ISSN: 2490-3442

UNIVERSITY OF EAST SARAJEVO
FACULTY OF AGRICULTURE

Agrofor

AGROFOR International Journal

AGROFOR International Journal, Vol. 1, Issue No. 1, 2016

www.agrofor.rs.ba

AGROFOR International Journal

PUBLISHER
University of East Sarajevo, Faculty of Agriculture
Vuka Karadzica 30, 71123 East Sarajevo, Bosnia and Herzegovina
Telephone/fax: +387 57 340 401; +387 57 342 701
Web: www.agrofor.rs.ba; Email: agroforjournal@gmail.com

Frequency: 3 times per year
Number of copies: 300
ISSN 2490-3434 (Printed)
ISSN 2490-3442 (Online)

CONTENT

10.7251/AGRENG1601006G
UDC 633.12

THE INFLUENCE OF LOCALITY AND FERTILIZATION ON BUCKWHEAT QUALITY

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ABSTRACT

Buckwheat (Fagopyrum esculentum Moench.) is a plant species which has been spreading in Bosnia and Herzegovina in the last decade. Because of its brief vegetation period, this crop species is especially interesting for hilly-mountainous regions. In 2015, the experiments were set in three localities (experimental field of the Faculty of Agriculture "Kula", private economy "Sando" on the Nišići plateau and private economy "Jugović" in Mokro), and two variants of fertilization (control variant – without the use of organic and mineral fertilizers and the use of $N_{60}P_{60}K_{70}$). The Slovenian sort Darja was used for the experiments. The analysis of seed quality included the following analyses: humidity content (%), mineral matters content (%), protein content, starch content, carbohydrates content. In testing the qualitative characteristics for all localities and fertilizations we determined: 14.2% of humidity in seed, 1.47% of mineral matter in a peeled buckwheat grain, 11.88% of proteins in a peeled buckwheat grain, 51.9% of starch in a peeled buckwheat grain and 71.87% of carbohydrates.

Key words: *buckwheat, locality, fertilization, proteins, agroecological conditions, grain.*

INTRODUCTION

Buckwheat (*Fagopyrum esculentum* Moench) is an old plant species which originates from mountain regions of northeastern Asia. It was brought into Europe by Mongols in late 14^{th} century. Today, buckwheat is grown throughout the world on about 2.3 millions of acre, with average yield of about 1.0 t ha^{-1}.

After the World War II, the buckwheat production in Bosnia and Herzegovina stopped due to intensified production of wheat, migration of population from countryside to industrial areas and especially because of low and unstable yield, and therefore non-economical production. Since 1995, the buckwheat is returning again on the fields of Bosnia and Herzegovina (Milić et al., 2013). The surfaces under buckwheat are increasing year after year. The reasons for intensive increase in surfaces under buckwheat are: it is suitable for growing in hilly-mountainous regions which are dominant in our areas; it has humble demands in regards of fertilizers and pesticides; there is a significant number of producers whose

production is certified as organic. Due to various uses in nutrition and medication there is a big demand for buckwheat products on both domestic and foreign market. Peeled grain consists from around 80% starch, 10-15% proteins, 1-2% fibers, 2-3 % fats and 1-2 % of mineral matters, iron, phosphor and iodine (Jevđović et al., 2012) It also contains B vitamin complex (buckwheat grain contains 150% more of B vitamin complex than wheat grain), essential amino acids (8,6-9,3%).

Thanks to simple agrotechnics which implies growing without use of chemicals, it can be grown as main or additional crop, or as a part of „eco – corridor" between some crops *(Krupa-Kozak et al.,* 2011).

The purpose of this paper was to examine and compare the quality of buckwheat sort Darja on three different localities in the Sarajevo – Romania region (entity of Republic of Srpska, Bosnia and Herzegovina). This research, although they are short – term, can contribute to expansion of buckwheat grow, and also to determination of areas for production of quality buckwheat.

MATERIAL AND METHODS

In 2015, research was conducted on the territory of Sarajevo – Romania region (Bosnia and Herzegovina), to determine which locality is suitable for growing buckwheat, and does mineral nourishment influence the buckwheat quality. The experiments were set up on three localities, and seeds of buckwheat sort Darja were used for seeding. Darja was created by crossbreeding of black buckwheat and chosen genotypes of Russian buckwheat. The flowers are white, seeds dark brown, with slightly larger shell percentage. Diploid sort, lateral flower branches end in flower blossoms, while the main flower branch is of unlimited growth. It's drought and high temperatures, as well as lay down resistant, but it's sensitive on low temperatures. Soil samples were taken before setting of the experiment with agrochemical probe from the depth: 0–30 cm.

Chemical analyses were conducted in the laboratory of Faculty of Agriculture in East Sarajevo:

- PH values of soil: (I) in the water (H_2O) or active soil reaction, (II) in a 1M KCl solution or substitute soil reaction, electrometric.
- Determination of humus content, bicromatic Tjurin method,
- Deteremination of easy – access phosporus (P_2O_5) spectrophotometric and potassium (K_2O), photometric,
- Determination of total nitrogen by modified Kjehdals method.

Bifactorial experiment (locality and fertilization) is set by random block system with four repetitions.

Factor one – locality (A):

- Faculty of Agriculture in east Sarajevo, experimental field, located at 550 meters above sea level (A_1);
- private property of Jugović family in Mokro, located at 905 meters above sea level (A_2) and
- private property of Sando family at Nišići plateau at about 1000 meters above sea level (A_3).

Factor two – fertilization (Б):

- Control ($Б_0$)
- $N_{60}P_{60}K_{70}$ ($Б_1$)

Basic soil treatment was conducted at fall, plowing at a depth of 30 cm, and at pre - sowing soil treatment the NPK fertilizer was added in the part of the experiment where fertilization was required. The surface of basic parcel was 12 m^2. The sowing was conducted by hand at a depth of 4 cm and sets of 250 plants per m^2.

At the Faculty of Agriculture's experimental field the sowing was done by hand on 08.05.2015., and the harvest was done by hand on 18.09.2015. The experiment in Mokro was set on 25.05.2015., and the harvest was done on 14.09.2015. At Nišići plateau the sowing was done 01.06.2015, and harvest was done 22.09. 2015. The harvest, as well as threshing was done by hand.

Meteorological data (temperature and rainfall) were monitored at two registered Meteorological stations (Butmir and Sokolac).

Seed quality analysis included following analysis:

- moisture content (%) – using Sl.l. SFRJ : 74/88 M.BR.8,II-1 method
- mineral matters content (%) – using Sl.l. SFRJ : 74/88 M.BR.10 method
- proteins content (Nx6,25) y % - ISO 20483:2006
- starch content (%) - Sl.l. SFRJ 74/88 M.BR.28
- carbohydrates content (%) - Sl.l. SFRJ 74/88 M.BR.28

All of the data was statistically processed using the Sigma Plot Windows 2000 (Jandel Scientific, Erkhart, Germany) and Statistica for Windows programs. The differences between individual localities for every tested parameter as well as fertilization differences were tested with LSD test.

Agroecological conditions in 2015

Faculty of Agriculture's experimental field „Kula“, East Ilidža Municipality

Faculty of agriculture's experimental field is located at 550 meters above sea level. Sarajevo Climate is under the strong influence of continental climate. Average annual temperature is 12,5 °C, and average rainfall amount is around 900 mm. The warmest month is august, and the coldest is January. There is the most rainfall in June, and the least in March. There is average of 85 days with temperatures over 30 °C in Sarajevo.

Table 1. Meteorological conditions in 2015 and perennial averages for Sarajevo (Meteorological station Sarajevo)

Month		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Average (1961-1990)	Temp.(°C)	-0.8	1.7	5.5	10	14.8	17.7	19.7	19.4	15.9	10.9	5.6	0.4
	Rfa. (mm)	74	69	73	76	85	94	83	73	73	79	98	88
2015.	Temp.(°C)	0.9	1.7	5.3	9.2	16.1	17.8	23.2	21.8	17.6	11.1	6	-0.5
	Rfa. (mm)	112.6	56.6	80.4	43.6	52.9	91	9.4	57.4	60.2	124	75	12.5

When comparing meteorological conditions during the experiment in 2015. On the experimental field at East Ilidža with perennial average we notice largger monthly temperature averages, as well as smaller amount of rainfall. In July there were only 9, 4 mm of rainfall, while the perennial average for this month is 83 mm. The experiment was set on alluvial soil (fluvisol) Chemical analysis is depicted in table 2.

Table 2. Chemical properties of soil on experimental field (East Ilidža – Kula)

Depth (cm)	pH/H_2O	pH/KCl	Humus	N	soluble mg/100g	
			%	%	P_2O_5	K_2O
0-30	7.16	6. 39	4.12	0.27	>40	36.41

Jugović private property (Mokro)

The experiment was set on a private property in the Mokro area. Average annual air temperature is 6,8°C, absolute maximum air temperature is 33,6°C, and absolute minimum temperature -30°C. According to Mićević (1979), the climate of the Romanija area is mostly mountainous, with harsh winters and chilly summers. Vegetation season starts on April 8th and lasts until October 22th, or 197 days in average. It's a period when air temperature exsceeds 5°C and when the movement of wood vegetation is noticable. Active duration of the vegetation season with temperatures over 10°C starts on May 6th and lasts until September 24th, that is 141 days. Late spring frosts can appear until the and of May, which is rear, and are almost regular in the first ten days of may. The intensity of theese frosts is milde od medium strong , with temperatures between -1°C and -4,2°C. During the year there is about 800 mm of rainfall, 430 mm which of are in the period April – September. Based on meteorological data(perennial average) it's visible that August is the critical month, because the amount of rainfall isn't suficient, considering that it's a month with high daily temperatures, so a lot is lost by evaporation. Meteorological conditions, as well as perennial average for Jugović private property is shown in table 3.

Table 3. Meteorological conditions in 2015. and perennial aerages for Sokolac (Meteorological station Sokolac)

Month		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Average (1961-1990)	Temp.(°C)	-4.2	-2.6	2.2	5.7	11.5	14.6	16	15.7	12.2	7.7	2.8	-1.8
	Rfa. (mm)	51	45	63	71	81	96	67	76	75	86	80	57
2015.	Temp.(°C)	-2.5	-1.3	2.1	6.2	13.4	15.3	19.8	18.9	14.5	8.4	3.2	-1.6
	Rfa. (mm)	89.9	56.1	74.7	53.2	75.4	113.3	25.2	85.7	84.3	106.9	71.2	0.3

When comparing meteorological conditions during the experiment in 2015. on the private properties in Mokro and Nišićki plateau, with perennial average we notice larger middle temperature averages, while there were variations with amount and disposition of the rainfall. There was less rainfall compared to perennial average in May, while there was 17,3 mm more rainfall in June, deficit of 41,8 mm in July, and in August around 10 mm more than the average.

According to Bosnia and Herzegovina soil map (Resulović and assoc., 2008) the most whidespred type of soil in the mokro area is acidly brown land (distric cambisol), which is found on the parcel where the experiment was set. The acidly brown soil (distric cambisol) is asoil with Ah-Bv-Cn type profile, and it is found on hilly – mountanious areas, 450 – 100 meteras above sea level. Distric cambisol forms on acid quartz – silicate substrates, compact roks and loose sediments. It is a soil characterized by high amounts of acids and low amounts of alkalies. It is suitable for growing potatoes and real and millet grains.
These soils require reparation measures so they could be cultivated. When grading soil's suitability for irrigation and agricultural production, mechanical composition is considered as one of the most important physical characteristic, because other physical characteristics depend on mechanical composition. Soil analysis is depicted in table 4.

Table 4. Chemical analysis of the soil

Depth of sample collection (cm)	pH/H_2O	pH/KCl	$CaCO_3$ (%)	Humus (%)	Total N	P_2O_5 (mg/100 g)	K_2O (mg/100 g)
0-30	6.22	5.17	1.1	5.1	0.336	1.43	34.3

Chemical analysis of acid brown soil samples collected from the depth of 0-30 cm showed that the soil is of acid reaction, rich in humus, rich in potassium, but poor in easy – access phosphorus (table 4) Values of the soil samples taken from the depth of 30-50 cm differ from the samples taken from the depth of 0-30 cm, in the way that they contain les carbonates, humus, easy-access phosphorus, as well as easy – access potassium. According to Resulović et al. (2008), these types of soils are poor in easy – access phosphorus , and have a large scale of physiologically accessible potassium, which was the case with the analyzed samples of acid brown soil taken from two depths, that they had low content of accessible phosphorus, and a relatively high content of accessible potassium.

Sando private property (Nišići plateau)

Nišići plateau is located at 950 to 1000 meters above sea level. This area is characterized by continental-mountain climate, specific for higher areas of central Bosnia. Main feature of this climate type are harsh winters with temperature minimums going as low as -30°C, while the summers are warm, with temperatures above 35°C . Annual rainfall amount is around 1200 mm. The closest meteorological station is in Sokolac (results depicted in table 3).

Table 5. Chemical analysis of the soil

Depth of sample collection (cm)	pH/H_2O	pH/KCl	$CaCO_3$ (%)	Humus (%)	Total N	P_2O_5 (mg/100 g)	K_2O (mg/100 g)
0-30	5.00	3.89	<1	6.68	0.34	2.32	23.03

The soil on this parcel was of a very strong acid reaction with high humus content (6.68%) and well supplied with nitrogen, poorly supplied with easy-access phosphorus and well supplied with potassium.

RESULTS AND DISCUSSION

Buckwheat grain contains a lot of nutrients, whose total content depends on species and growing conditions. Peeled grain is, in its nutritional composition, very much similar to other grains. It contains around 55% starch, 12% proteins, 7% of total nutritional fibers, 4% lipids, 2% soluble carbohydrates and 18% of other components, such as organic acids, polyphenol compounds, tannins, nucleotides and nucleic acids (Bonafaccia et al., 2003). Due to its positive properties, particularly high – quality proteins, flavonoids, phytosterols, fagopirins and thiamine – binding proteins, buckwheat flour is suitable for nutrition enrichment and production of many functional components and final products (Sarač and assoc., 2012). Compared to other grains, (wheat, corn, rice) buckwheat contains more magnesium, zinc, potassium, phosphorus, cuprum and manganese.

Beside the yield other grain, more and more attention is paid to physical quality (shell content, absolute and hectoliter mass) and the amount of some matters with high biological and nutritive values. Buckwheat is appreciated for its high proteins content, especially essential fatty acids, fats carbohydrates and proteins. Buckwheat's yield and quality depends on agroecological conditions and fertilizers application (Eggum et al., 1980).

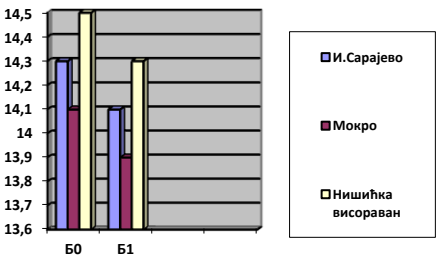
Milić et al. (2014) examined buckwheat quality on four localities. Depending on elevation, agroecological conditions, especially meteorological conditions and soil quality influenced the chemical content of peeled buckwheat grain.

Moisture content

Average moisture content in buckwheat grain for all localities and all fertilization varieties was 14.2 % (table 6, graph 1). Statistical analysis of locality influence on moisture content didn't found significant differences. Significant differences in moisture content weren't found between control variation and application of NPK fertilizer.

Table 6. The effects of locality and fertilization on grain's moist content (%)

Locality	Fertilization		Average
	$Б_0$	$Б_1$	
A_1	14.3	14.1	14.2
A_2	14.1	13.9	14.0
A_3	14.5	14.3	14.4
Average	14.3	14.1	14.2
	A	Б	AxБ
LSD 5%	0.532	0.321	1.137
1%	0.941	0.759	1.953



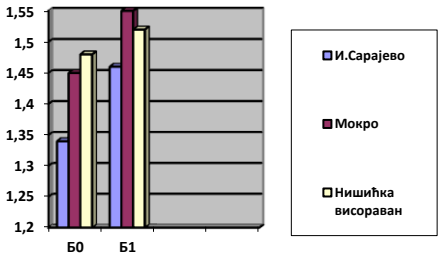
Graph.1 The effects of locality and fertilization on grain's moisture content

Mineral matters content

Mineral matters in buckwheat are primarily located in the shell and the involucre of the grain, so they are high in content in brans, as well as in the flours that mostly contain external parts of the grain (Bonafaccia et al., 2003; Stredman et al., 2001). According to these authors the largest content of mineral matters is in the shell.The average mineral matters content in peeled buckwheat grain was 1,47% (table 7 and graph 2). Statistical analysis didn't found significant differences in mineral matters content of peeled buckwheat grains grown on different localities, while significant differences were found for fertilizer use. In control variety mineral matters content was 1.42%, and in variety where mineral fertilizers were used 1.51%.

Table 7. The effects of locality and fertilization on mineral matters content

Locality	Fertilization		Average
	$Б_0$	$Б_1$	
A_1	1.34	1.46	1.40
A_2	1.45	1.55	1.50
A_3	1.48	1.52	1.50
Average	1.42	1,51	1.47
	A	Б	AxБ
LSD 5%	0.115	0.075	0.185
1%	0.161	0.135	0.265



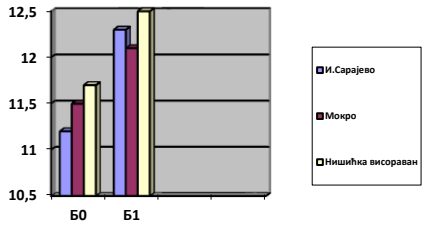
Graph 2. The effects of locality and fertilization on mineral matters content

Proteins content

Buckwheat proteins have high biological value because of well balanced content of amino acids and high content of lysins, which is limiting amino acid in wheat and barley. Main issue with buckwheat proteins is their low digestibility, which is caused by the presence of proteases (like tripsin inhibitors) and tannin (Ikeda et al., 1991; Ikeda, 2002). Average proteins content in peeled buckwheat grain was 11,88 (table 8 ad graph 3). Locality where buckwheat was grown had no influence on the proteins content, while the application of mineral fertilizers had statistically high influence. In variety where mineral fertilizers were used proteins content in peeled grain was 12,3%,and in control variety 11,47%.

Table 8. The effects of locality and fertilization on proteins content (%)

Locality	Fertilization		Average
	$Б_0$	$Б_1$	
A_1	11.2	12.3	11.75
A_2	11.5	12.1	11.80
A_3	11.7	12.5	12.10
Average	11.47	12.3	11.88
	A	Б	AxБ
LSD 5%	0.498	0.217	1.024
1%	0.951	0.743	1.642



Graph 3*. The effects of locality and fertilization on proteins content*

According to the data (*Fachmann-Souci-Kraut*, 1989/90) peeled buckwheat grain contains 9.1% proteins in total and 1.73% of oils, and in our research the average proteins content was 11.8%.

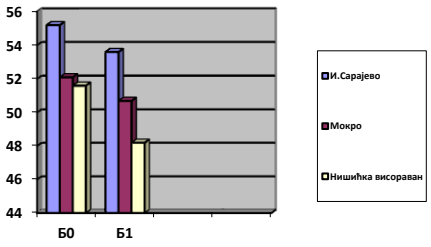
Starch content

Buckwheat starch is characterized by high fat and amylose content. From nutritious aspect there are three different starch fractions: fast digestible starch, slow digestible starch and resistant which is similar to nutritive fibers. Furthermore, resistant starch can be divided into: physically unreachable, natural granular and retrograde starch. Resistant starch in raw buckwheat grain varies in the interval between 33-38% of total starch, but is reduced by hydrothermal treatment to 7-10%. As opposed to that, the retrograde starch content is increased by hydrothermal treatment from 1% to 4-7% (Sakač et al., 2012).

Average starch content in peeled grain was 51.9 % (table 9 and graph 4). The biggest starch content (54.4%) was at East Sarajevo, and smallest (49.99 %) on Nišići plateau. Starch content in peeled buckwheat grain at East Sarajevo was statistically much larger compared to other localities, while there was no difference between starch contents on other localities.

Table 9. The effects of locality and fertilization on starch content (%)

Locality	Fertilization		Average
	$Б_0$	$Б_1$	
A_1	55.2	53.6	54.4
A_2	52.1	50.7	51.4
A_3	51.6	48.2	49.9
Average	52.97	50.83	51.9
	А	Б	АхБ
LSD 5%	2.132	1.548	3.217
1%	2.962	2.371	4.012



Graph 4. *The effects of locality and fertilization on starch content*

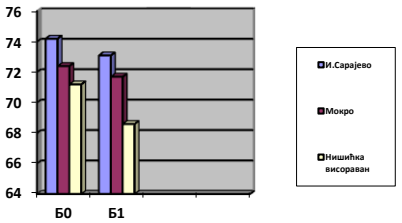
In control variety starch content (52.97%) was compared to variety with fertilizers use (50.82%). Determined differences were statistically significant.

Carbohydrates content

Soluble carbohydrates are located mostly in the germ (71.4 % of total soluble carbohydrates) and in bran, and are fewest in endosperm. Most widespread carbohydrates are saccharose and fagopiritols. The most widespread of the fagopiritols is the B1 (41.2 % of total soluble carbohydrates) (Sakač et al., 2012) Average carbohydrates content is 71.87 % (table 10 and graph 5. The biggest amount of carbohydrates was in buckwheat grains grown in East Sarajevo (73.65%), and the smallest at Nišići plateau (69.90%).

