments

with two irrigation regime were set on mentioned crops. Except the yields of tested crops the important quality parameters will be tested.

4. Conclusions

The different irrigation treatment impact on tested cops is expecting. The set irrigation equipment will be factor to ensure stability of yields and quality of agricultural products. Quality water, irrigation equipment and knowledge are basic suppose for safe and good yield.

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