Table 10. The effects of locality and fertilization on carbohydrates content (%)

Locality	Fertilization		Average
	$Б_0$	$Б_1$	
A_1	74.2	73.1	73.65
A_2	72.4	71.7	72.05
A_3	71.2	68.6	69.90
Average	72.60	71.13	71.87
	A	Б	АхБ
LSD 5%	4.432	3.048	5.819
1%	5.362	3.911	6.643



Graph.5 The effects of locality and fertilization on carbohydrates content

CONCLUSION

Based on the results gathered from growing buckwheat on three localities (East Sarajevo, Mokro and Nišići plateau) and two fertilization varieties (control variety and $N_{60}P_{60}K_{70}$), the following conclusions can be made:

- Buckwheat is very interesting wheat whose grain has high nutritive value and can replace the true wheat in nutrition because it doesn't contain gluten;
- In our agroecological and land conditions it grows well, giving high yield in grains that are rich with proteins, mineral salts, oils and that contain considerable amounts of nutritive carbohydrates and cellulose;
- Buckwheat grown at East Sarajevo had the biggest % of starch and carbohydrates and smallest % of mineral matters and proteins;
- Buckwheat grown in Mokro had the smallest % of moisture;
- Buckwheat grown at Nišići plateau had the biggest % of proteins, and smallest % of moisture, starch, and carbohydrates;
- The application of mineral fertilizers affected the most of tested buckwheat properties in a positive way, the only deviation being % of starch and carbohydrates, which were bigger in buckwheat crops that weren't fertilized.

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10.7251/AGRENG1601016S
UDC 316.334.55:338.48(450.721)

RURAL TOURISM IN APULIA REGION, ITALY: RESULTS OF 2007-2013 RURAL DEVELOPMENT PROGRAMME AND 2020 PERSPECTIVES

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ABSTRACT

Apulia Region has many resources for rural tourism development. The review paper analyses opportunities of Apulia region (south-eastern Italy) in rural tourism. The paper describes financial instruments of the European Union (EU), mainly the European Agricultural Fund for Rural Development (EAFRD), allowing rural operators to develop innovative and unique rural tourism offer. An important share of the EAFRD is dedicated to diversification including rural tourism. The paper sheds also light on opportunities offered by 2007-2013 Rural Development Programme (RDP) of Apulia region and the role of Local Action Groups (LAG). The manuscript illustrates as well tourism statistics evolution in the period 2007-2013. The paper ends with perspectives offered by the new RDP 2014-2020, that was just approved; it specifically focus on new financing measures for strategies to develop incoming rural tourism in Apulia region and cooperation networks among LAGs.

Keywords: *rural tourism, rural development program, Apulia region.*

INTRODUCTION

Apulia is a peninsular region located in the south-east of Italy. It has a land area of 1,954,090 hectares (6.5% of the Italian territory surface) and a resident population of 4,050,072 inhabitants (6.7% of the Italian population). Local institutional structure includes six provinces and 258 municipalities. The average density of regional population is 209.26 inhabitants/km² (Apulia Region authority, 2015).

Figure 1. Italy and Apulia Region

**Source: University of Padua, 2016.*

To better define the areas with most significant problems in terms of social and economic performance, Apulia Region (Apulia Region authority, 2015) has taken steps to refine the classification of the degree of rurality defined by Eurostat (European Commission, 2012), identifying the following types of rural areas (Figure 2):

- Urban and peri-urban areas (A zones);
- Areas with industrial agriculture (B zones);
- Intermediate rural areas (C zones);
- Rural areas with development problems (D zones).

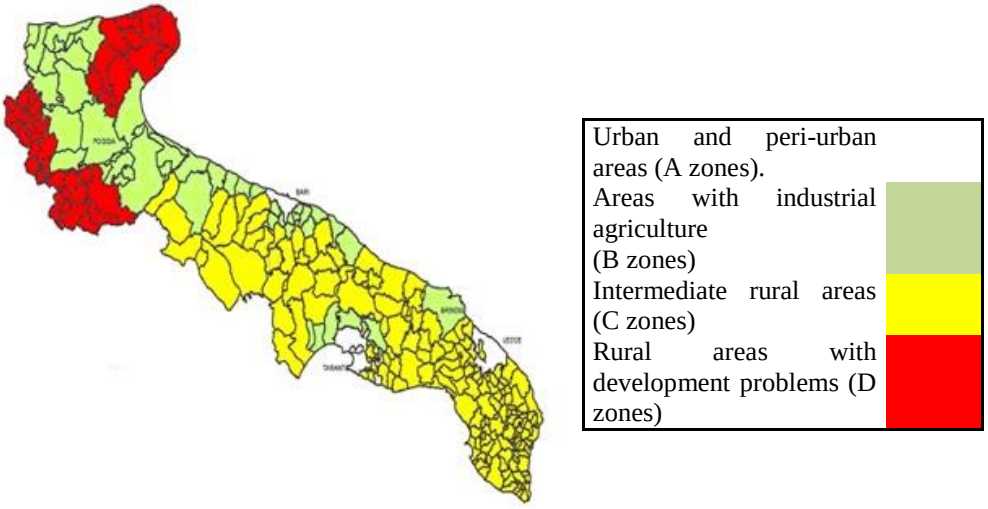

Figure 2. Rural areas in Apulia region

**Source: Apulia Region authority, 2015.*

Overall, rural areas amount to 97.1% of the regional area, within which resides 85.1% of the total population. The average population density in rural areas is 183 inhabitants per square km, much lower value than that recorded in urban centres - 600 inhabitants/km^2 (Apulia Region authority, 2015).

The region has a mainly flat land and low hills with limited mountainous areas. Around 70% of municipalities of Apulia region are located in lowland areas, 27% in hilly areas and, therefore, only the remaining 3% in mountain areas. Agricultural use represents the largest destination of regional soil. A strong diversity of production situations characterizes the Apulian agriculture. Farms are almost 272,000, with a utilised agricultural area of over 1.2 million hectares (Apulia Region Authority, 2015). In Apulia about 110,000 people work in agricultural holdings (9.2% of agricultural workforce in Italy), 41% of whom are women. The majority of companies from Apulia are conducted directly from the grower (Istat, 2016). Also in Apulia region many producers and rural communities have turned to tourism for achieving sustainable development through economic activity diversification (Ivona, 2006; OECD, 2010). Rural tourism encompasses a huge range of activities, products and services (Sharpley and Sharpley, 1997 *in* Irshad, 2010). In general, tourism is termed rural when the rural culture is a key component of the tourism product (Gopal *et al*., 2008). Rural tourism is not just farm-based tourism; it also comprises ecotourism, adventure, sport and health tourism, educational travel, arts and heritage tourism, and ethnic tourism (Irshad, 2010). The review paper analyses opportunities of Apulia region in rural tourism sector and explores the impact of the regional rural development policy on rural tourism structures and the tourism industry as a whole.

CONTRIBUTION OF RURAL TOURISM TO THE TOURISM INDUSTRY IN APULIA REGION

In 2015, Apulian tourism industry generated a turnover of 2.2 billion Euros. The tourist offer in rural areas is well diversified today. There are 224,241 beds in collective tourist accommodation establishments amounting to 93.8% of the number of places surveyed at regional level (IPRES, 2016).

Tourism supply in Apulian rural areas is characterized by the prevalence of hotel facilities (91.2% of the beds) and camping sites and tourist villages (95.6%). These two types of rural tourism structures and facilities offer 182,798 beds in rural areas alone. In recent years, there is more attention to the creation of educational farms and social farms: 66 structures were identified, an increase by as much as 83% compared to 2008. Along with the extra hotel facilities, the Apulian rural area beds represent approximately 67% of beds in Apulia (Apulia Region Authority, 2015).

In 2014, around 3.2 million tourists spent an average of 4 nights in Apulia. The predominant feature of the regional tourism system is represented by the marked seasonality, mainly in case of seaside tourism. There is a strong concentration of Italian tourists in August and foreign tourists in summer till September. Therefore, Apulian rural policy aims to increase tourism flow throughout the year by enhancing historical and artistic resources of Apulian rural areas (PugliaPromozione, 2015).

RURAL DEVELOPMENT POLICY REFORM AND RURAL DEVELOPMENT PROGRAMMES

The EU's rural development policy has continuously changed to meet the emerging challenges in rural areas. The most recent reform process, that introduced the general reform of the Common Agricultural Policy (CAP), has been largely completed in December 2013 with the approval of the basic legislative acts for the Programming period 2014-2020.

In line with the Europe 2020 Strategy and with the overall objectives of the CAP, the EU policy for rural development in 2014-2020 identified three long-term strategic objectives (Apulia Region Authority, 2015):

a) to increase the competitiveness of the agricultural sector;
b) to ensure sustainable management of natural resources and climate action;
c) to achieve balanced territorial development of the economy and rural communities, including the creation and protection of jobs.

The reform of 2013 maintains many of the main features of the rural development policy of the 2007-2013 programming period. In particular, as in the past, the policy will be implemented through the seven-year rural development national and/or regional programs.

Overall, the 2013 reform introduced the following changes (Apulia Region Authority, 2015):

- to improve the strategic approach in the preparation of RDPs;
- to strengthen the content of the rural development measures;
- to simplify the rules and/or reduce the administrative burden where possible; and
- to create greater synergies between rural development policy and other structural and investment funds.

Member States draw up their RDPs based on at least four of the six EU priorities (Apulia Region Authority, 2015):

1. promoting the transfer of knowledge and innovation in the agriculture and forestry sectors and in rural areas;
2. enhancing the profitability and competitiveness of all types of agriculture and promoting innovative technologies for farms and sustainable management of forests;
3. promoting the organization of the food chain, animal welfare and agriculture risk management;
4. restoring, preserving and enhancing ecosystems related to agriculture and forests;
5. encouraging the efficient use of resources and the move towards a low CO_2 emission and climate proofing economy in agriculture, food and forestry sector;
6. promoting social inclusion, poverty reduction and economic development in rural areas.

In turn, for each rural development priority, a series of more detailed policy areas (cf. "priority areas") was identified. As part of their RDPs, Member States/regions set quantified targets in relation to these priority areas, based on an analysis of the needs of the RDP area. Later, they set up measures to use to achieve these objectives and the corresponding funding. The funding comes in part from the European Agricultural Fund for Rural Development (EAFRD) and partly from national/regional funds and at times private resources. The policy implementation and impact are subjected to detailed assessment and monitoring by the Management Authority.

In its RDP 2014 - 2020, Apulia Region authority has endorsed all the six priorities and for each of them has identified the priority areas of intervention. Specifically, it wanted to focus on targeted financial measures promoting social inclusion, poverty reduction and economic development of rural areas. The aim is ensuring social and economic development of the territories through the support of economic activities linked to the elements of the agro-food chains, environmental, landscape, cultural, touristic and social resources of the individual territories; as well as increasing employment opportunities and development of new businesses, improving profitability, and encouraging the participation of local actors. Local development actions are implemented through a specific funding measure "Support to LEADER local development community", which is entrusted and fully managed by the LAGs).

LOCAL ACTION GROUPS (LAG) IN APULIA REGION

LAG is a local feeling and it is a part of a European process. The LAGs, that manage the LEADER (*Liaisons Entre Actions de Développement de l'Economie Rurale*) program funds, are active partnerships operating at the local level to promote integrated actions for development of rural economies (European Commission, 2006). The LAG promote the implementation of quality development strategies built around one or more priority themes that can make rural areas more dynamic, create new employment opportunities and have lasting effects. The goal is to help create lasting and endogenous development dynamics in every rural area, based on the history and on the specific competitive factors in each area. Therefore, the initiative aims to (European Commission, 2006): support the implementation of quality development strategies; support the implementation of integrated and/or complementary actions with the development objectives of the Community programs; encourage the opening of rural areas to other European and non-European countries; promote the dissemination of experience, knowledge and know-how; test solutions to the development problems of rural areas that could be an example for future EU policies. The LAG usually consists of actors belonging to three main categories: individuals or groups of persons (e.g. cultural, environmental, community groups); economic operators and private companies (e.g. employers' organizations, large companies, etc.); public institutions (local authorities, public services, etc.).

Currently, in Apulia LAGs are 25 and cover almost all the rural population of the region (Figure 3).

1. Daunia Rurale
2. Gargano
3. Meridaunia
4. Daunofantino
5. Piana del Tavoliere
6. Murgia Più
7. Le Città di Castel del Monte
8. Ponte Lama
9. Fior d'Olivi
10. Conca Barese
11. Terra Di Murgia
12. Sud Est Barese
13. Terra dei Trulli e del Barsento
14. Luoghi del Mito
15. Colline Joniche
16. Valle d'Itria
17. Alto Salento
18. Terra dei Messapi
19. Terre del Primitivo
20. Terra d'Arneo
21. Valle della Cupa
22. Isola Salento
23. Serre Salentine
24. Terra d'Otranto
25. Capo di Leuca

Figure 3. Local Actions Groups in Apulia region
**Source: Apulia Region authority, 2015.*

Below, is presented a case of a beneficiary farm, which has enhanced its activities in a rural area, creating a different tourism product (box 1). This is specific example (that is rather not isolated) allowing to understand how the EAFRD co-financing of activities has contributed to the promotion of cultural heritage of this region and raised the level of quality of tourists' reception in Apulia.

Box 1. Example of a rural tourism structure in Apulia region: *Masseria Losurdo* Farmhouse.

I am Domenico Losurdo, I'm the owner and together with my family manage the Masseria Losurdo (Figure 4), dating back to the beginning of '900. We are a real farm, basic producers and small farmers. We decided to diversify our activities, creating a small accommodation and farm restaurant in a wing of the farm, so we successfully got a funding from the LAG to renovate unused wing of the farm and turn it into a tourist accommodation and catering facility.

Figure 4. View of *Masseria Losurdo* Farmhouse.
Photo credit: Agriplan s.r.l

We made the structure in order to accommodate people with physical disabilities; we also have a menu based on local products while meeting the needs of vegetarians and for people with food intolerances. Since we manage it, during the years, we wanted to protect the intended agricultural use of the system. Not only as an economic activity, but also as an expression of a rural culture that strongly belongs to the territory of Alta Murgia (eastern and hilly part of Apulia region). We decided to diversify our activities and offer a small tourist accommodation service, as we believe in tourism as an experience and authenticity that in our case, only the rural culture offers. We believe that this kind of tourism can help enhancing and promoting local culture and productions.

*Source: Domenico Losurdo, personal communication.

The two graphs below show the change in the number of non-hotel accommodation facilities (Figure 5) and related beds (Figure 6) in Apulia region between 2008 and 2014.

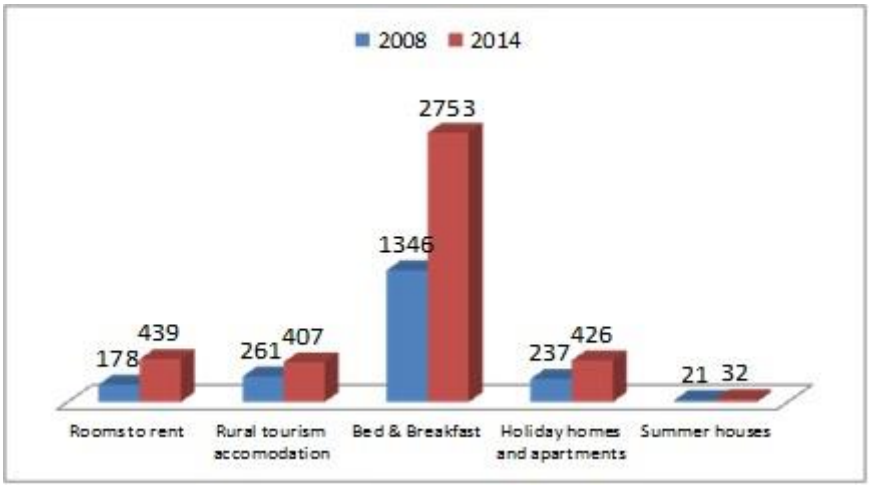

Figure 5. Evolution of the number of non-hotel accommodation facilities in Apulia region between 2008 and 2014

**Source: Authors' elaboration based on IPRES (2009, 2016) data.*

It can be noticed that between the 2008 and 2014 there was an average increase of about 70% in all non-hotel accommodation structures categories with a consequent increase also in the number of beds at regional level (Figure 6).

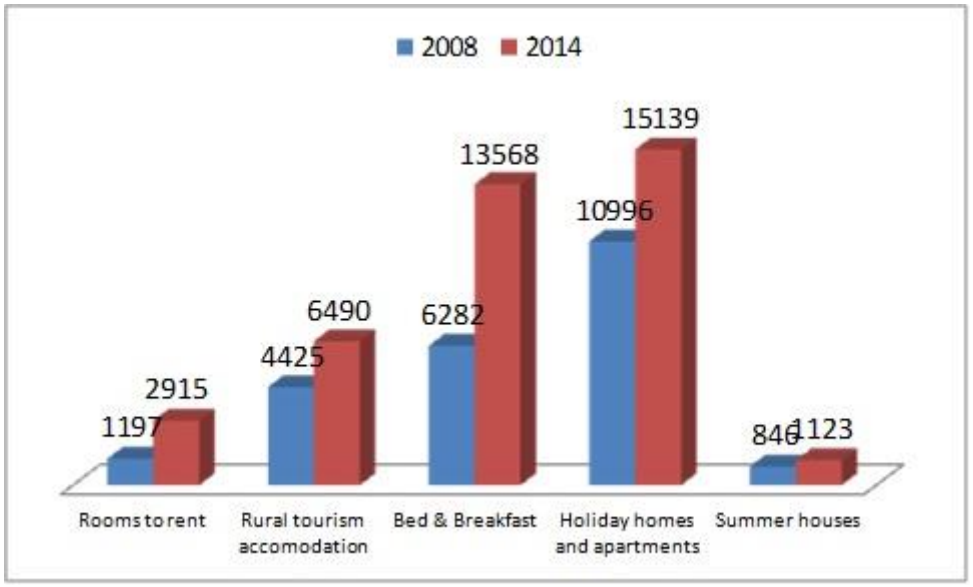

Figure 6. Changes in the number of beds between 2008 and 2014

**Source: Authors' elaboration based on IPRES (2009, 2016) data.*

At this point it is interesting to know how much the finance provided by the LAG to structures in rural areas, contributed to such a strong and positive change. At present, as the Apulia Region authority has formally closed the reporting of the

Fund on 31/12/2015, there are no official documents that indicate definitive and reliable data on the impact of the Fund. However, considering that the funds for diversification in non-agricultural activities are approximately equal to about 22% of the budget directly managed by the LAGs in Apulia between 2007 and 2013, it is assumed that these funds have largely contributed to the increase of the accommodation capacity of rural areas in Apulia region.

RURAL TOURISM DEVELOPMENT PERSPECTIVES IN APULIA REGION

As part of the RDP 2014-2020, Apulia region authority, through LAG, applies the priority intervention axis on the development of rural economies for reinforcing and systematizing the results achieved under the RDP 2007-2013, characterized by the application of the diversification strategy.

The EU funding has, therefore, allowed a programming for the agricultural and forestry sector in Apulia, with a budget of 1.64 billion Euros, to generate investments of over 2.1 billion Euros (Apulia Region Authority, 2015).

Hereafter are some figures that Agriculture Commissioner of Apulia region authority envisaged for agricultural and rural development in the coming years (Apulia Region authority, 2015b). More than 2,200 farmers will receive support for the modernization of their companies and about 2,000 young farmers will receive financial support to start their own business: there are about 100 million dedicated to start-up businesses for young farmers and a premium grant between 40 and 60 thousand Euro. About 30% of agricultural land will be subject to contracts for the environment: 62 thousand hectares (ha) will be subject to biodiversity interventions; 150 thousand ha to the improvement of water and soil management and 180 000 ha associated with the improvement of soil management. In addition, almost 139,000 agricultural ha will receive support for organic production. More than 1,700 farmers will receive support for participating in quality schemes, local markets and short supply chains, or investing in the processing and marketing of agricultural products (investments that will affect 5% of food companies). The regional authority intends also to provide training services to more than 8,600 beneficiaries. Moreover, 30 operations will be supported in the field of renewable energy production. Finally, 94.3% of the rural population will be involved in participatory local development strategies implemented by LEADER local action groups, 17% will have access to services or improved infrastructure and 15% will benefit from broadband internet services or improved information and communication technologies. In terms of innovation, the region expects to finance 118 projects to strengthen the link between the agricultural, food and forestry sectors on the one hand and research on the other hand, in the frame of the European Partnership for Innovation.

RURAL DEVELOPMENT PROGRAM 2014-2020 AND LAGS ROLE IN RURAL TOURISM DEVELOPMENT

The 2014-2020 RDP, replies with different measures to six economic, environmental and social priorities. And what about tourism?

The planning documents, that led to the approval of the new lines of LAG management funding, highlight excellent results already achieved, and widely discussed in this paper, as well as difficulties encountered by rural tourism operators in the area.

In fact, the 2007-2013 OP-EAFRD, providing funding for the creation or improvement of accommodation facilities, focused on the design and development of a range of quality rural tourism packages, but once launched, did the offer succeed on setting in the market? It is wondered if have been used some instruments and strategies to identify the right target, thus working on a real improvement of rural economies, that is, exponentially increasing the income of local communities in these territories.

In fact, what missed in the LAGs management of public funds is that they assumed that each small rural territory, could present itself as a tourist destination. They have not worked in synergy with other rural areas of Apulia region. In other words, they were not able to meet the system need to respond efficiently and effectively to the needs of the tourism market.

As a matter of fact, in recent years LAGs had a greater need for skills focused on local tourism development, not only in terms of programming and planning, but also to design tourism products (tours, packages, themed networks) and marketing.

In summary, LAGs started investing in their area to create the tourist offers. Then, only at the end, when they needed to set them on the market, they begun to worry about real things. Except that, the tourism offers that were funded were not designed for the market but only to meet the local requirements. So they are usually "unsaleable" and, often, "non-communicable".

However, what about the other critical issues?

Many LAGs started their rural tourism promotion activities without any knowledge about tourism and after they found the same solutions/actions:

- service (more or less qualitative) and standards to which companies had to adhere in order to be networked and promoted as part of a tourism offer;
- structural funding by government and public authorities (visitor centres, educational workshops, food museums and popular traditions) often creating unconnected tourist services;
- inter-regional projects to promote tourism, maybe about the construction of the same itineraries: a very common way, but without taking into account how in practice tourists choose destination and their mobility;
- portals, websites and pages without the possibility of purchase;
- participation in tourism fairs or similar, where a tour operator is just a buyer of a well-defined and technically functioning tourism offer.

In general, for LAGs, it was hard to look in from the market and tourists' point of view; starting from their actual reputation and from the strengths directly related to

the territory, and they almost ignored the basic rules of the tourism market (sustainability, demand-supply, hiking and overnight, proximity and medium-long range, individual and intermingled, etc.).

Regarding these issues, many professionals have been called to intervene, very often lagging behind or suggesting predefined and strict actions, usually conceived by inexperienced staff.

At the same time, in fact, the LAG have taken, and will take on an increasingly central role in guiding the rural areas development, also relying on huge financial resources from the 2014-2020 programming period. Actually, each LAG territory configures an important opportunity for the region of Apulia, because it's a unique area, where to develop a seasonally adjusted tourism that stands out from other tourism products. Indeed, while the seaside tourism is a mass tourism product, it is structured and sold in each macro-continental area and, therefore, it proves less able to attract international flows from the medium and long distance. The only "new era" in tourism to explore and exploit is another idea of Apulia; that of the protected nature, of the low mountain, of the quality agriculture; one of the territories with large and unique identity, but that is disappearing.

The new 2014-2020 LAG (and the new Internal Areas and Protected Areas) should also develop their "sustainable" tourism projects and products. In order to manage EU funds better than in the past programming period the LAG will have to adopt a Local Action Plan; a document with a strategy and actions through which investing the funds.

However, unlike in the past and according to EU directives, such a strategy will be developed in a participatory way, or through the creation of local focus groups. Professional associations, tour operators and all actors in the rural economy will participate. They will have to set up the expenditure strategy regarding pre-defined themes within OP-EAFRD such as:

- development and innovation in local short chains (food, crafts and manufacturing);
- development of renewable energy chain (production and energy savings);

sustainable tourism;

- nature, land use and biodiversity (plant and animal) care and protection;

development and management of environmental and natural resources;

- enhancement of local cultural and artistic heritage;
- access to key public services;
- social inclusion of specific disadvantaged and/or marginal groups;
- urban renewal through the creation of inclusive places and services for the community;
- networks and smart communities.

The strategy of each LAG will be drafted by a focus group and will address maximum three of the themes listed above. Many of the themes concern or are directly related to local tourism development. Of course, the Region of Apulia authority, as the Managing Authority, will ensure that all LAGs have many themes

in common, to create a development and investment strategy favouring synergies and avoiding as much as possible results dispersion.

CONCLUSIONS

Apulia region - thanks to its cultural heritage as well as its natural capital - has a great potential for the development of rural tourism. Rural tourism packages concern typical agro-food product, sport activities, cultures and history of the region. Regional authorities are aware of this potential therefore they have dedicated a high attention to supporting tourism in rural areas in the previous rural development program (2007-2014) as well as the current one (2014-2020). In fact, tourism is considered as a strategy for the diversification of rural economies thus making local communities more vital and vibrant. The co-financing of the EAFRD allowed many rural operators to develop innovative and unique rural tourism products. In this a crucial role is played by the Local Action Groups as rural tourism is included in the local development strategies implemented by them. However, while it is doubtless that good results were achieved (e.g. increase of non-hotel accommodation facilities number in rural areas as well as number of beds) it is also true that the initial development phase was characterised by many weaknesses and deficiencies. That's to say that there is room for improvement in order to use in a more efficient and effective way the public funding dedicated to the development of the sector. What is urgently needed is to improve the governance of the rural tourism sector at regional level. This can be achieved, among others, by fostering coordination among the regional LAGs and also by fostering synergies among the rural tourism structures scattered in rural areas of Apulia region. Improved vertical and horizontal coordination will make easier the marketing of the unique tourism package represented by the region and its rural heritage. Finally, it is important to create an effective communication strategy targeting the travel market in order to achieve proper development of rural tourism and consequently that of local economies.

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10.7251/AGRENG1601030T
UDC 613:641(64)

SUSTAINABLE FOOD SECURITY IN MOROCCO: CHALLENGES & OPPORTUNITIES

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ABSTRACT

Food security is a major issue and constant challenge in the developing world. Morocco has reached the target of the first MDG and, since 1990-1992, has maintained the prevalence of undernourishment level of 5%, but it remains vulnerable to climate change in case of recurrence of drought and external shocks. Researches on food security in Morocco and its relationship with sustainable development are not been sufficiently developed in the direction of proposing models of sustainable food security strategies. Then, this study aims to clarify the relationship between food security and sustainable food chain and to propose a roadmap for food security in Morocco, learnt from the visit study to Singapore as a leading country in food security. According to GFSI (Global Food Security Index) of the Economist Intelligence unit, Singapore is ranked second in the world after United States in 2015. Results outline the issues and challenges of food security at both global and national levels and highlight the strengths and weaknesses of food security in Morocco via the analysis of the Moroccan's food security balance through the GFSI (Global Food Security Index) of the Economist Intelligence Unit. Finally, this study proposes a roadmap to ensure sustainable food security in Morocco focused on two strategic pillars: governance and organizational pillar and technical and financial support pillar. The first pillar concerns the establishment of a national authority in charge of coordination and implementation of food security strategies. The second pillar includes a set of recommendations related to technical and financial support aspects as optimizing storage foods, increasing agricultural productivity via agro-ecological intensification and sensitizing farmers in adoption of sustainable agriculture principles.

Keywords: *food security, sustainable food value chain, sustainable development.*

INTRODUCTION

The issue of sustainable development is today at the heart of both south's and north's countries' development strategies and policies. These countries are looking increasingly sustainable and inclusive development models.

Given the importance of sustainable development for humanity, the 193 United Nations member states adopted on September 25, 2015 the program for 2030 which includes the three dimensions of sustainability: economic, social and

environmental. It consists of 17 Sustainable Development Goals (SDGs) that will build on the progress made within the framework of the Millennium Development Goals (MDGs).

Food and agriculture are at the heart of the SDGs, including the first SDG ''Eliminating poverty in all its forms and everywhere in the world'', and the second SDG ''Eliminating hunger, food insecurity, improve nutrition and promote sustainable agriculture''. Food security and its relationship to natural resources and rural development appear behind each goal on UN Agenda.

Agriculture as a primary sector has a strategic and central role in ensuring food security of a country. A more productive agriculture can improve food security via available commodities in larger quantities and at lower cost and more easily accessible.

Morocco has reached the target of the first MDG and, since 1990-1992, has maintained the prevalence of undernourishment level of 5%, but it remains vulnerable to climate change in case of recurrence of drought and external shocks. Researches on food security in Morocco and its relationship with sustainable development are not been sufficiently developed in the direction of proposing models of sustainable food security strategies.

Then, this study aims to clarify the relationship between food security and sustainable food chain and addresses the following fundamental questions:

- What is food security?
- What place must have food security in a sustainable food value chain?
- How secure it is Morocco? What are the strengths, weaknesses and challenges of food security in Morocco?
- What are the opportunities of Morocco to ensure its food security?
- How to ensure sustainable food security in Morocco?

MATERIAL AND METHODS

This study is inspired from the Food Security, FAO report on the World, the Economist Intelligence Unit (EIU) report on the Global Food Security Index (GFSI) and the visit study[1] to Singapore, which has allowed us to inquire of the Singaporean strategy for food security.

Taking into account the different dimensions of food security and its underlying dynamics, the EIU developed the GFSI[2]. Its calculation is based on the method of scoring selected indicators based on expert analysis of the EIU and consultation with a panel of food security experts. The scores are calculated from the weighted average of the underlying indicators that scale from zero to 100, where 100 (the

[1] Visit study " Building Food Security " is part of the Singapore Technical Cooperation Program in support of the G20 developing countries and non-member countries such as Morocco. It aims to understand current trends and issues of food security in the 21st century and inquire about the experience of Singapore on management issues and food security challenges.

[2] The Global Food Security Index is a dynamic index constructed from 28 indicators measuring the affordability, availability and quality of food products to 109 countries.

most favourable). The overall score for the GFSI (on a 0-100 range) is calculated from a simple weighted score[3].

In comparison with indicators defined by the FAO and the GFSI, it seems that GFSI is more comprehensive and complete in terms of inclusion of other indicators such as food safety, food losses, and access to finance for farmers and the volatility of agricultural production. It is based on indicators of FAO and opts for ranking and scoring methods to better facilitate data analysis and guide the development of food security in a country. In addition, the data of each country through the GFSI is updated by the EIU. Therefore, we opted for the choice of this index for analyzing food security in Morocco. In the final, the methodology for this study followed these steps:

- Bibliographic review about food security and sustainable development approaches
- Data analysis of the food security of Morocco through the GFSI
- Visit Study in Singapore as a leading country in food security.

RESULTS AND DISCUSSION

Food security and sustainable food value chains: a close relationship

Over the past decade, the value chain has become one of the main approaches for thinking and practice in the field of development. In the agricultural sector through the Moroccan Green Plan[4], value chains are the basic approaches to the formulation of projects (first pillar and second pillar) of this plan.

The functioning of the food value chain highlights the complexity of the environment in which it operates and its four main basic functions: production, processing, distribution and consumption. This complexity refers to an essential element of the basic food value chain, which is its governance structure (David, 2015).

In fact, a food chain qualified as sustainable and accessible to the poor, has to ensure food security. At the same time, ensuring food security is designing a food chain that assures main dimensions of food security, namely availability, accessibility, stability, safety and quality of foods offered to consumers.

This close relationship between food security as sustainable agricultural development objective and the food value chain as an approach and tool for development of the agricultural sector requires public policies to develop food value chains with food security as a core and a guiding force of its functioning. Therefore, consultation and coordination around a clear and precise vision of food security between the different actors of the value chain is essential.

[3] From EIU report on GFSI.

[4] The Moroccan Green Plan is the agricultural strategy of the country focused on 2 pillars: the first concerns the development of small agriculture and the second aims the development of investment in modern agriculture.

Morocco's ranking

According to the GFSI index of 2015, Morocco is ranked 62th out of 109 countries (Fig1). This ranking is considered less advanced considering the agricultural potential of Morocco.

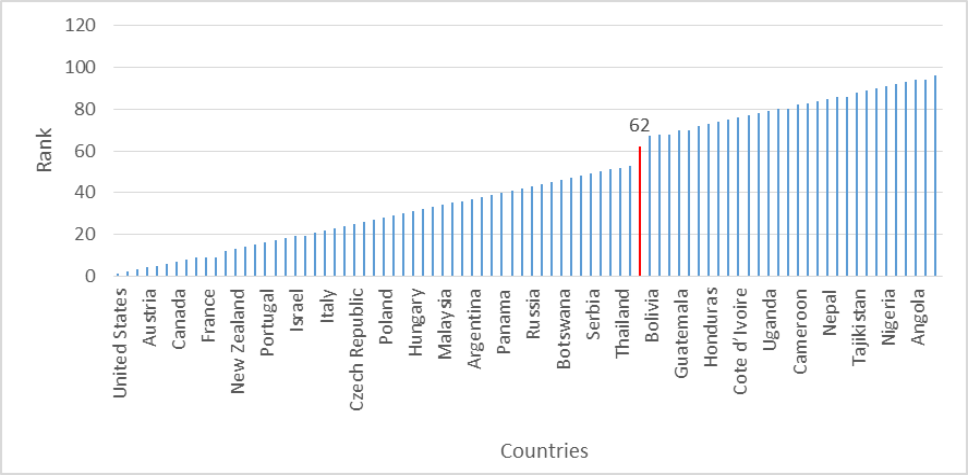

Figure 1. Morocco's ranking

**Source: EIU 2015*

Strengths and Weaknesses of food security in Morocco

For Morocco, each category mentioned above of GFSI and its indicators is synthesized in the following graphs[5]:

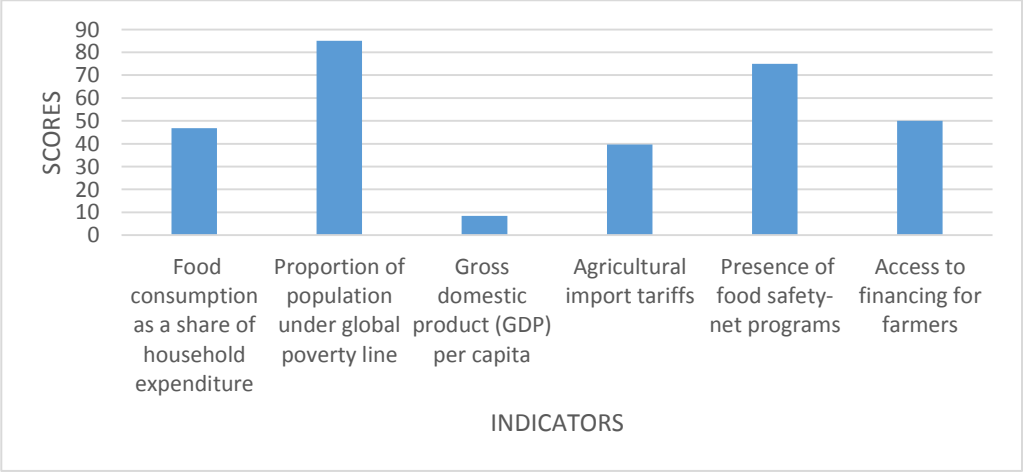

Figure 2. Affordability indicators of GFSI for Morocco on 2015

[5] Graphs illustrate the data collected from indicators of each category of GFSI (EIU)

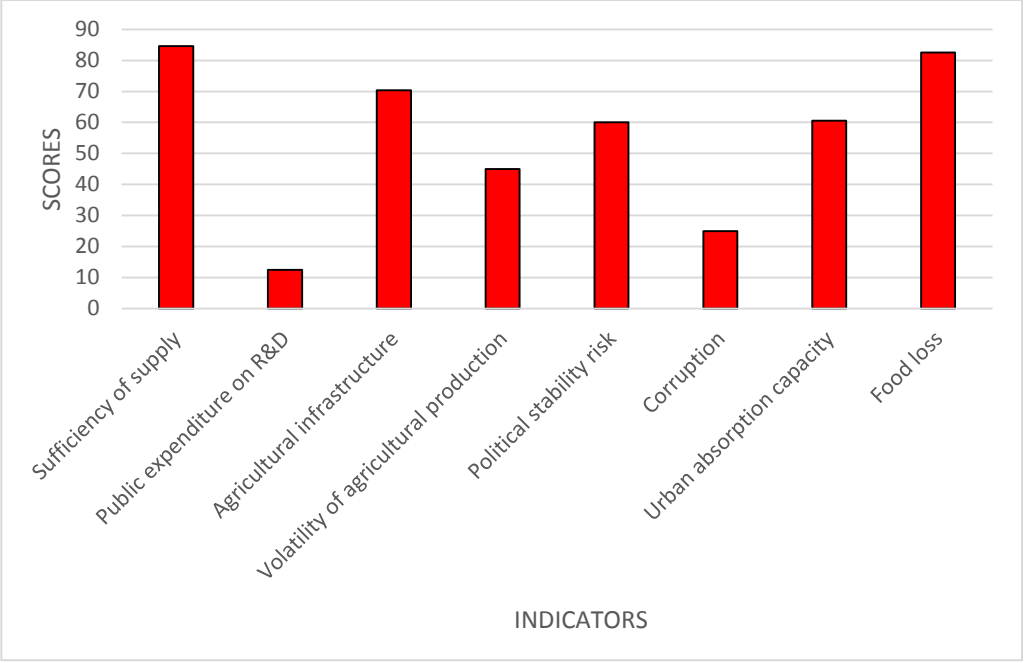

Figure 3. Availability indicators of GFSI for Morocco on 2015

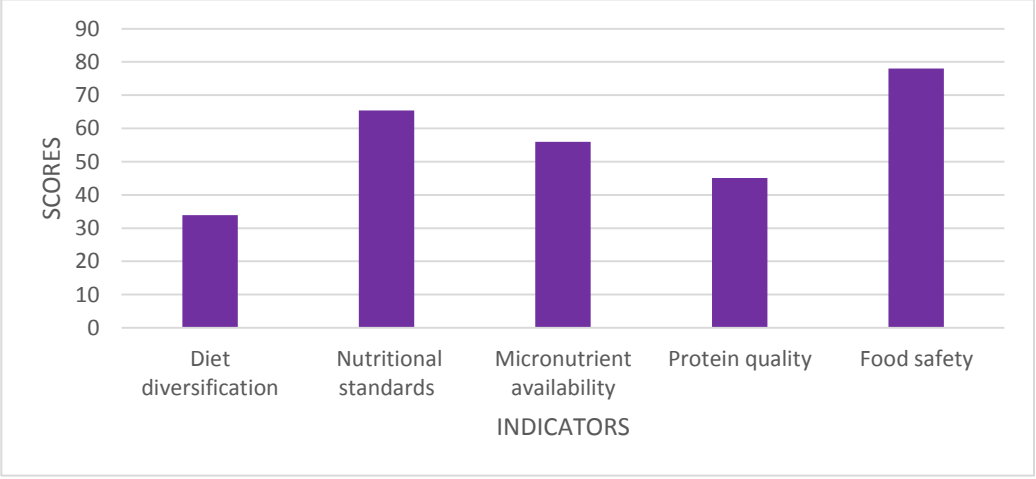

Figure 4. Quality and safety indicators of GFSI for Morocco on 2015

It is clear from those graphs that Morocco has strengths and weaknesses that focus on the specific indicators representative of the basic criteria for classifying

countries with each other. The main strengths concern the following indicators with high scores:

- Sufficiency of supply
- Proportion of population under global poverty line
- Food loss
- Food safety and presence of food safety-net programs
- Agricultural infrastructure
- Political stability risk.
- The negatives points that Morocco is expected to make efforts to improve them are:
- Gross domestic product (GDP) per capita, which does not encourage the household food consumption and dietary diversification
- Public expenditure on agricultural research and development (R&D) is low to improve agricultural production
- Corruption and its negative impact on agricultural development
- Access to financing for framers is still modest.

Agricultural import tariffs deemed high due to the need to protect agricultural products in the framework of the tariff policy of Morocco, particularly for animal products, dairy products, grains and fruits and vegetables.

These weaknesses are facing two major risks having a negative impact on food security of Morocco. This is, firstly, episodes marked by a sharp rise in world agricultural prices (most recently in 2008), whose impact has been mitigated by subsidies of wheat flour and sugar prices and energy. Secondly, recurrent drought due to climate change, which are regularly subject to emergency programs in various forms, ranging from livestock backup programs (in the form of subsidies to cattle feed) to job creation projects and rural incomes[6].

In addition, food security in Morocco is subject to the following main challenges:

- Need to improve the productivity of agricultural lands to track demographic changes and ensure the prevalence of undernourishment level of 5% (FAO,IFAD,WFP, 2015)
- Sustained increase in food demand
- Internal factors of production increasingly rare, especially the recoverable water and better governance of water resources management (M'hamed, 2008)
- Upgrading of family farming and small dominant agriculture in terms of agricultural productivity to secure food supply in the country (Maros, 2008)

[6] The emergency program to manage the rainfall deficit in the crop year 2015-2016 includes the following components: 1. livestock Backup Schedule 2. Plantation maintenance Irrigation 3. Supervision of crops of irrigated perimeter 4.Compensation of affected farmers 5. Implementation of pillar II project's creators of income and employment 6.Access to drinking water in rural areas.

- Local development in lack of innovation.

Opportunities for ensuring food security in Morocco

To meet the food security challenges, opportunities exist and Morocco does not miss assets to be exploited in a sustainable and integrated clear vision:

- Diversity of climate and territories

Climate, bio-geographical and cultural diversities of Morocco offer a variety of cultivars, animal breeds and rich local knowledge of production. Our farmers have shown in the past a good individual and collective capacity to manage local agriculture.

- Hydro-agricultural skills recognized

In terms of water management for irrigation, Morocco has a rich expertise and it is in the transition to localized irrigation. The National Irrigation Water Saving Program aims to equip 550,000 Ha in 2020 including 330,000 ha by individual reconversion to localized irrigation and 220,000 hectares by the collective reconversion. The achievements have reached 75% of the planned program[7].Similarly, Extension Program of Irrigation aims to enhance 1.5 billion m3 of water through the creation of irrigation scheme downstream of dams built or underway of construction. This program will improve the distribution of irrigation water and increase agricultural production.

- Public Private Partnership in irrigation

The Public Private Partnership in irrigation is an effective tool for achieving performance improvement objectives for agriculture irrigation in terms of water resources development and improving the efficiency of irrigation systems and sustainability of irrigation schemes. Two major successful projects were implemented and include the Project for the Protection of citrus in El Guerdane on an area of 10,000 ha and the development project of the area Azemmour -Bir Al Jadid an area of 3,200 Ha.

- Agricultural research

The role of scientific and agronomic research has a great contribution to guide agricultural production in a sustainable vision. Sustainable intensification of production systems also involves the implementation of conservation farming techniques and agro-ecology. Indeed, National Institute of Agronomic Research in Settat showed that farmers moved to no-till direct seeding (6,500 ha in 2013) achieved an average performance gain of 30 to 40%, a water efficiency gain of 60

[7] Source: DIAEA/Ministry of Agriculture and Maritime Fisheries.

%, a decrease in energy consumption by 70% and an organic matter in soil enrichment from 3 to 14% (SESAME, 2013).

Singapore's experience in Food Security

Why Singapore?

Singapore is a small country of 714 km2 with very limited natural resource, located at the southern tip of the Malay Peninsula between the mainland of Malaysia and Indonesia. It is one of the few countries, despite its limited resources, has developed an expertise and advanced technology in the field of food safety. According to the GFSI (2015), Singapore is ranked second in the world after the United States. Indeed, despite its limited resources and its reliance on imports of agricultural products by more than 90% of food needs, Singapore focused its food security strategies on the transformation and enhancement of agricultural imports.

To achieve this objective, the Agri food Veterinarian Authority of Singapore has reviewed and reaffirmed its food supply resilience and food security strategies after extensive consultations with the private sector and other government agencies (Robert, 2015). These strategies are part of the Road Map of Singapore synthesized in the following figure[8]:

Figure 5. Food Security Roadmap for Singapore

[8] Source : Nanyang Technological University NTU of Singapore, 2015.

Learned lessons

It's clear that food security is now a major issue both for developed countries than in developing countries. The lessons learnt from Singapore's experience in food security, are summarized as follows:

- Food security must be a national priority of a nation with all its stakeholders (private, public, NGOs, municipalities and regions, others) and around which there is an attachment of a whole country.
- The adoption of an integrated system of food security management with a single national authority responsible for coordination and communication between the different stakeholders involved in the formulation and implementation of strategies with one unique objective: ensure sustainable the country's food security.
- In the 21st century, food security of a country is closely linked and connected to regional and global food security (PS Paul, 2014).
- Food security is multidimensional: several factors influence the four dimensions defined by the FAO including availability (production, exports / imports), physical access (market, logistics, infrastructure and value chains), affordability (pricing and employment), use (health and nutrition, hygiene and sanitation, storage facilities / processing, food safety).
- A change in the approach to food security is needed: from one dimension to another, from one sector (agriculture) to another, from procurement (supply) to the influence of food demand, from rural to urban and from self-sufficiency to self-reliance.
- The role of agriculture as the locomotive sector of the food security of a country.
- The inclusive agribusiness as key to food security.
- Food security should be the core and the guiding force of the whole chain of sustainable food value.
- Food security is closely linked to climate change and its impact on agricultural production.

Proposal of a roadmap for sustainable food security in Morocco

Inspired by Singapore's experience in terms of food security strategies, we propose priority actions for the development of a roadmap to ensure sustainable food security in Morocco. This roadmap is centered around two strategic pillars:

- ***Governance and Organizational Pillar***:

1. Establishment of a national authority in charge of coordination and implementation of food security strategies
2. Adoption of the integrated management approach.

- ***Technical and financial support Pillar:***

1. Establishing and updating of a database of food security through the selection of a battery of strategic and operational indicators to measure food security;
2. Optimizing storage of food products;
3. Use of financial instruments to cope with food price volatility in the short-term;
4. Promotion of agro-ecological intensification to increase productivity of agricultural water and resilience of systems (agro-forestry-pastoral, storm water, irrigation), based on both local knowledge, research and innovation;
5. Awareness of family agriculture to food security issues and climate change through training activities;
6. Integration of small farmers in food value chains;
7. Training and sensitization of value chains actors on the management of food losses;
8. Encouragement of R & D in reducing food losses and recycling;
9. Strengthening of the effort of the state in terms of irrigation water saving and mobilization of conventional and unconventional water;
10. Promotion of Public Private partnership on projects / programs to increase food security;
11. Promoting nutrition in rural areas through training of agricultural workers in nutrition, food safety and food preservation issues
12. Strengthening food safety measures throughout the food chain;
13. Strengthening of price control and supply the domestic market with quality foods.

CONCLUSION

In conclusion, food security includes economic, social and environmental components involving all stakeholders of a nation. Morocco faces increasing risks of " exogenous shocks'' in food security (volatile global markets and climate change), when the internal factors of agricultural production are increasingly rare. Moreover, food demand is experiencing a steady increase due to population and economic growth on the one hand, and the transition to a diet rich in calories, on the other.

In Morocco, the development of solutions that reconcile the search for food security considering climate change, water scarcity and grouped in a road map, seems a priority and complementary to the Moroccan Green Plan's efforts to establish a sustainable agriculture.

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10.7251/AGRENG1601041L
UDC 632:633.16(470+571)

ECOLOGICALLY BASED DISEASE MANAGEMENT TECHNIQUES IN BARLEY CULTIVATION IN THE CENTRAL BLACK SOIL REGION

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ABSTRACT

At present, there are microbiological Bacillus-based products used to preserve valuable micro biota and improving the level of biological soil productivity as well as sustaining the local environment. The research focuses on discovering how some particular biological products and autochthonous microorganisms influence the yield capacity of barley grown in the Black-Earth region of Russia. The research objectives included a search for autochthonous strains of microorganisms that improve resistance to diseases, estimation of how biological products contribute to the quality of barley seeds, biological products effect on the spread and disease resistance and estimation of how biological products enhance the yield capacity of barley. The paper describes the results of identification of an autochthonous *Bacillus* strains. PCR diagnostic methods were used to confirm the strain specific origin of two sample cells extracted from soil (S1 and S2). The study involved the analysis of micro biota of leached chernozem, which revealed the autochthonous strain of *Bacillus* S1 having a germicidal effect. The S1 strain revealed *Bacillus subtilis* and *Bacillus cereus*, while S2 revealed only Bacillus subtilis, as detected by the method of molecular diagnostics based on using species-specific primers. Biological treatment of the seeds improved their sowing qualities, namely, germination readiness and germination capacity. In addition, it was found out that such treatment improves the resistance to disease affection and spread. *Bacillus* S1, in particular, reduces the disease affection by 16,5 % and the disease spread 3,5 as much. Finally, the experiment demonstrated that biological treatment can contribute to sustaining healthy environment for the plants and thus increase their yield capacity.

Key words: *identification of Bacillus, the polymerase chain reaction (PCR), sowing quality of seeds, barley disease control.*

INTRODUCTION

One of the most popular crops in Russia today is barley, which is actively involved in intensive agrarian technology. Barley covers about 8 bl ha of the territory of the country and about 180.000 ha in the Central region of Russian Federation.

Introduction of new highly productive cultivars, application of fertilisers and modern farming techniques undoubtedly account for barley high yield capacity. However, it is not enough to ensure the increase in the yield due to different diseases (Lukina et al., 2013).

The most common barley diseases today include *Alternaria* blight, Fusarium blight, Helminthosporium blight, and barley smut diseases. One of the methods of dealing with these barley diseases is the chemical one, but we should also take into account the side-effects that fungicides have on other elements of farming ecology. Chemicals produce both a direct, fungicidal and indirect effect causing changes in plant nutrient sources or environmental conditions required by a particular taxonomic group of microorganisms. In other words, they affect the entire microbial community in soil. Alternatively, we can use microorganisms, which can affect the development of pathogenic population of phylloplane and pathogenic elements in the soil. In the natural environment microorganisms live in communities based on complicated relationships of both symbiosis and antagonism. (Ponyatayev V. et al., 1999). One of the well-known species of microorganisms that has antagonistic characteristics is Bacillus. Many Bacillus-based products are used today in farming and help to reduce the effect of opportunistic pathogenic or pathogenic microorganisms. (Maraeva et al., 2015)

Thus, Bacillus subtilis, for example, is antagonistic to saccharomyces, salmonella, proteus, staphylococcus or streptococcus. Also, Bacillus influence synthesis of vitamins, amino acids as well as immune-active factors. These bacteria are involved in producing enzymes which eliminate the saprogenic, or putrefactive, products.

At present, there are quite effective microbiological Bacillus-based products used to preserve valuable micro biota and improve the level of biological soil productivity as well as sustaining the local environment.

The present study aimed at establishing how some particular biological products and autochthonous microorganisms influence the yield capacity of barley grown in the Black-Earth region of the Russian Federation.

The research objectives included: search of autochthonous **s**trains of microorganisms that improve resistance to diseases; estimation of how biological products contribute to the quality of barley seeds; estimation of how biological products affect the spread and resistance to diseases; estimation of how biological products contribute to the yield characteristics of barley.

MATERIAL AND METHODS

In 2014 – 2015, a number of micro plot tests were conducted on the territory of the Botanical garden named after B.A. Keller (the Voronezh State Agricultural University). Also, some tests were carried out on one of the local farms.

The micro plot tests included the following variants: 1. C; 2. C+B1+$N_{60}P_{60}K_{60}$; 3. C+B2+$N_{60}P_{60}K_{60}$; 4. C+B3+$N_{60}P_{60}K_{60}$; – where C is the control variant; B1 – biological product Baikal ЭМ-1; B2– biological product Phytosporin M; B3– biological product with an autochthonous **s**train of Bacillus.

The experimental design (germination was in rolls) was as follows: 1. Control - water; 2. Baikal ЭМ–1; 3. Phytosporin M; 4. autochthonous strain of Bacillus. The seeds were treated with the solution at 10 litres per ton at the seeding rate of 500 seeds/m^2.

The biological products used in the experiment were analysed in the context of the barley micro plot tests. The biological treatment was applied at different stages, namely, at the stage of seeding, tillering and booting.

A traditional PCR analysis involved DNA purification, for which we used 0,2 ml of bacterial culture (DNA-sorb developed by Gamaleya Research Institute of Epidemiology and Microbiology of RAMS, Russia). The quality of the DNA was tested by electrophoresis on agarose gel containing ethidium bromide (Gowdaman et al., 2014).

The PCR-analysis with specific primers for Bacillus spp. was conducted in the PCR thermocycler "Tercik" ("DNA-technology", Russia). The nucleotide sequences of the primers for *Bacillus sp.* were as follows: direct - 5`-TCACCAAGGCRACGATGCG-3`, reverse - 5`-CGTATTCACCGCGGCATG-3`, for *Bacillus subtilis*: direct (Bsub5F) - 5'-AAGTCGAGCGGACAGATGG-3 ', reverse (Bsub3R) - 5'-CCAGTTTCCAATGACCCTCCCC-3', for *Bacillus cereus*: direct (BCFomp1) - 5'-ATCGCCTCGTTGGATGACGA-3', reverse (BCRomp1) - 5'-CTGCATATCCTACCGCAGCTA-3' and *Bacillus thuringiensis*: direct (Un4d) - 5'- GCATATGATGTAGCGAAACAAGCC-3 ', reverse (Un4r) - 5'-GCGTGACATACCCATTTCCAGGTCC-3'. The amplification parameters were as follows: preliminary denaturation at 94^{o}C for 3 minutes, followed by 40 cycles at 94^{o}C – 30 sec, 65^{o}C (B. subtilis), 54.5^{o}C (B. cereus), 60^{o}C (B. thuringiensis) – 30 sec., 72^{o}C – 60 sec. and the final stage of elongation of the chain was at 72^{o}C for 3 min (Guidi et al., 2010, Wattiau et al., 2001).

The microorganisms using organic nitrogen were grown by plate method on meat-and-peptone agar (MPA). The mineral nitrogen was assimilated on starch-and-ammonia agar (SAA) (Selyavkin et al., 2015).

RESULTS AND DISCUSSION

The autochthonous strain was detected in the soil samples while they were studied for ammonification. Figure 1 demonstrates the growth of the colony showing the zone of bactericidal activity in relation to other microorganisms.

Figure 1. Mixed growth of Bacillus subtilis and Bacillus cereus colony

The strain obtained during the experiment was purified and pure culture was obtained. To define its Bacillus origin, we used the method of molecular genetic diagnostics based on using generic species-specific gen 16s pRNA.

The PCR analysis based on generic-specific primers for Bacillus sp. and the analytic agarose gel electrophoresis demonstrated the presence of the amplification product in all of the studied samples (Fig. 2). Besides, the DNA markers showed that the length of the amplicon is 1100 base pairs, which is characteristic of Bacillus and already established. (1)

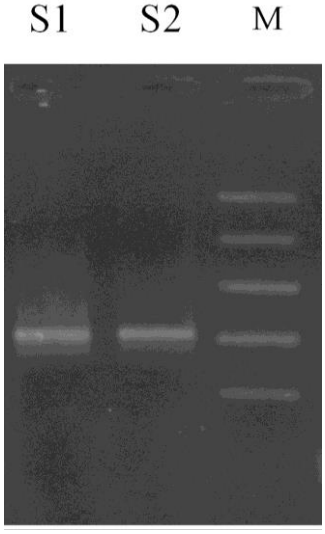

Figure 2. The results of the DNA amplification based on generic-specific primers for Bacillus sp. S1, S2, M – markers of the DNA length (base pairs): moving downwards – 5000, 3000, 2000, 1000, 500.

The results of the study demonstrate that samples S1 and S2 contain Bacillus DNA, which is proved by the presence of only one specific amplicon in both samples. In each of the samples the amplicon is 1140 base pairs long.
The amplification of the same samples with species-specific primers for Bacillus subtilis (2), Bacillus cereus (3) and Bacillus thuringiensis (4) varued among the samples. For example, samples S1 and S2 demonstrated amplification with species-specific primers for Bacillus subtilis, which proves the presence of genome DNA of this species in the sample. Also, it was found that the DNA of S1 contained the products of amplification with primers for Bacillus cereus, while S2 demonstrated the absence of PCR-products (Fig. 2). Finally, none of the samples gave amplification products with primers specific for Bacillus thuringiensis.

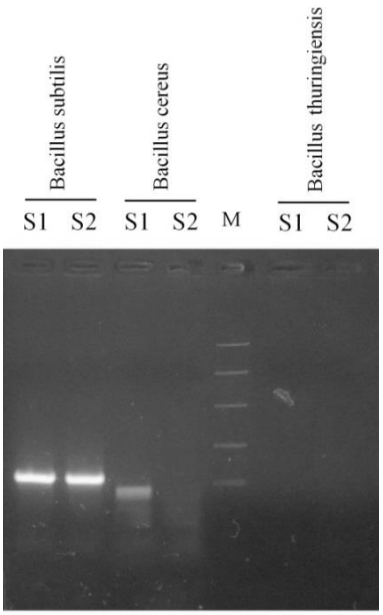

Figure 3. The results of the amplification of the DNA with species-specific primers for Bacillus subtilis, Bacillus cereus and Bacillus thuringiensis. S1, S2, M – markers of the DNA length (base pairs): moving downwards – 5000, 3000, 2000, 1000, 500.

The results obtained on the basis of using genus specific primers show the presence of DNA of Bacillus genus in S1 and S2. Species-specific analysis of S1 and S2 demonstrated the presence of Bacillus subtilis as well as Bacillus cereus. Presumably, S1 contains bacteria species, namely Bacillus subtilis and Bacillus cereus. However, neither of the studied samples revealed Bacillus thuringiensis, which was proved by using the respective species-specific primer. The obtained autochthonous strain (Bacillus subtilis, Bacillus cereus.), Bacillus S1, was used for treatment of the seeds and barley plants according to the methods described in the literature. (Lukin et al., 2015)

To define the laboratory germination, the seeds were germinated in rolls at 20 ^{0}C. Table 1 shows the results of the analysis of the rolls effect on laboratory germination and germination readiness of the barley seeds (the sort Vakula) after biological treatment.

Table 1. The effect of biological products on germination readiness and laboratory germination of barley seeds

Variants	germination readiness		laboratory germination	
	number	%	number	%
Control	46,0	92,0	46,6	93,3
Phytosporin M	47,0	93,5	47,0	94,0
Baikal EM-1	47,3	94,0	47,0	94,0
Autochthonous strain of Bacillus S1	47,0	94,4	47,0	94,0

As shown in the table, the germination readiness of the control seeds is lower than that of the biologically treated. The same is observed in regard to laboratory germination index.

While studying the germs of the seeds affected by diseases (in the rolls), spores of causal agents of helminthosporiose, fusariose, alternaria and barley smut were detected. The analysis of barley seeds resistance to diseases and disease affection was conducted in accordance with the well-established methods. Table 2 describes data on the influence that biological products have on the seeds capacity to resist diseases as well as spread of the disease.

Table 2. Index of barley seeds disease affection and capacity to resist disease

Variants	Affected seeds (%)	Disease spread (%)
Control	25,8	15,0
Phytosporin M	20,5	14,8
Baikal EM-1	22,5	14,2
Autochthonous strain of Bacillus S1	16,5	11,5

As shown in Table 2, the treatment of seeds with the autochthonous strain of Bacillus S1 helps to reduce the rate of disease affection and increases capacity to resist disease .

The control of the plants affected by barley smut was carried out visually on the basis of elimination of the affected ears (Fig.4). Table 3 demonstrates data on affection by barley smut.

Figure 4. The plant ear affected by barley smut

Table 3. Affection by barley smut

Variants	Number of ears affected by barley smut (%)
Control	3
Phytosporin M	2
Baikal EM-1	1
Autochthonous strain of Bacillus S1	1

As shown in the table, biological treatment contributes to healthy environment affecting phytopathogens. Also, the affection by barley smut reduced after application of biological products and the autochthonous strain of Bacillus S1 1,5-3 as much.

Table 4 demonstrates data on yield capacity and the mass of 1000 seeds, which are important elements of the yield formula.

Table 4. Yield capacity and the mass of 1000 seeds (dt/ha)

Variants	Yield capacity per year on average		Average per 2 years	the mass of 1000 seeds (gram)		Average per 2 years
	2014	2015		2014	2015	
Control	20.1	22.6	21.35	42.5	54.3	48.4
Phytosporin M	21.6	26.6	24.1	43.8	58.4	51.1
Baikal EM-1	24.9	28.4	26.65	44.2	58.6	51.4
Autochthonous strain of Bacillus S1	28.0	29.9	28.95	44.2	59.0	51,6
The least significant difference (0,05)			3.24			

All biologically treated variants demonstrated the increase in the barley yield, which was 3-7 dt/ha and thus provides confirmation of the data presented above.

CONCLUSIONS

1. The study of micro biota of leached chernozem revealed the autochthonous strain of Bacillus S1, which has a germicidal effect.
2. The S1 strain revealed Bacillus subtilis and Bacillus cereus, while S2 revealed only Bacillus subtilis, as detected by the method of molecular diagnostics based on using species-specific primers.
3. Biological treatment of the seeds improves the seed quality: germination readiness and germination capacity.
4. Biological treatment improves the capacity to resist disease and reduces spread of the disease. Bacillus S1, in particular, reduces the disease affection by 16,5 % and the disease spread by 3,5.
5. Biological treatment contributes to sustaining healthy environment for the plants and thus increases their yield capacity.

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10.7251/AGRENG1601049D
UDC 551.311.21(556)

EFFECT OF EXCLOSURE ON RUNOFF, SEDIMENT CONCENTRATION AND SOIL LOSS IN EROSION PLOTS

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ABSTRACT

Nowadays watershed and rangeland management projects play the important role in water resources and soil management worldwide. Although watershed and rangeland management projects have the considerable importance as approaches to rural areas development and natural resources management, more studies have been focused on their effects on sediment and their effects on soil erosion have rarely been considered. The present study was conducted in two treated and control sub-watersheds with exclosure treatment and under grazing respectively, in Khamsan representative watershed with an area of 4337.27 ha in south of Kurdistan Province, Iran. Three plots were installed in each western, northern and eastern slopes for the runoff volume and coefficient, sediment concentration and soil loss measurement. The exclosure treatment was operated for installed plots in treated sub-watershed from 2007. Then, all the data of runoff volume and coefficient, sediment concentration and soil loss from USLE standard plots in both control and treated sub-watersheds for 52 events over the years 2009 to 2014 were compared and evaluated. Therefore, in order to the number of plots and sub-watersheds, 18 USLE standard plot data were finally recorded and analysed for each storm event. The results showed the significant ($p \leq 0.05$) decreasing effect of exclosure treatment on runoff volume, sediment concentration and soil loss at plot scale. Finally, decreasing rates of 15.68, 6.13, 16.67, 24.37 and 21.43% due to exclosure respectively for runoff volume and coefficient, sediment concentration, soil loss and sediment yield were obtained. The variables of runoff volume, soil loss and sediment yield had statistically significant differences ($p \leq 0.05$) in treated and control sub-watersheds. The sediment concentration variable had p value of 0.058 and therefore the effect of exclosure treatment on sediment concentration was also significant ($p \leq 0.06$).

Keywords: *Khamsan watershed, soil conservation, soil loss, vegetation cover, watershed management.*

INTRODUCTION

Erosion and sediment transport is not only the cause of an imbalance of natural rivers and streams, but also the cause of change in the river channel and sediment accumulation behind dams reducing their storage volumes (Sadeghi et al., 2014; Spalevic et al., 2014). Nowadays, watershed management projects especially in upstream of the dam reservoirs are essential because of increasing population and cultivated lands, drop in groundwater levels, freshwater shortages, lack of rainfall, reducing fertility and increasing soil loss and diminution of water quality (Eskandari et al., 2014). Therefore, in recent years, the extensive practices for soil and water conservation carry out as one of the most important goals of watershed management projects. Overgrazing as well as early and late grazing and continuous movement of livestock in rangelands lead to more soil compaction and degradation and decrease the vegetation role in runoff and flood control, especially in developing countries. Therefore, from the watershed management and soil conservation view, it can be stated that grazing management leads to decrease runoff severity and amount and consequently, soil loss. In this regard, one of the basic and fundamental tools is the evaluation of the effects of watershed management projects. Assessment of the impact of watershed management projects plays an important role to achieve a clear view about the practices efficiency, improvement of available methods, review of macro and micro policies and the innovation of new methods (Eskandari, et al. 2014). Many researchers have evaluated and assessed the effects of watershed management practices in the world (Kohnke, 1968; Busby and Gifford, 1981; Wood and Blackburn, 1981; Sadeghi, 1996; Radwan, 1999; Sadeghi et al., 2004; Goff and Gentry, 2006; Shahrivar and Molaii, 2006; Hayashi et al., 2008; Eskandari et al., 2014).

The management practices affecting soil and vegetation cover and consequently, affect runoff and soil loss control (Ghoddousi et al., 2006; Spalevic et al., 2013). Vahabi (1989) stated that the exclosure treatment in Iran could replace desirable forage species, so that the soil loss controlled with increasing vegetation density. Gharehdaghi (1997) studied the effect of rangeland exclosure on physical and chemical characteristics of soil in some rangelands of Iran and stated that this conservation operation could improve the soil physical and chemical characteristics and reduce soil loss. They also showed that the exclosure management had the direct impact on infiltration rates (about 52%) and prevented soil compaction. Ghoddousi et al. (2006) evaluated the exclosure impact on runoff and soil loss and revealed that the pastures exclosure could reduce soil loss and also help to water optimization in pastures surface. Mohammadpoor et al. (2010) studied the effect of short-term exclosure in some highland rangelands of Iran and showed that the exclosure application could decrease runoff amount. Shahid et al. (2014) also stated that the land use change is an important factor in increasing runoff and sediment amount in a small watershed in Pakistan.

The literature review showed that the exclosure can reduce surface runoff and soil loss by changing the vegetation species and also increasing vegetation density which lead to soil and water conservation. Therefore, evaluation of the effects of exclosure on runoff and soil loss is very essential (Lang, 1962; Slayback and

Cable, 1970; Vallentine, 1971; Wood and Blackbur, 1981; Vahabi, 1989; Ghoddousi et al., 2006; Barovic et al., 2015). For this purpose, the present study was conducted in two treated and control sub-watersheds with exclosure treatment and under grazing respectively, in Khamsan representative watershed, located in west of Iran.

MATERIALS AND METHODS

Study area

The present study was conducted on the data of 52 events over the years 2009 to 2014 in two treated (with area of 107.54 ha) and control (with area of 110.54 ha) sub-watersheds with exclosure treatment and under grazing respectively, in Khamsan representative watershed, west of Iran Table 1 shows the physiographic characteristics of treated and control sub-watersheds. Fig. 1 shows the location of Khamsan Representative and treated and control sub-watershed in Iran.

Table 1. Physiographic characteristics of treated and control sub-watersheds

Physiographic characteristics	Khamsan representative watershed	Treated sub-watershed	Control sub-watershed
Area (km^2)	43.37	1.08	1.10
Perimeter (km)	30.25	4.06	4.56
Main River Length	5.18	1.11	0.83
Total river length	198.85	5.02	5.98
Slope (%)	42.95	48.23	40.09
Maximum elevation	2378	1817	1820
Minimum elevation	1580	1618	1610
Average elevation	1936.27	1698.73	1695.03

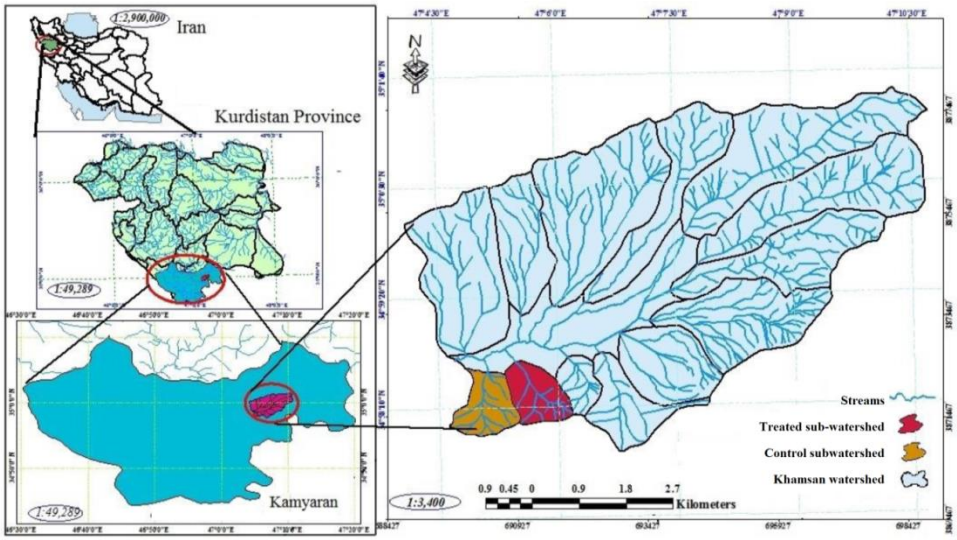

Fig. 1. Location of Khamsan Representative and treated and control sub-watersheds in Iran

The exclosure treatment was operated for installed plots in treated sub-watershed from 2007. Three USLE standard plots were installed in each western, northern and eastern slopes to measure the storm-wise runoff volume and coefficient, sediment concentration and soil loss. Then, all the data of runoff volume and coefficient, sediment concentration and soil loss from 18 plots in both control and treated sub-watersheds for 52 events over the years 2009 to 2014 were compared and evaluated. Fig. 2 shows the location of standard plots in treated and control sub-watersheds.

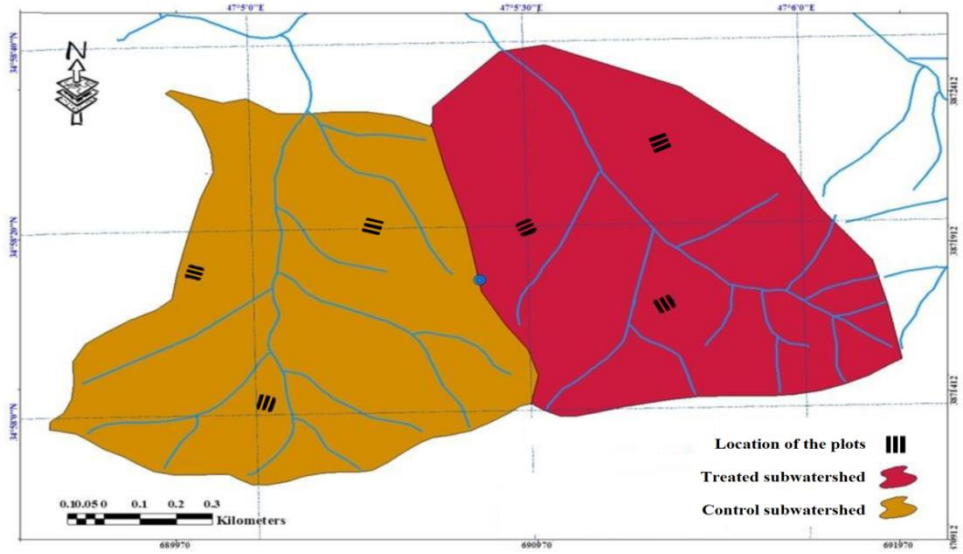

Fig. 2. Location of USLE standard plots in studied sub-watersheds

Methods

Three erosion plots with the area of 22.13 × 1.83 m (dimension of Universal Soil Loss Equation plots) were installed in each western, northern and eastern slopes of both control and treated sub-watersheds. The surface runoff and soil loss at the output of all 18 plots were collected and measured after each rainfall event which led to runoff (Fig. 3).

A B

Fig. 3. A view of standard erosion plots (A) and a view of runoff and sediment collected in plot output reservoir (B).

All the data of runoff volume and coefficient, sediment concentration and soil loss from 18 USLE standard plots in both control and treated sub-watersheds for 52 events over the years 2009 to 2014 were then measured and evaluated. The collected runoff samples transferred to the laboratory and sediment concentration was measured using decantation procedure and oven drying at 105 °C for 24 h and weighed by high-precision scales (Gholami et al., 2014; Khaledi Darvishan et al., 2014).

RESULTS AND DISCUSSION

The results of runoff volume and coefficient, sediment concentration, soil loss and sediment yield in treated and control sub-watersheds are presented in Table 2. Table 3 also stated the average coefficient of variation due to exclosure in studied variables.

Table 2. Runoff volume and coefficient, sediment concentration, soil loss and sediment yield in treated and control sub-watersheds

Variable	Sub-watershed	Mean value	Mean standard error
Runoff volume (L)	Treated	34.78	1.05
	Control	41.25	1.18
Runoff coefficient (%)	Treated	3.52	0.18
	Control	3.75	0.21
Sediment concentration	Treated	0.65	0.05

($g\ L^{-1}$)	Control	0.78	0.06
Soil loss (g)	Treated	24.15	2.02
	Control	31.93	2.67
Sediment yield ($t\ ha^{-1}$)	Treated	0.011	0.001
	Control	0.014	0.001

Table 3. The average coefficient of variation due to exclosure in studied variables

Variable	Variation coefficient (%)
Runoff volume (L)	15.68
Runoff coefficient (%)	6.13
Sediment concentration ($g\ L^{-1}$)	16.67
Soil loss (g)	24.37
Sediment yield ($t\ ha^{-1}$)	21.43

Table 2 showed that the exclosure practice could decrease runoff volume and coefficient, sediment concentration and soil loss in treated sub-watershed. It can be stated that the exclosure practice as conservation method can increase the canopy cover which leads to decrease runoff and soil loss (Gholami, 1995; Sadeghi, 1996; Alidoost et al., 2006; Ghoddousi et al., 2006). The results also showed the decreasing rates of 15.68, 6.13, 16.67, 24.37 and 21.43% due to exclosure respectively for runoff volume and coefficient, sediment concentration, soil loss and sediment yield (Table 3). Table 4 presented the results of independent samples t-test between runoff volume and coefficent, sediment concentration, soil loss and sediment yield in treated and control sub-watersheds.

Table 4. The results of independent samples t-test between runoff volume and coefficent, sediment concentration, soil loss and sediment yield in treated and control sub-watersheds

Sources of variations	Significant level	Degree of freedom
Runoff volume (L)	0.028 *	887.754
Runoff coefficient (%)	0.166 ns	916.385
Sediment concentration ($g\ L^{-1}$)	0.058 ns	903
Soil loss (g)	0.020 *	903
Sediment yield ($t\ ha^{-1}$)	0.020 *	933

ns, *: not significant and significant at $P \leq 0.05$, respectively.

The results showed the significant ($p \leq 0.05$) decreasing effect of exclosure treatment on runoff volume and soil loss at plot scale. In other words, the variables

of runoff volume, soil loss and sediment yield had statistically significant differences ($p \leq 0.05$) in treated and control sub-watersheds which is in agreement with previous researches including Vahabi (1989), Kerr and Chung (2002), Ghoddousi et al. (2006) and Hematzadeh et al. (2009). The sediment concentration variable had p value of 0.058 and therefore the effect of exclosure treatment on sediment concentration was also relatively significant. The variables of runoff volume, sediment concentration, soil loss and sediment yield were significantly decreased in treated plots as well as treated sub-watershed due to exclosure. The exclosure was clearly an efficient method which led to increase the vegetation density and infiltration rate and consequently reduce runoff and soil loss which is in agreement with previous researches (Kohnke, 1968; Vahabi, 1989; Gholami, 1995; Akbarzadeh, 1996; Sadeghi, 1996, Rahmati et al., 2004; Alidoost et al., 2006 and Ghoddousi et al., 2006). Also, the splash erosion which is the first step of water erosion could decrease with the vegetation cover.

CONCLUSION

The present study was conducted in two treated and control sub-watersheds with exclosure treatment and under free grazing respectively, in Khamsan representative watershed in south of Kurdistan Province, Iran. Based on the results, it can be revealed that the exclosure treatment, because of increasing vegetation density and cover, caused the increasing infiltration and significantly decreased runoff, sediment concentration and soil loss.

ACKNOWLEDGMENT

The laboratory investigations were conducted in Khamsan representative watershed laboratory which have been supported by the natural resources general office of Kurdistan province, Iran. The authors would like to thank to Farhang Saeidi and Aref Bahmani, Asadollah Karamzadeh and Rezaali Moradi for their ongoing assistance in Khamsan representative watershed. All the supports provided by the natural resources general office of Kurdistan province is gratefully acknowledged.

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10.7251/AGRENG1601058S
UDC 550.34:63(541.35)

EVALUATION OF IMPACT OF EARTHQUAKE ON AGRICULTURE IN NEPAL BASED ON REMOTE SENSING

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ABSTRACT

The big earthquake happening in April 2015 killed over 9000 people in Nepal. The effect of earthquake affected not only safety of local people but also agricultural field. Agricultural economy dominates in income of local people. Therefore, restoration of agricultural areas is required for improving life of locals. However, lack of information about agricultural areas is the main problem for local government to assess and restore damaged agricultural areas. Remote sensing was applied to access damaged agricultural field due to its advantages in observing responds of environment without temporal and spatial restriction. Accordingly, the objective of the study is to evaluate disaster risks based on data from questionnaire survey, remote sensing and geographic information system (GIS) in agricultural areas of Nepal. Firstly, we conducted questionnaire survey about thirty indicators of agriculture-related issues. Moreover, based on USLE (Universal Soil Loss Equation), soil erosion risk was compared between before and after the earthquake. To clarify the relation between soil erosion risk and land-use, land-use map was created based on Worldview-3. Finally, statistical analysis was conducted based on the collected data. From the results of field survey and analysis, it turned out that there was little damage on agricultural areas but huge damage on houses and barns in the villages in the research site. It is attributed to the vulnerable house materials. Soil erosion risk, that has been little observed in agricultural area, decreased in forest area and increased in residential area compared to the pre-earthquake time. From the statistical analysis, multi regression analysis was applied and age of house and elevation was computed as dominant factors of building damage in the research site. It is suggested that it is important to improve house materials in the villages and increase vegetation cover to prevent from further soil erosion in the research site.

Keywords: *GIS, remote sensing, soil erosion, worldview-3.*

INTRODUCTION

An earthquake of magnitude at 7.8 occurred at Gorkha District in the northwestern part of Nepal on April 25, 2015. The earthquake caused an estimated death toll of 9,000 (Wilkes and Sharma, 2015). It triggered a number of human casualties, damages of buildings and landslides in Kathmandu and the surrounding rural areas. Although the situation of affected area became clear immediately, it has not been investigated sufficiently in rural areas. As most of people are engaged in agriculture in steep slope areas in Nepal, it is concerned about damage on agriculture and secondary or tertiary disasters such as slope failure, erosion or destruction of dams. Facing such issues, there is a strong need to clarify the disaster impact on the rural areas and identify safe place to live and resettle for their sustainable living and livelihood. However, lack of information about agricultural areas is serious problem for local government to assess and restore damaged agricultural areas (Ashalata and Dibya, 2015). As many agricultural areas are located in high elevation and remote area from the arterial highway, the access to that areas are difficult. In addition, the data that the local government has is limited. Therefore, the research requires the long field work to collect the necessary data. Remote sensing was applied for accessing damaged agricultural field due to its advantages in observing responds of environment without temporal and spatial restriction.

Accordingly, the objective of the study is to evaluate disaster risks based on data from questionnaire survey, remote sensing and geographic information system (GIS) in agricultural areas of Nepal. These results can contribute to suggest the Nepalese Government high resilience area to natural disasters.

MATERIAL AND METHODS

The research site is targeted at Panchkhal Municipality in Kavrepalanchok of Gorkha District (Nepal) where most of people are engaged in agriculture and suffered the immense damages (Figure 1).

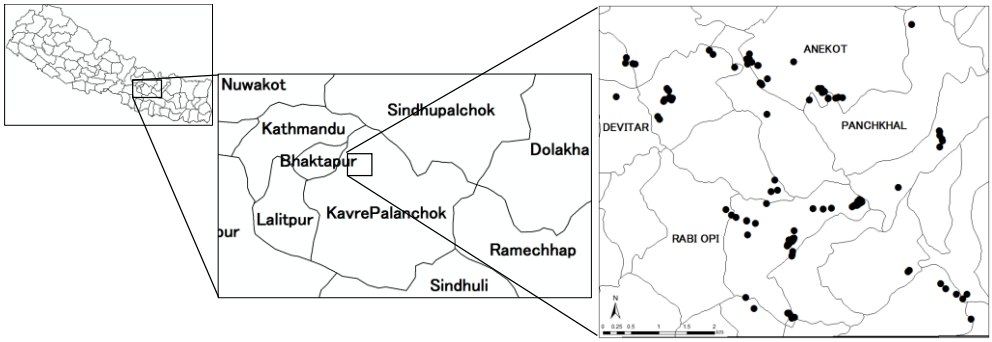


Figure 1. Research area in Nepal

The research consists of data collection not only from the governmental offices but also from the field survey including questionnaire survey, soil erosion risk analysis, land-use mapping and statistical analysis to reach the research objectives. The methods of each study are explained below.

Field survey (Questionnaire survey and soil sampling)

The research team conducted questionnaire survey from November 2015 to May 2016 in the research site. The survey targeted 136 households in thirteen villages and the questionnaire contained about thirty indicators such as building (house and barn) damage, building materials, main crops, water source, agricultural productivity and other agriculture-related issues, comparing the current situation to the one in the pre-earthquake time. The respondents were given scales to answer each indicator. In case of building damage, three-point scale such as partial, half and total collapse was provided. Soil sampling was conducted at nine spots in total in the research site in February 2016.

Soil erosion risk analysis and land-use mapping

Based on USLE (Universal Soil Loss Equation), soil erosion risk was compared between before and after the earthquake as seen in the formula (eq 1). Soil Loss Equation (USLE) have been used to calculate annual soil erosion rate (Wischmeier and Smith, 1978). USLE is empirical model, originally developed to predict soil erosion rate, mainly in agricultural land. Vegetation cover conditions before the earthquake were taken on June 14, 2014 and that after the earthquake on June 1, 2015. The calculation of soil erosion risk was based on the following equation.

$$\text{Soil erosion risk (SER)} = K * LS * C \quad \ldots \text{eq 1}$$

where K is soil erodibility factor, LS topographic factor and C cropping management factor. The soil erodibility factor was extracted from physical condition of sampled soils, topographic factor was from land slope degree calculated from ASTER GDEM, and cropping management factor was calculated from the Normalized Difference Vegetation Index (NDVI) generated by LANDSAT8 (pre-earthquake on June 14, 2014 and post-earthquake on June 1, 2015). In cropping management factor, although empirical value is used in general, this research applied NDVI instead. Regarding this, it has been confirmed that NDVI has sufficient accuracy based on an experiment which used spectroradiometer which has the same sensor as satellite. Based on the factors, soil erosion risk map was created which normalized the value gap of soil erosion risk between pre- and post-earthquake. To clarify the relation between soil erosion risk and land-use, land-use map was created based Worldview-3. The map was classified into houses, forest, agricultural land, water and road.

Statistical (multi-regression) analysis

Statistical analysis was conducted based on the collected data, such as the results of questionnaire survey, land slope degree, soil erosion risk map, etc. It aimed to clarify the causal (dominate) factor of earthquake damages in the research area.

RESULTS AND DISCUSSION

The results of each analysis are discussed into three parts as field survey, soil erosion risk analysis and land-use mapping and statistical analysis shown as follows.

Field survey (Questionnaire survey and soil sampling)

As results of questionnaire survey, most of the farmers mentioned that soils became dry after the earthquake, although its cause could not be identified. For the loss of water source and the lack of precipitation after the earthquake, it was causing them poor harvesting and living. The houses and barns were significantly damaged in most of the villages. Besides that, the relief has been insufficient to repair them. By the time of the survey, they had made quite temporal and simple repair on their houses. Therefore, many of them sleep outside of their houses because of fear of house collapse and suffer from cold during nights. Although some houses were mainly built by bricks and woods, most of houses were built only by muds, rocks or unbaked bricks (Figure 2). Thus, the building damages were more significant in houses built only by muds, rocks or unbaked bricks.

For this reason, the loss of livestock was also significant because of the collapse of barns. Severe damage on agricultural facilities such as canals was not observed. Totally 136 houses were investigated and the damage scale among partial, half and total collapse was 21.3%, 12.5% and 65.4%, respectively. Thus, most of houses were totally collapsed (Figure 3). The valuable data such as the results of the questionnaire survey and location information of damaged buildings was obtained through visiting villages one by one.

In soil sampling, soil texture, permeability and structure were observed in agricultural soils. For this reason, it is able to maintain certain agricultural productivity if water management is conducted at certain level. On the other hand, forest soils contain a lot of clay, thus are hardly water permeable.

Figure 2. Difference of building damages between house materials Bricks and woods (left) and Muds and rocks (right)

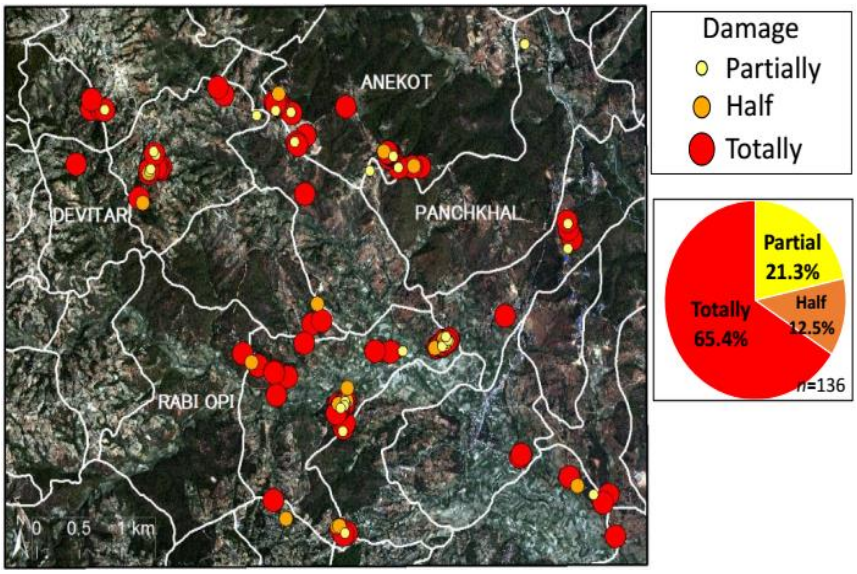


Figure 3. Distribution map of building damage scale and damage degree

Soil erosion risk analysis and land-use mapping

The changes in soil erosion risk between the pre- and post- earthquake was measured based on the relation of soil erosion risk (Figure 4) and land-use (Figure 5). The change value of soil erosion risk (VSER) was calculated by the following equation (eq 2).

$$VSER = SER\ (A) - SER\ (B) / SER\ (B) \quad \ldots \text{eq } 2$$

where VSER is changed value of soil erosion risk, SER (A) soil erosion risk after earthquake and SER (B) soil erosion risk before earthquake.

From this, it was observed that the soil erosion risk was not changed in agricultural land averagely, but decreased in forest area and increased in residential area (Figure 6). Therefore, vegetation cover needs to be increased to avoid further erosion phenomena after the earthquake, and land reclamation is not encouraged for dwelling or agriculture from forests. Although soil erosion risk would be influenced by land slope degree, the correlation coefficient was low (R=0.08) between the risk and the slope degree generated from ASTER GDEM. As ASTER GDEM's spatial resolution is 30m, there might be the map was not sufficiently replicate the undulating and steep slopes in the research area. Therefore, there is a need to apply a DEM (digital elevation model) with higher resolution for the more accurate study.

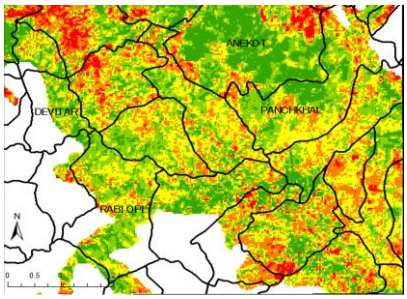


Figure 4 Changed value of soil erosion risk map

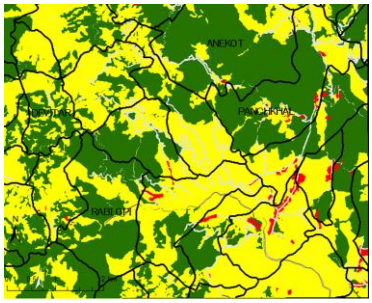
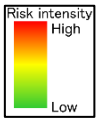


Figure 5 Land-use map based on Worldview-3



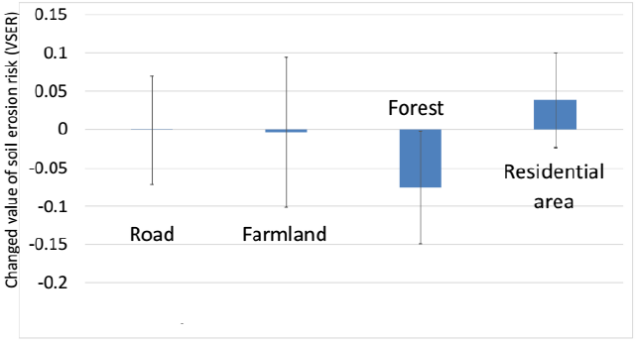


Figure 6 Changed value of soil erosion risk (error bar shows standard deviation)

Statistical (multi-regression) analysis

It was observed from the field survey that there was little damage on agricultural land because most of the farmers do not own them in large scale. However, houses which also play a role of granary are the most important in this case for their living and agricultural activities. For this reason, multi regression analysis was conducted by making intensity of damage as an objective variable, and age of house, building material type, soil erosion risk, cropping management factor, soil erodibility factor, land-use type, irrigation type, slope in degree, crop type, farmland productivity, elevation and so on as explanatory variables. As the consequence, 'age of house' and 'elevation' was computed as dominant factors for building damage in the research site with 95% confidence interval (Table 1). The both factors are considered to have affected on damage on buildings. It is considered as valid that age of house is a factor because of its vulnerability. In case of elevation, it is considered that vulnerable house materials are used more in the research site. However, because 'house materials did not emerge as a dominate factor, there is doubt on this result. Therefore, it is necessary to analyze further with more details

to make a conclusion. The data and results obtained from this research, such as land-use map and soil erosion risk map have been compiled on GIS database.

Table 1. Result of multi-regression analysis

Explanatory variables	P Value
Age of house	*0.0257
Farmland productivity	0.0519
Irrigation type	0.1036
Elevation	*0.0464
K factor	0.1386
Land use	0.1865
C factor	0.0608
Soil erosion risk	0.1369
Constant	**0.0047

* $P \leqq 0.05$ ** $P \leqq 0.01$

CONCLUSION

From the overall research results, the followings are the concluding remarks corresponding to the research objectives.

- Agricultural land was not damaged directly by the earthquake in research area.
- Building structures such as houses and barns were significantly damaged and caused a large number of livestock losses.
- Most of collapsed houses were made by unbaked bricks, stones or muds. Because of that fact, it is important to improve house materials in villages.
- Based on USLE (Universal Soil Loss Equation), soil erosion risk was compared between before and after the earthquake. In farmlands, the changed value of SER (VSER) was small. However, there were tendencies for VSER to increase in residential area and decrease in forests in the research area. Accordingly, it was concluded the vegetation cover is important to eliminate further erosion phenomena.
- From the results of multi regression analysis, the dominate factors were 'Age of house' and

'Elevation' at 95% confidence interval. However, there is a tendency that in the higher in elevation the smaller in the damage occurred, and in the lower in elevation the larger damage occurred in general. Therefore, analysis that is more detailed is necessary to conclude it.

From above conclusions, it suggests that it is necessary to promote the use of more resilient house materials for houses and barns to aim for sustainable agriculture and livelihood for the locals. In this research analysis, it applied damage on buildings and erosion phenomena. However, because productivity of crops is significantly important for farming, there is the need to continue observing agricultural productivity to suggest high resilient area for resettlement.

ACKNOWLEDGMENTS

This research is supported by the J-RAPID Program from Japan Science and Technology Agency (JST). Authors received generous support from research members of Kathmandu University (Nepal) to questionnaire survey.

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10.7251/AGRENG1601066D
UDC 641:17(496.5)

ALBANIAN CONSUMER'S BEHAVIOR TOWARD ETHICAL VALUES OF AGRO-FOOD PRODUCTS: A SOCIO-ECONOMIC ANALYSES

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ABSTRACT

The aim of this work was to analyze and find out the relation between socio-economic characteristics of Albanian consumers and their behavior toward agro-food products with ethical values. Organic, fair-trade and typical/traditional agro-food products were ethical products object in this study. Information was collected by face-to-face interviews with 311 adult Albanian consumers concentrated mainly in the central, south-eastern, south-western and northern part of Albania. The Logit model is used to study correlation between consumers' behavior and their socio economic characteristics such as: origin, age, gender, marital status, family size, children and elder presence, family monthly income, employment, level of education and their knowledge about ethical agro-foods. Logistic regression is used to predict a categorical (usually dichotomous) variable from a set of predictor variables. Analyses demonstrated that only "Education", "Age" and "Knowledge level about ethic food" have a significant contribution to their behavior ($p \leq 0,05$). The correlation between Albanian consumers' behavior and last three variables is significant.

Keywords: *consumer, agro-food, ethical values, socio-economic, logistic regression, Albania*.

INTRODUCTION

More recently food scandals driven by a desire to drive down costs and increase profit have hit the supermarket shelves – 'horsegate' being one notable example. On top of this political and economic turmoil international organizations including the World Bank and the UN told us about the 'perfect storm' of climate change, resource constraint and population growth. These three factors, they warned, will undeniably place great strains on society and on the businesses that operate within it. It is needed to meet these difficult issues face on; the strength to rise to the challenge and create new business models and new food systems that are fit for a new world (Barling L. 2015).

Ethical consumption, the successive term of "green consumerism" (Elkington and Hailes, 1989) could be part of the answers to these challenges. As a form of

critical consumption, in the present paper, it refers to the consumer's behavior of purchasing products and services produced in a way that minimizes social, animal welfare and/or environmental impacts, while avoiding (boycott of) products and services considered having a negative impact on three mentioned dimensions. It encompasses a broad range of ethical issues including matters of conscience such as animal welfare and fair trade, labor standards, self-interested health concerns (Cowe and Williams, 2000), deep-seated problems of people of third world (Shaw and Clarke, 1999), people of minorities, right of workers, children's labor, product transportation distances, (Harrison *et al.*, 2005), environment etc.. Products that respond to each of ethical issues there is relatively wide such as vegetarian, vegan, organic, kilometer zero, cruelty-free not tested on animals, fair trade, those not use children's work, those from minorities or other people communities in need, territory/local products, etc. Literature identifies three waves of consumerism (Lang and Hines 1993). The third wave, ethical consumerism is described as ''a marriage of environmentalism and citizenship (Tallontire *et al.*, 2001). The rise of ethical consumption thus connects to a broader popular critique focused on a range of concerns around environmentalism, anti-materialism, and unsustainable lifestyles (Lewis, 2012; Horne *et al.*, 2015).

Ethical products and services are experiencing growing market shares and this phenomenon is not restricted only in Europe (Freestone and McGoldrink, 2008). The UK publication "The ethical Consumer: Markets Report 2014", that assesses changes of "ethical spending" in UK for a time-span of 15 years, reports a shift from about 12 billion pounds in 1999 to about 75 billion pounds in 2013 (Consumer Data Research Centre, 2014). The main factors that helped to the development of this market are the economical shift of post-industrial area (consumerism) (Martinengo, 2012), government policies, and consumer information (Freestone and McGoldrink, 2008). The shift toward values of social responsibility can be find explanation in the Maslow's hierarchy of needs, and corresponds to self-actualization and self-fulfillment. Not to be forgotten other factors such as consumer culture and sub-culture together with socio-economic factors: incomes, education, family structure (presence of children) and age. Then particular food poisoning episodes of listeria, salmonella, e-coli and Bovine Spongiform Encephalopathy or "mad cow", have damaged consumer faith in the food industry and especially factory farming. The conditions of animals in chicken batteries, veal calves and pigs have also helped to turn people against mass-production methods (Cowe and Williams, 2000).

However the share of ethical consumption is still very low compared to the today's market size (Freestone and McGoldrink, 2008; Tallontire *et al.*, 2001). It is hampered by other barrier factors such as brands and big companies, already well known to be influencing factors in the markets. The syndrome of 30:3 for ethical products (English case but even global phenomena) suggests that about a third (30%) of consumers declare to care about ethical issues (companies' policies and records on social responsibility), but ethical products rarely achieve more than a 3% of the market share (Cowe and Williams, 2000; Stolle and Micheletti, 2013).

Recently, at a global level, there is a huge research about ethical consumption analyzing consumer behavior and attitude toward ethical values as well as assessing their trends in the market share. Despite the growing popular currency of the concept, there have been relatively few large-scale academic studies of ethical consumption though, perhaps not surprisingly, a number of large national and international surveys have been undertaken in the field of marketing (Lewis, 2012; Horne *et al.*, 2015). Various in-depth qualitative studies have also begun to emerge on specific aspects of ethical consumption, including Fair Trade products, food and fashion while a number of geographers have conducted research on commodity 'chains' or 'networks', situating consumption globally and articulating ethical consumption within the politics of production, marketing and retail practices and policies (Lewis, 2012; Horne *et al.*, 2015). However, there is still need for further research due to new dynamics in this kind of consumption, continuous increase of its market share and because of particularity of local factors which brings to different dynamics in different countries and regions. The benefit of results of international studies not always can predict or explain what happens in particular countries: usage of ethical products due to particular characteristics and values is influenced by local factors independently from the fact that it is influenced by factors that are known from general marketing theory. Results of surveys can offer information on consumers behavior in the market, their believes and motivations stay behind their behaviors, factors that influence more the choice for certain products that have ethical values in a territory, country, region etc.. Information and conclusion of analyses from such surveys can serve to market experts, to businesses oriented in ethical issues as well as to policy-makers. Government can benefit of this information and take actions in order the mainstream manufacturers could adopt "ethics" and transform "ethical markets" from niche to mainstream markets. The Government might offer tax incentives to help build ethical markets, or require companies to publish the kind of reliable information about their social and environmental performance which ethical consumers need. Companies also need to be encouraged to move beyond activities supporting communities to embrace social responsibility throughout their business (Cowe and Williams, 2000).

Coming to Albanian reality, there is few literature and research on consumer's behavior toward agro-food products and almost not at all research which deal with particular aspects of ethical consumption. To the best knowledge of authors of the present paper, the studies dealing with Albanian consumer's behavior refer to individual products such as wine, lamb meat, olive oil, table olives, apple fruits and milk. They take into consideration the different attributes of products in general and no one of them has studied consumer behavior, knowledge, perceptions and attitudes toward ethical products. Some preliminary results of current work presented previously showed a positive attitude of Albanian consumers toward products with ethical values especially those originated from organic, natural and local production (*Driouech et al.*, 2013). The present work is aiming to contribute to fill this gap through consumer behavior analyses. The objective was to find out the relation between socio-economic characteristics of Albanian consumers such as

geographical origin, family incomes, age, gender, employment, education and their knowledge about ethical food and their behavior toward agro-food products with ethical values.

MATERIAL AND METHODS

The 311 face-to-face questionnaires were applied to adult individuals selected randomly in urban areas near or inside the commercial centers, supermarkets, small markets , small shops and farmer's markets. Study includes four different areas of Albania with the scope of different economic and social distinguished characteristics: central Albania (Tirana, Kruja and Durres), northern part (Tropoja and Kukes), south-western part (Berat) and south-eastern part (Gramsh and Korça. The respondents were chosen randomly composing a sample that was belonging to different ages, gender, education, origin, family status and size. The questionnaires had three main sections: a) socio-economic data; b) consumer's behavior in the market c) knowledge, beliefs, motivations and attitudes toward ethical products, sources of information and knowledge about them and the channels of communication they would prefer in the future.

a. The first section related to socio- economic data collected information like: origin, age, gender, level of education, employment, marital status, family size, children and elder presence, family monthly income; b. The second one dealt with questions related to consumer's behavior in the market: what type of product they buy, in what basis, how often, and where they buy; whether they read and what they search in the label, willing to pay, what type of products would prefer, to what extension and frequencies would buy, etc; c. The last section asked respondents on: what does mean ethical product, what is the contribute of organic, fair-trade and local/typical products to ethical issues such as environment (decreasing food miles and emissions, biodiversity and ecosystem conservation, better natural resource use), consumer's impact on animal health and welfare, social and civic impacts (food quality and safety, safe and equitable workplace, gender equity, transparent and trustworthy food systems, civic responsibility and care, human rights), economic impacts (fair and equitable financial returns for local farmers/producers, etc.

The Logit model from the SPSS 20 software was used to study relation between consumers behavior and their socio economic characteristics such as: age, gender, education, family incomes, employment and their knowledge about ethical foods. As dependent variable we have used "Consumer Behavior", assuming that the Albanian consumer do or do not eat ethical food. At the beginning of this study we considered a larger number of explaining (independent) variables, such as "Geographical origin", "Gender", "Age", "Education", "Employment", "Income", "Family status" "Family size", "Presence of children and elders" and "Knowledge level about ethic food". After the first data analysis some of these variables, precisely "Family status" "Family size, "Presence of children and elders" and "Geographical origin", were left out of the model due to the very poor correlation between them and "Consumer Behavior".

So, in the further analyses we have used as predictor the following variables: "Gender", "Age", "Education", "Employment", "Income", and "Knowledge level about ethical food" (equivalent to long expression "Knowledge level about products that during production and all chain from producer to consumer take care for ethical issues such as environment, animal welfare, human rights"), while "Consumer behavior" was dependent variable.

Logistic regression was applied to predict a categorical (usually dichotomous) variable from a set of predictor variables. With a categorical dependent variable, logistic regression is often chosen if the predictor variables are a mix of continuous and categorical variables and/or if they are not nicely distributed (logistic regression makes no assumptions about the distributions of the predictor variables). For a logistic regression, the predicted dependent variable is a function of the probability that a particular subject will be in one of the categories. The Hosmer-Lemeshow tests the null hypothesis that predictions made by the model fit perfectly with observed group memberships. Cases are arranged in order by their predicted probability on the criterion variable. A chi-square statistic is computed comparing the observed frequencies with those expected under the linear model. The Wald statistic and associated probabilities provide an index of the significance of each predictor in the equation. The Wald statistic, tests the unique contribution of each predictor, in the context of the other predictors -- that is, holding constant the other predictors -- that is, eliminating any overlap between predictors.

RESULTS AND DISCUSSION

Respondents consisted of respectively 58% male and 42% female. Most of them were married (71%); 58.7% of interviewed had children; 91.9% had the education at least at secondary school level. The range of age intended was from 18 to above 50 : 65.5% of respondents belonging the age between 31- above 50 years old, the age that in general do more shopping. Most respondents (63.4%) were working (52.4% employed and 11% business-runner); 23.2 % were students and housewives , only 12.2% were retired and 1.2 % unemployed (Table 1).

Table. 1. Respondents profile for demographic and economic characteristics

Characteristics		Percentage %	Characteristics		Percentage %
Gender	Male	58.0	Family size	Tilll 2 members	11.1
	Female	42.0		3 members	11.1
Age	18-24	19.0		4 members	32.5
	25-30	15.0		5 members	24.4
	31-40	18.0		6 members	13.0
	41-50	21.0		More than 6 members	7.8
	51 and over	27.0	Employment	Student	15.0
Level of education	Primary school	8.50		Employee	52.4
	Technical professional school	37.8		Businessman	11.0
	Secondary school	39.0		Housewife	8.2
	College/University	10.0		Retired	12.2
	Postgraduate (Master, PHD)	5.1		Unemployed	1.2
	Other	0.00	Family income (Albanian currency/Month)[9]	Less than 20 thousand	7.2
Family status	Single	29.0		21-40 thousand	26.5
	Married	12.3		41-60 thousand	33.7
	Married with children	58.7		61-100 thousand	22.3
Household composition	Children	77.7		More than 100 thousand	10.2
	Elders	47.0			
	People with health problems	6.0			
	None of above	12.0			

**Source: Driouech et al., 2013*

It was noticed that most of Albanian consumers have not clear concept about ethical products but only 20% of them declared to not know what "ethical products" means. Furthermore, the Albanian respondents give the same meaning to the terms: "ethical"-"organic"-"natural" and "farmer's products". About 82% of the Albanian interviewees declare that buy ethical products (Fig.1) while about

[9] The calculation of income from Albanian currency into euro is done dividing it with 140

50% of them declare buy this products in weekly basis (mostly any product but not all, directly from farmers, from extensive agriculture or wild).

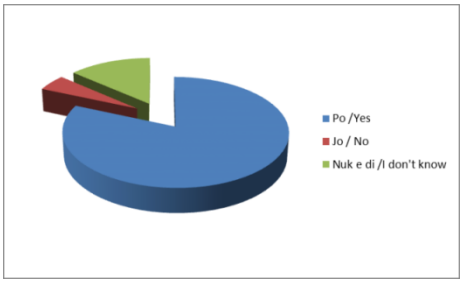

Fig.1. Consumers that consume ethical

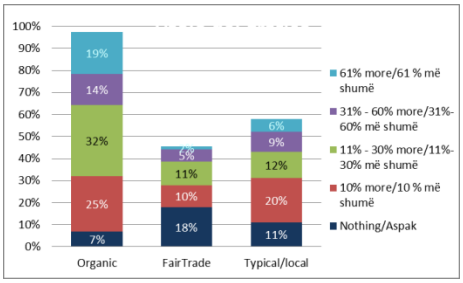

Fig. 2. Consumer's readiness to pay more products

This means that 82% of them declare that buy ethical products that they think are "organic": the term "organic" in their understanding is a mix of organic (certified), natural (wild or extensive) and directly from farmers; from the other side to the Albanian consumers when they buy this products, buy because think are healthier. Ethical products that respondents buy more as "organic" are: olive oil (50%), fruits (47%), cereals and pulses (40%), processed food (39%), vegetables (35%) and meat (31%).

Albanian consumers, in general, have positive attitude toward ethical agro-food products but particularly toward organic products. This emerged from the answers they offered evidencing that they think "organic" products are healthier and tastier. To understand better the link between their positive attitude and behavior toward ethical products (preference of organic products or directly from the farm) and their awareness for the impact of their behavior: 67% responded positively/they were aware, but only 17.7 % of them have ethical motives behind (4.7% for protection of natural resources, and 13% for social concern and helping farmers).; the most important motive for buying were food-safety and health.

Consumers would like to buy more organic food but the price and especially the availability are the limiting factors; compared to the conventional products they would pay more even for the other ethical products. Summarizing what written above the answers related to the willingness to pay premium price offered these results: 90% of respondents would pay more for organic products, 28% of them would pay more for fair-trade products and 48% of them for typical/local products (Fig.2). According to the literature, the most important factors influence the willingness to pay premium price for ethical products are level of income, awareness for the ethical issues of the products (knowledge) and market characteristics of the product (Tallontire *et al.*, 2001).

The Logistic regression was used to understand which of the socio-economic factors ("Geographical origin", "Gender", "Age", "Education", "Employment", "Income", "Family status" "Family size", "Presence of children and elders" and "Knowledge level about ethic food") could influence Albanian consumer's

behavior toward ethical agro-food products. the very poor correlation between "Consumer behavior" dependent variable and the factors like "Family status" "Family size" "Presence of children and elders" and "Geographical origin" suggested to leave out from further analyses. The other remaining variables: "Gender", "Age", "Education", "Employment", "Income", and "Knowledge level about ethic food" fitted to the model for further analyses. "Gender" is measured in Female and Male, "Employment", "Income", "Age" and "Education" in Likert scale from 1 to 5, and "Knowledge level about ethic food" as a Dummy variable with Yes/No.

Table 2. Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	288.758[a]	.268	.495

a. Estimation terminated at iteration number 4 because parameter; Estimates cł

The Nagelkerke that does range from 0 to 1 is a more reliable measure of the relationship. Nagelkerke's R^2 will normally be higher than the Cox and Snell measure. The Nagelkerke R Square is quite good, 0,495 meaning that 49,5% of the variability in the independent variable is counted for independent variables. In our case it is 0.495, indicating a moderate relationship of 49,5% between the predictors and the prediction. The test of the full model against a constant only model was statistically significant, indicating that the predictors as a set reliably distinguished between do and do not consume ethical agro- food. Nagelkerke's R^2 of .495 indicated a moderate relationship between prediction and grouping. Prediction success overall was 91,6%. The Hosmer-Lemeshow tests (Table 3) and a non-significant chi-square statistic indicated that data fit well to the linear model.

Table 3. Hosmer and Lemeshow test

Step	Chi-square	df	Sig.
1	9.475	8	.304

The Wald statistic tested the unique contribution of each predictor, in the context of the other predictors eliminating any overlap between them. According to our results the predictors "Gender", "Employment" and "Income" have not significant values and contribution to the Albanian consumer's behavior. In the contrary for the predictor "Age", "Education" and "Level of Knowledge" we have significance values less than .05 showing that the variable does make a significant contribution.

Table 4. Variables in the model

	B	S.E.	Wald	df	Sig.	Exp(B)
Gender	.020	.604	.001	1	.0973	1.020
Age	.301	.259	5.348	1	**.0246**	1.351
Education	.066	.027	5.867	1	**.015**	0.351
Employment	.358	.275	1.687	1	.194	1.430
Income	.058	.532	.012	1	.913	1.51
Level of Knowledge	1.813	.377	23.146	1	**.000**	6.128
Constant	-29.129	8182.631	.000	1	.997	.000

The Exp(B) column in Table 4, presents the extent to which raising the corresponding measure by one unit influences the odds ratio. We can interpret EXP(B) in terms of the change in odds. If the value exceeds 1 then the odds of an outcome occurring increase; if the figure is less than 1, any increase in the predictor leads to a drop in the odds of the outcome occurring. For example, the EXP(B) value associated with Age is 1.351. Hence when age is raised by one unit (year) the odds ratio is 1,3 times as large and therefore consumers are 1,3 more times likely to belong to the take offer group.

At the end we can summarize that the Albanian consumer's behavior towards ethical products is strongly affected by age, education and level of "Knowledge" about these foods. Similar research on consumer behavior toward ethical products in England confirms that active consumers cross most socio-political boundaries. Their behavior is not defined by political party affiliation, social class, gender and less defined by age. Ethical consumer group participations are defined mainly by their attitudes to and behavior on ethical issues, and not by standard socio-demographic criteria (Cowe and Williams, 2000).

CONCLUSION

Albanian consumers have positive attitude toward ethical products especially for organic and farm/typical/local agro-food products. The logistic regression analysis was conducted to predict behavior of 311 Albanian consumers towards ethical agro-foods. The socio-economic characteristics of consumers such as "Gender", "Employment" and "Income" have not any influence on Albanian consumer's behavior regarding ethical agro-food products. The logistic regression and Wald criterion applied for socio-economic characteristics "Education", "Age" and "Knowledge level about ethic food" as predictors, demonstrated that "they have a significant contribution to prediction ($p \leq 0,05$) which means that Education", "Age" and "Knowledge level about ethic food" influence the consumer behavior toward agro-foods with ethical values. Changing social patterns of Albanian consumption, however, will eventually make a difference. Once individuals begin to understand how their purchases are connected within a global framework (e.g. environmental costs of production), they can demand new, sustainable methods of

production. Living with fewer "things" and assuring that all resources, including labor, are used wisely and fairly will help create a more equitable and ecological world. Finally, advocacy of conscience consumption may raises fundamental questions about the ethical capacities of market-driven societies and whether it is possible to develop a sustainable consumer culture.

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10.7251/AGRENG1601076M
UDC 338.43:349.414(496.5)

TOWARDS A NEW CONCEPT FOR THE AGRICULTURAL LAND-USE PLANNING IN THE NEW SOCIO-ECONOMIC CONDITIONS IN BULGARIA

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ABSTRACT

The goal of this paper is to present a new concept for Agricultural Land-Use Planning as a land-administration activity in today's market economy. The planning process consists of preparing projects for land use in the agricultural territories. Agricultural Land-Use Planning is developed for the purpose of materializing and stabilizing land tenure, for environmental protection and for ensuring efficient farm economy. The current market economy conditions are new to the country. So far, land management has served the principles of the centralized planned economy under the totalitarian governance of the land. The main deficiencies of that governance are connected with the alienation of land owners from their properties and the liquidation of their interest in land stewardship. Another problem has been the occurrence of soil degradation processes as a consequence of extreme soil exhaustion. The cooperative land cultivation in the past prevented land-use planning from addressing the issues of land tenure.

The socio-economic conditions of today's market economy pose new challenges to the Agricultural Land-Use Planning due to differing and compliance the interests in the public and private sectors. The strategy has to be constructed in such a way that it simultaneously secures land-tenure, environmental protection, and the farms' economic prosperity. This brings together a number of activities such as research and assessment of soil quality, agricultural cadaster, appraisal of land property, soil protection and soil fertility, environmental and landscapes protection, agricultural land structure design, etc. Based on a survey conducted among professionals and farmers, and on the authors' critical approach, a new concept for the Agricultural Land-Use Planning as a socio-economic activity has been developed. A number of design activities in the dynamic market environment are included, as well. The paper is written in the form of a comparison between the two socio-economic systems (centrally planned land-use and cooperative land cultivation systems) and contains the main highlights of the new concept.

Keywords: *land policy, land legislation, agricultural land-use planning, land tenure, land protection.*

INTRODUCTION

Agricultural Land-Use Planning is an activity that is a part of land administration. It consists of preparing projects for land use in the agricultural territories and serves the following purposes: 1) to stabilize land tenure on the terrain; 2) to plan activities for preserving and improving soil fertility; 3) to provide environmental protection; 4) to provide optimum use of the agricultural machinery; and 5) to ensure good land-use conditions for the efficient economic development of the farms. During the country's centrally planned economy, there were no clear stimuluses for achieving these agricultural land management goals. The lack of efficient private property, real land market and economic competition turned the Agricultural Land-Use Planning into a well-motivated activity with no practical value. The only real governing factor – the State – failed at implementing the Agricultural Land-Use Planning. Only some cooperatives and state agrarian enterprises, led by fairly competent managers, were able to partially implement it. In general, though, there was lack of holistic approach to land-use planning. One can hardly find Agricultural Land-Use Projects from that time). This affected negatively the individual interest in land ownership and stewardship. Land property alienation resulted in irresponsible exploitation of natural resources, extreme exhaustion of the soils and establishment of soil degradation processes. The land use was clearly unsustainable.

Nowadays, Bulgaria is part of a global policy for combating hunger and preserving the land as a natural resource. The socio-economic conditions of today's market economy, however, create complex issues for the Agricultural Land-Use and Planning, based on private and public motivation. The cooperative land cultivation in the past prevented land-use planning from addressing the issues of land tenure. Today, Agricultural Land-Use Planning serves three main goals: land-tenure protection, environmental protection, and economic prosperity of the farms. To complete these goals, the following land-administration activities take place: research and assessment of the soil quality, agricultural cadaster, appraisal of land property, soil protection and soil fertility improvement, environment and landscape protection, and agricultural land structure design, among others.. (Williamson et al., 2012).

Market economy is new to Bulgaria. The modern land-use planning strategies meet the following pre-existing conditions in the country: land ownership multiplicity; individual control over the land; dynamic market relations, and the treatment of land as a commodity. Agricultural Land-Use Planning aims to create new territorial conditions for the regulation of land relationships, for the protection of land-tenure rights, for soil and environmental conservation, and for providing information for efficient land management.

This paper will introduce a frame of a concept for Agricultural Land-Use Planning as a socio-economic activity for collaboration between existing and newly established land properties, which will benefit both parties and will contribute to the rational use of land resources in the specified area. The concept has been based on the author's own experience and on a survey conducted among professionals and agricultural producers. A number of design activities which consider the

dynamic market environment are included. The paper is written in the form of a comparison between the two socio-economic systems (centrally planned land-use and cooperative land cultivation systems) and contains the main highlights of the new concept.

MATERIAL AND METHODS

The paper is based on pre-existing literature in the field of land-use planning and on the author's personal research. To inform the development of a new concept for Agricultural Land-Use Planning a questionnaire survey of professionals and producers was conducted by the authors. Two focus group discussions were conducted to acquire more in-depth information and qualitative context. The data gathered through these methods were systematically recorded, organized, compiled, tabulated, computerized, and analyzed in accordance with the objectives of the study. A variety of statistical analysis such as frequency, range, mean, percentage, distribution, standard deviation, categories, etc. were used to describe, represent, and explain the relationships between the variables in this study. Researchers collected the data personally in 2015 through face-to-face visits with all selected interviewees. The data was collected from 250 respondents - 50% professionals in agricultural land management and 50% agricultural producers.

The questions asked of professionals were divided into four thematic groups: (i) *land legislation* – what is the current legal and regulatory context governing land use and are there any potentially beneficiary changes in the laws and regulations currently governing spatial planning, land ownership and use?; (ii) *Planning for agricultural land use and consolidation* – is it important for solving the contemporary environmental and economic issues and for obtaining EU and national subsidies for agricultural production?; (iii) *Agricultural land use projects and plans* – are such projects significant to the economic development of a farm economy and what is the best mechanism for financing them? (iv) *Land ownership* - what is an optimal property size from both economic and social perspectives?

The central questions for the agricultural producers were related to the following fields: (i) *Problems in agricultural production* – are there any legal or financial problems effecting production, and what are they?; (ii) *Problems in situating and applying crop rotations* – are there any significant issues and could these be alleviated with professional assistance?; (iii) *Agricultural Land-Use Planning* – is there a benefit or opportunity for improving and expanding land use planning amongst farmers and how would this expansion be funded?(iv) *Land use plans* - what features of those plans are important for proper economic and environment development?; (v) *Quality of land* - what is the current base quality of each farmer's land and does the farmer apply measures for improving it?; (vi) *Land property* - what is the optimal size for land ownership; and (vii) *Land leasing* – are there problems with this system and what are they? The development of a new approach to Agricultural Land-Use Planning is based on the knowledge of land legislation in different countries and different approaches to land administration.

RESULTS AND DISCUSSION

During the period of planned economy, the main objective of the land development policy was to organize the territory in such a way that it expands the socialist reproduction, "on behalf of the organizational and economic strengthening of the socialist agricultural enterprises… " (Michev, 1978). By means of land-use planning, the socialist state "regulated" the imaginary at that time land relationships. Land management and land-use planning served the interests of a small body of governing personnel that considered a limited number of issues, mainly maximization of the production results (Michev, 1978). Protecting the inviolability and the integrity of the state and municipal land seemed to be the only reasons for land management. The management policies were mostly dedicated to creating conditions for intensification of the agricultural production. Land use was treated regionally, without considering the global environmental problems of the planet and without taking into account the real engines of the economic progress - private property and market competition.The updated land-use planning concept of the transition period is connected to the main objectives of the democratic process – the democratization of society, the rationalization of economy and the social balance. The limitations of the socialist land management and land-use planning became realistic on the base of the natural socio-economic conditions. The return to normal living conditions brought a combination of factors, which introduced new requirements and evoked new challenges to land management. The new factors consisted of: multiple ownership of land; efficient private property; market regulation of land relationships; market competition; functioning market economy; restored producer-consumer connections; the information revolution based on computerization and new technologies; new era of synthesis; globalization and location of the productive forces; new role of the state. There is awareness of the environmental issues - the deficit of the planet resources, the demographic problems, climate change, shortage of food and feed, need in particular and safe foods, new branch structure. The State policy for land and agriculture is realized by new legislation (Fig. 1).

Currently, private property and land-use in our Bulgaria suffer several deficiencies: (i) lack of adequate state policy during the period of Land Reform to guarantee further consolidation of land ownership; (ii) lack of legal mechanisms to prevent land ownership from further fragmentation in the process of ongoing inheritance, partitions and buys/sales transactions; (iii) improper management of land and water resources, improper management of land relationships and the agricultural production process (which results into a dual agricultural structure where a small number of large farms wield significant part of the agricultural land and a large group of small semi-subsistent farms wield the considerably smaller part); (iv) lack of legal certainty for land tenure which evokes problems for obtaining EU subsidies for agricultural production; (v) lack of state guarantee for the market sales output which affects the agricultural production structure negatively and makes it inefficient;

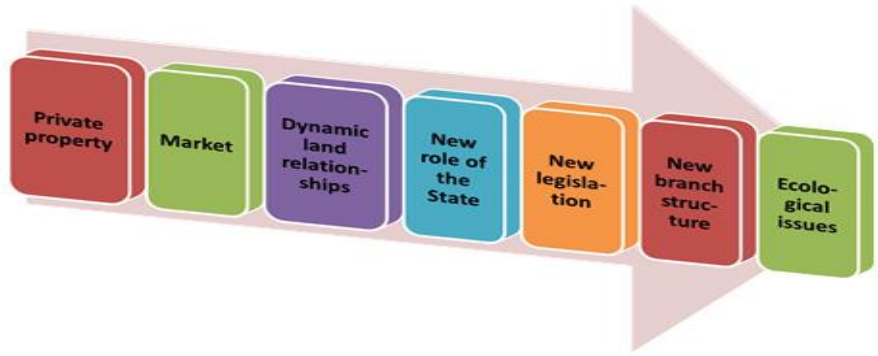

Figure 1. Towards a new land administration concept in the contemporary socio-economic conditions.

(vi) losses of GDP because of inefficient use of the irrigation and drainage infrastructure; (vii) great discrepancy between the intentions and the implementation of environmental protection; (viii) a deepening process of depopulation in the rural areas.

The results of the questionnaire survey definitely show that the Agricultural Land-Use Planning (ALUP) is essential to the creation of favorable territory conditions for farm growth and sustainable land use. Furthermore, the planning should be regulated by the state. The main results are shown in Fig. 2 and Tables 1 and 2.

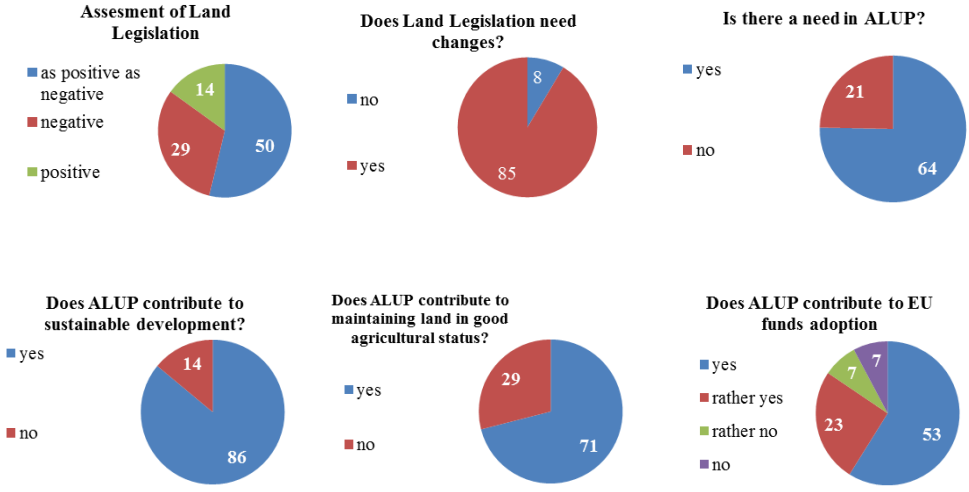

Figure 2. Distribution of the opinions on the main problematic questions on land management among the experts (%)

The main results also show that:

- Agricultural Land-Use Planning in the current conditions of dynamic land relationships and market-regulated income from the agricultural production is virally needed. This is confirmed by both professionals and farmers.
- The first step towards regulating land-use planning should be the construction of a definitive national policy for agriculture. The experts in land management believe that coping with the demographic collapse and elaborating the methodologies for small farm support should be the mail topics addressed in the new policy
- The legislation for spatial planning and land use planning in the agricultural territories is rather inadequate. The prevailing assessment of the actual land legislation by the professional respondents (50% of them) is both positive and negative.

Table 1. Distribution of the opinions on main problematic questions on land management among the agricultural producers (%)

Question	yes	as yes as no	no
Difficulties that farmers meet			
Do you suffer from deficiency of funds?	92		8
Do you have difficulties in selling the production?	60		40
Is the procedure of adoption of EU fund difficult?	58		42
Opinion of the Farmers on Agricultural Land-Use Planning (ALUP)			
Do you cope with the territorial organization of the farm?	67		33
Do you have interest in educational programs for planning and management of your lands?	92		8
Does Land Management contribute to the increase of your income?	67		33
Do you need an ALUProject?	25	17	8
Would you use ALUProject?	75	25	-
Is optimization of field area and sizes ok for successful land management?	92		8
Will the ALUProject costs be reimbursed from improved land use and production?	50	30	20
Opinion of the farmers on sustainable land use			
Is it important to apply antierosion measures?	50		50
Is proper operation of grassland important?	100		
Is it important to apply other measures for improvement of soil fertility?	100		

Table 2. The desired features of an ALU Project

Feachures of the ALUProject	vary importa nt	rather importa nt	as yes as no	rather not importa nt	not importa nt	no opinion
Land consolidation	50	30	10		10	
Contribution to arable area increase	38	50				12
Optimal number of crop rotations in the farm		43	43	14		
Compact arrangement of the crop rotations	47	40				13
Irrigation for the vegetable and fodder crop rotations and the perennials	72	14		14		
Minimal road area	33	33		17	17	
Antierosion slope for the field roads	22	56	11	11		
Minimum transportation distance to the production fields	75		25			
Minimal working slope for the tilling machines	89		11			
Proper form of the fields	22	78				
The working direction with respect to the long side of the fields	22	78				
Minimum number of non-production crossings of the agricultural machinery	25	50	25			
Prevention of harmful winds through protective forest belts	25	50	25			
Antierosion mearures	50	50				
Measures to improve soil fertility	67	33				
Proper operation of grasslands through grazing turnover and haymowing turnover	71	29				

- A Law on Land Consolidation would provide for overcoming the inconveniences, proceeding from the existing land legislation (Yarlovska, 2014).
- Sustainable land use is possible only if the agricultural territory is properly planned. If Agricultural Land-Use Planning is guaranteed and regulated by the state, it will help utilize the EU financial aid for construction of infrastructure and field road network.
- Society needs professionals in agricultural land use planning. A specialized education in Agricultural Land-Use Planning is necessary for proper agricultural land management.
- The Agricultural Land-Use Plan is an essential tool for land tenure stabilization under dynamic land relationships.

- Agricultural Land-Use Planning and land consolidation should be supported by the state. Farmers tend to pay for professionally elaborated land-use projects. They believe that the expenses payed for the project will be compensated by the revenue of the optimized production process.
- The interviewees believe that the agricultural land-use plan will contributes to the following: the consolidation of the tenure, the increase of the arable areas, the compact arrangement of the crop rotations, the irrigation for vegetable and fodder crops, the minimum lost area for field roads, the anti-erosion disposition of the field roads, the minimum transportation expenses, the minimum inclination of the agricultural machinery from the proper working direction, the proper sizes and configuration of the fields, the working direction along the long side of the field, the minimum number of non-productive passes of the agricultural machinery, the measures against wind and water erosion, and the proper operation of grasslands.
- The most desired farm size is 1,000 ha, but there are opinions in favor of 500 and 300 ha. The size factor is closely related to the specialization of the farm. The opinions in favor of the maximum size land ownership and land use in the country pool around 100 ha. The range, though, is quite wide - from 50 to 1,000 ha.

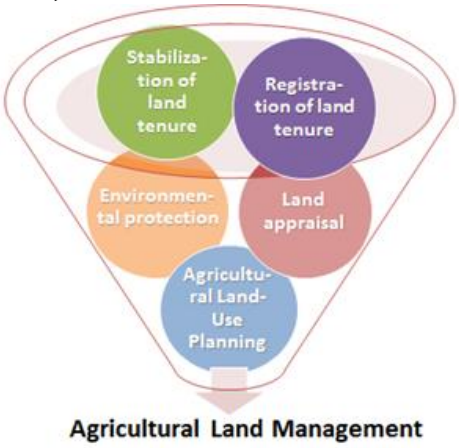

Figure 2. Activities in contribution to Agricultural Land Management

The new philosophy of land-use planning consists of a understanding it as a part of the "agricultural land administration" (Williamson et al., 2012; Shypulin, 2016). The latter consists of several interrelated activities: (i) stabilization of land tenure on the terrain; (ii) registration of land tenure in the cadastral and property registers; (iii) land property appraisal for the purposes of the land relationships; (iii) building of infrastructure and implementation of activities for environmental protection and sustainable land use.

As a consequence of this new concept, Agricultural Land-Use Planning can be allied to the following status characteristics:

- It is a scientific field, in which statistical, mathematical, experimental and other investigation methods are used for the purpose of optimization the territory structure; it is an inventive design activity for creating agricultural land-use plans; it is a continuum driven by the dynamics of land relationships and by the socio-economic processes.
- It is done for the agricultural territory as determined by the Master Plans of the Municipalities (LAU) and Municipal centers.

- Subject of the Agricultural Land-Use Planning are 1) the functional unit (farmland) and 2) its territorial elements (stacked area and linear). It establishes the regime and the standards of land use.
- Agricultural Land-Use Planning aims at rational land use and protection of the land. Its main issues are: (i) creating equal conditions for all forms of tenure - equitable distribution by land quality and location; (ii) establishment of certain indications of land borders on the terrain; (iii) developing activities for maintenance and increase of soil fertility, for reclamation of disturbed lands and for improvement of low lands; (iv) protection and prevention of degradation processes - erosion, secondary salinization, swamping, drying, flooding, desertification, compaction, contamination with industrial waste and chemicals, conservation of degraded lands; (v) preventing the spread of shrubs. It establishes an efficient land tenure system – motivates activities for land reclamation and infrastructure, improves the mutual disposition of cultivated areas, implements crop rotations, and haying and grazing rotations; implements rational labor organization.
- The parties affected by the Agricultural Land-Use Planning can be natural and legal persons, the State and the Municipalities, as well as the population in the affected territories.
- Agricultural Land-Use Planning is a precondition for preparing data based on the quantity, quality and location of land for the estimation of the taxation, lease payments, and compensation for expropriation land property for the construction of national and regional infrastructure.

The main principles of such Agricultural Land-Use Planning are:

- Strict observance of the land legislation.
- Compliance with the complexity of spatial planning by ensuring proportionality and balance in land use.
- Respect of the interests of participants in the land management process and of the population living in areas affected by the land-use planning.
- Compliance with equal organizational and territorial conditions for all participants.
- Compliance with the prospects and complexity of the territory development.
- Protection of land resources and natural landscapes.
- Provision of compactness, optimum space and access to land tenure.
- Avoidance of fragmentation, dispersion and other inconveniences of land tenure, leading to inability to agricultural land use.
- Publicity and transparency among the population living in the affected territories.
- Provision of land tenure security through protection of its permanent boundary elements

An important aspect of the contemporary Agricultural Land-Use Planning is the role of the State (Moteva, 2016). The new idea is that Agricultural Land-Use Planning in conditions of the market economy is a tool for implementing the state policy on the agricultural land use. To ensure the public benefits, the state takes

control of the land use in the agricultural territories by a set of legal activities. It is responsible for the legal validity of land tenure, for environmental protection, for the efficiency of land use, and for the regulation of the land market and land relations. Further, the government regulation ensures implementation of programmes for land development, support for the depressed regions and balance in the development of all territories.

CONCLUSION

Agricultural Land-Use Planning is essential for ensuring proper territorial conditions for sustainable social and individual development. It enables the development of the democratic idea. Nowadays, it is a part of the agricultural land administration. Market economy poses new challenges to it. The frame of the new conception for Agricultural Land-Use Planning includes agricultural spatial planning for the purpose of rational land use, protection of the natural properties of land, rational use of the agricultural machinery, economic growth of the farms, stabilization of land relationships, and prosperity of the rural areas.

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10.7251/AGRENG1601086N
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AGRICULTURAL PRODUCTION IN THE CONTEXT OF INDUSTRIALIZATION AND FOOD SECURITY IN VIETNAM

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ABSTRACT

Since 1990s the bloom of industrialization and urbanization brings the changes of social and economic issue of Vietnam rural areas. During this process, rural households have reduced agricultural land for cultivating. From the status of food producers now they become food consumers. Through surveying 215 households in Bac Ninh province, the study shows that that industrialization and land conversion process affected household food security in several aspects: the lost of agricultural land and surplus agricultural production decrease; unguaranteed decent work for peasants and high living cost; the decline of living quality and food safety. Food consumption of the family has shifted from self-reliance to the way that more depend on market which increases food expense propotion on household budget. However, spending more on food does not mean satisfied since the suspiciousness of food quality. Household food security becomes more vulnerable, especially for households that have limited access to land and incapability of finding stable jobs. One of the strategies of rural households is diversify their livelihoods, accepted multi-spacial household model. And when income from non-farm jobs could relatively supply enough their need of cash, they would rather consume high quality food than grow and sell high yielding variable. Rural households move back to the local traditional agricultural activities to ensure their own food quality.

Keywords: *industrialization, land conversion, food security, agricultural activities, rural development.*

INTRODUCTION

Since the introduction of Doimoi (The Innovation Reform) in the mid-1980s, Vietnam has experienced the fundamental changes in social-economic development. Vietnam economy has maintained an annual economic growth rate of 6-8 percent per year since the early 1990. In line with the process of economic development, resources have shifted from agriculture to other sectors. Agricultural land has been converted toward more market and industrial orientation to gain faster economic development. According to the recent National Survey on Land, in a decade from 2000 to 2010, the non-agricultural land increased 89000 hectares while the land for rice production decreased more than 34000 hectares annually (Bui Minh, 2012). These modernize policies have clearly influenced on agricultural

production and rural households' food security (FAO, 2009). Household livelihood approach (Bebbington, 1999, Ellis, 2000)) has emphasized the role of land in ensuring the sustainability of the livelihoods of households where food security is an output. Therefore, the article focused on understanding the relationship between industrialization process leading to the deterioration of agricultural land and food security issues in Bac Ninh province, which is located in Red River Delta, about 30km far north from the capital Ha Noi. Having an area of 823 km2 in total and with around 1.038 million populations, it is the smallest province of the Delta. However, the province has been considered as prominent in term of industrial development in Vietnam. It has been ranked fifth amongst provinces that have the highest investment in the whole country. At the time of its formation in 1997, Bacninh was an agricultural province, with only several handicraft villages and no industrial zone or industrial cluster. Since 1998 the provincial government started acquiring agricultural land for industrial purposes, after which the first industrial zone has been built. To date, BacNinh has 15 industrial zones and more than 35 industrial clusters with more than 9400 migration and agriculture ha agricultural land acquired[10]. This context makes Bacninh a suitable place for research agricultural production in the context of industrialization and food security in Vietnam.

MATERIALS AND METHODS

To understand agricultural production adaptation for the industrialization and food security, 215 households in BacNinh were selected within and outside industrialized area, based on the land conversion status.

The surveyed households are classified into 2 groups:

- Group 1: Households in the communes which have not got industrialized zones, including 104 households
- Group 2: Households in the communes which have got the industrialized zones and experienced the land conversion, including 111 households.

Beside household survey, the group discussions and in-depth interviews are carried in selected communities. A combination of qualitative and quantitative methods is used to analyze the data and information about the ways peasants' households secure their food safety under the context of industrialization in Vietnam.

RESULTS AND DISCUSSION

Industrialization and food security

The industrialization process started in BacNinh province since 2001 with the large agricultural land acquisition to build up the industrial parks such as Que Vo and Tien Son. The decline of agricultural land associated with the growing opportunities to find a job outside agriculture lead to the mass labor migration.

[10] The data has been collected at the official website of Bacninh Industrial Zone (http://www.izabacninh.gov.vn/?page=home&portal=kcnbn accessed on 16 of Feb, 2014) and Decision 396/QĐ-UBND, issued on 31, October 2013 on the approval of the cluster planning in Bacninh province to 2020, vision 2030)

Table1 describes the main characteristics of surveyed households in which the changing agriculturallandholdings and demographic features of households are focused. The common trend in group 2 of the declining agricultural landholdings of surveyed households from 1993 to 2014 has a root from large land conversion for industrialization. In the opposite group 1 has increased their agricultural landholdings. Without lower migrating members, this group concentrates on agricultural production; therefore they rent more land of the village or commune since the agricultural land market is not well developed in Vietnam in general and in BacNinh in particular.

Table 1. The socio-economic characteristics of surveyed households

Indicators	**Group 1**	**Group 2**	**Total (N =215)**
Family size (mean, pers.)	5.7	5.1	5.4
Labor size (mean, pers.)	3.8	3.2	3.5
Migration size (mean, pers.)	2.1	2.5	2.3
Agricultural land (1993, m^2)	2745.68	3406.29	3075.99
Agricultural land (2014, m^2)	4548.17	1820.42	3194.29
Land converted for IDZs (m^2)	0	1217.40	1217.40
	104	111	

**Source: Household survey, 2015*

Table 1 shows that in average, the labor size of household is 3.5 labors in which migration labor size is 2.3 labors. The group 2 has lower labor size but it has higher migrant members of this group because the agricultural land reduction. The migration patterns in the research sites are diverse and the circular migration is a prominent feature of households in the research site. The circular migration or daily shift migration in which people are moving repeatedly in a close enough distance to be able to go back and forth in a day is the most favor migration pattern of surveyed households. Usually this form of migration does not consider the distance, only a change in the administrative boundaries as commune, district or province so that migrants can come back home daily.

The results from household surveys and interviews reveal that before industrialization, agricultural production of households in the villages was highly subsistence under the form of household economy. On average, each household had about 3000 m^2 agricultural land. They produced two rice crops per year and one winter crop for soybean, potato, sweet potatoes, corn, and carrot which most are supply for subsistence usage. They applied also new techniques in agricultural production and the rice productivity from 200 – 230kg/sao/crop (from 10 to12

tons/ha/year). Households did also some animal production such as pig, poultry and cattle in their home settlements. The home garden is also an important source to provide vegetable and materials for households. The size of the home gardens range from 100 m^2 to 300 m^2, is relatively small. Still, it provides various daily necessities for the households such as fruit, vegetables, spices, firewood, and even fish and shrimp in home garden pond year-around, making a steady contribution to the household food consumption all around the year and ensures stable life for peasants. The non – farm activities such as running small shops, retailing, artisan and food processing also contributed to the household's income. From the household view, the model of household economy during 1990s had ensured the food security for households and had allowed for some savings of households, especially in some hard – working households. Since 1998, the households had started conversion of their land to industrial enterprises. The companies compensated for households in cash with the amount of money based on the type and location of their land. Households used this money in different ways such as buying home facilities, building houses, saving in banks, finding jobs or investing in their own business. Table 2 shows that that after group 2 who had lost land for industrialization zones have higher dependence on rice market than the group 1. Group 2 has nearly 70 percent do not produce enough food, especially rice to eat. Among that, 45 percent households becomes rice net buyer from food producers. As the price of food increases year by year, the life of farming households who have lost their land become more challenging.

Table 2. Rice buyer and producer in surveyed households

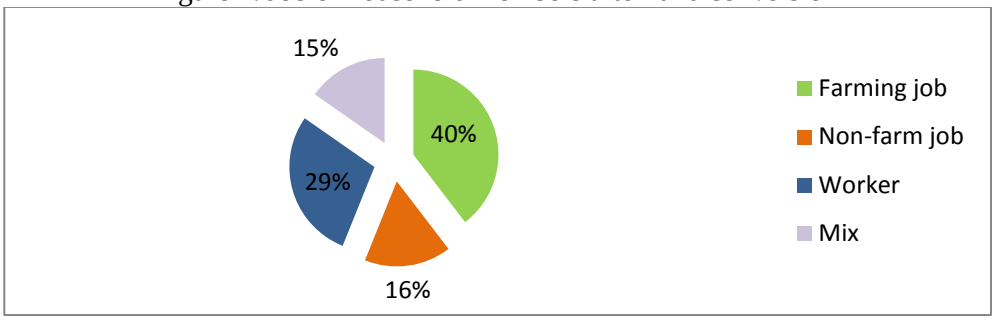
Indicator	**Group 1**		**Group 2**		**Total**	
	HH	**%**	**HH**	**%**	**HH**	**%**
Rice net buyer	14	13.4	51	45.9	65	20.2
Rice partly producer	31	29.8	28	25.2	59	27.4
Rice producer	59	56.7	32	28.8	96	42.3
Total	104		111			

**Source: Household surveys, 2015*

The way food enters the household through the production limited as land holding of household for food has decreased. The other way to have food through exchange depends upon the jobs and income from of household members. However, the industrial companies built on the converted land could not ensure jobs for all landless farmers in BacNinh. Besides, as for the lacking of necessary skills, education level, or over age requirement, many farmers could not find jobs in the enterprises. The results from key informant interviews also show that those farmers who do get jobs cannot adapt to the strictly working regulations of industrial enterprises. Some farmers had to stop working for enterprises because of low salary and long working hours to take other choice such as migrating out or continuing with farming activities. Figure 1 shows that 40% of household members stay with their farming activities and only 29% household members follow the job

in the industrialized zone while others pursuit non-farm job (freelancer) or keep mixed situation. However, given the jobs most farmers involve are informal, and their land was remarkably reduced, the food security is become more vulnerable.

Figure 1. Job of household members after land conversion



**Source: Household survey, 2015*

Table 3 shows that within household budgets, food remains reasonable at 24.1% of expense among group 1 who can mostly supply their own food and nearly double with 37.3% of expense among group 2 who only partly cover their meals. Even though the group 2 households' income is higher than the group 1, the main part of their earnings is used firstly in buying food for their daily consumption. Household members, especially the middle aged and elders, who had experienced food shortages during the wars and the cooperative period, recognized profoundly how food is important in their lives. The way that household had to buy rice and no more rice storage is the unstable life according to the view of many old farmers.

Table 3. Food share in household's expense

Commune	**Food expense (millionVND/HH/year)**	**Food share in HH expense (%)**
Group 1	28.38287037	24.1
Group 2	49.89607843	37.3

**Source: Household survey, 2015*

In all surveyed households, even though rice production remains enough for 42.3% household consumption (table 2), the other foods they produced were no longer enough. Some landless households and non-farm households in group 2 do not practice agricultural activities any more which means they totally depend on unstable market in Vietnam. From their status as owners of the land, farmers have now become wage laborers and from food producers, farmers in the industrial areas have now become net food buyers. They have been losing their self reliance on food and instead now totally depend on the food market. And with the rice prices increased 50-60 per cent (with the price of husked rice increasing a similar amount)

in 2008 (Oxfam and AAV, 2008), the farmers constraint increasing risks. Even in term of net rice producers and sellers**,** in theory, this group should benefits from increased rice prices. However, input prices for fertilizers, insecticide, labour costs and agriculture services were rising faster than prices of agricultural production, the profit of these households also limited.

Everyday practice: food safety and agricultural production

Even though the large-scale commercial agriculture is supported by the Government as the way of boosting food security. However, data shows this research area does not follow the trend of many other Northern villages in Vietnam where number of households increase diversifying their agricultural activities[11] beyond the previously predominant rice production. Rather, the p*easant keeps rice production*[12] *as the fundamental agricultural activities*, combining with some subsistence agricultural activities such as backyard cultivation and poultry rising rather than commercial agricultural production. From peasants' perspective, the reason is *not* because they lack of inputs to invest in other agricultural, but they consider on one hand animal raising or cash-crop is *time and labour consuming* than rice production; on the other hand its profit is lower than migration or other non-farm business. Therefore, by far the best combination strategy of households in BacNinh is practicing rice production while releasing some of their family members for off-village and off-farm business like a household model presented in figure 1.

[11] The popular trend in Vietnamese rural in agricultural diversification is raise large stocks of pigs and/or large flocks of poultry for sale, with intensive use of industrial animal feed

[12]In Vietnam traditionally the same term is used to designate both "Rice" and "Agriculture" LEBAILLY, P. 2015. Transformations récents et persistance de l'importance de l'économie rizicole dans l'économie paysanne: Leçons des expériences menées au Vietnam dans le carde de la coopération unviversitaire. *In:* LEBAILLY PH., PEEMANS J.PH. & VU, D. T. (eds.) *Rural development and small farmers in South East Asia. Lessons of experiences in Vietnam and Cambodia.*: GRAESE: Groupe de Recherches Asie de l'Est et du Sud-Est..

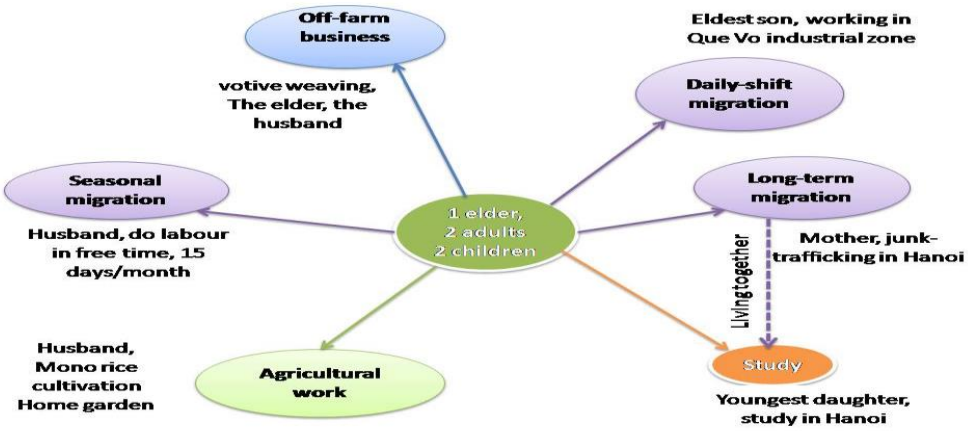


Figure 2. A model of labor division in a typical BacNinh's household

Household membership is usually defined as "under the same roof", however, under the context of industrialization, it is gradually changing this concept into multi-spatial household. The strong commitments and obligations between rural-based and urban-based individuals and units show that this model of households are well-functioned with mutual support is divided across space. For example, remittances from urban could be an important income source for rural family members, who in turn may do agriculture and supply for migrants with high-quality food and other kinds. These linkages are popular and crucial in the livelihood strategies of the rural households, but usually not taken into account of policy making.

Food security in Red River Delta is not only concern with quantity but also with the quality of food.Considering the satisfaction of quality in rural family meals, it is interesting that despite the amount of money spent to buy food have increased remarkably, but it does not come with the satisfaction level of the meal home families. It is explained by uncertain source of food supplied for rural areas. Table 4 shows that group 1 has higher satisfaction on food quality in comparison with the group 1 mainly because they could control their own food source. From peasant's perspective, it is much better if they consume foods that they or his neighbors grow and raise with their own insurance

Table 4. Satisfaction on food quality in surveyed households

	Group 1		**Group 2**	
Indicator	**HH**	**%**	**HH**	**%**
Very satisfied	11	10.6	21	18.9
Satisfied	54	51.9	38	34.2
Unsatisfied	29	27.9	35	31.5
Very unsatisfied	10	9.6	27	24.3

**Source: Household surveys, 2015*

Traditional trend of agriculture presents on the local variables and subsistence usage preference. In term of rice, from peasant's perspective traditional local variables are much more preferred than few high- yielding variety of rice has been grown for few years ago. According to the peasants interviewed, there were traditionally more types of rice, which had low yields, but were much more resistant to pests than the currently predominating varieties. It was reported that the high yielding rice has remarkably changed the quantity of output but at the cost of increases in the inputs such as fertilizers, insecticides andpesticides. Besides, these high yielding rice variables have not given the peasants the chance to sell the rice surplus in the market as before because of its low quality and consumer preferences. It is also noteworthy that unlike before when 100 percent of sampled households were found to sell surplus rice in the market at a mean of around 48 percent of their output, recently households in group 1 rather keeps their rice for their daily consumption up until the next planting season or *selling/sharing it to relationships who cannot cultivation*. These commercial agricultural productions are only used for sale.

CONCLUSION

This paper focused on the industry – agriculture interface in which the impacts of land conversion policies to household food security. Based on sustainable livelihood approach, this research contributes a holistic perspective on analyzing household food security. The important change of household food security caused by industrialization is not only in quantitative aspects but also in qualitative aspects. Further it is also the changes in the socio-economical status of peasant households. Before industrialization, farmer households are net food producers. Since their land was transferred to industrial companies, they have become smallholders or agricultural laborers; this has resulted in them becoming net purchasers of food as they do not own sufficient land to produce enough food for their families. The higher food prices make food expense always one of the main parts in the household budgets. However, spending more on food does not mean satisfied since the suspiciousness of food quality. Besides, not all the landless farmers have chance to find a decent work to cover their living cost. One of the strategies of rural households is diversify their livelihoods, accepted multi-spacial household model. And when income from non-farm jobs could relatively supply enough their need of cash, they would rather consume high quality food than grow and sell high yielding variable. In other words, they would like to sustain the traditional agriculture rather than moving to agro-industrialization. It implied the small holder peasants' role in food safeties. If the peasant can produce good food for them, they can participate in the production of healthy food (with low agrochemical products, which is major, concern of modern consumers) and, doing so, even improve their livelihoods.

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10.7251/AGRENG1601095K
UDC 633.15:551.5(497.5)(497.6)"2013/2015"

WEATHER CONDITIONS IN THE 2013 -2015 GROWING SEASONS FOR MAIZE IN CROATIA AND BOSNIA AND HERZEGOVINA

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ABSTRACT

Maize is the main field crop on the arable lands in Croatia and Bosnia and Herzegovina (B&H). In the 2001-2010 period, maize was grown on 333,736 ha (average yield 6.50 t ha^{-1}) in Croatia and 195,800 ha (4.42 t ha^{-1}) in B&H. Yield variations among years were from 3.86 to 7.98 t ha^{-1} and from 2.74 to 5.13 t ha^{-1}, respectively. Aim of this study was survey of maize yield and weather data (precipitation and mean air temperature) in Croatia and B&H in the 2013, 2014 and 2015 growing seasons. Average yields of maize were 6.5, 8.1 and 6.5 t ha^{-1} (Croatia), 4.0, 5.0 and 4.1 t ha^{-1} (B&H) in 2013, 2014 and 2015, respectively.

The 2014 growing season was very favorable for maize growth. Precipitation and temperature in April-September period were as follows: 520 mm and 18.2°C (Osijek), 910 mm and 17.2°C (Varazdin), 731 mm and 18.5°C (Bijeljina), 1228 mm and 18.0°C (Banja Luka). These precipitation values are higher by 41% (Osijek), 75% (Varazdin and Bijeljina), and 116% (Banja Luka) compared to averages 1961-1990. In extremely unfavorable 2012 (yield 4.34 and 2.74 t ha^{-1}, in Croatia and B&H, respectively), precipitation and temperature at the same period were 293 mm and 20.0°C (Osijek), 461 mm and 18.8°C (Varazdin), 288 mm and 21.0°C (Bijeljina), 488 mm and 20.1°C (Banja Luka). However, in 2013 and 2015, yields, precipitation and temperature regimes in both countries were more close to average values. Considerable variation of precipitation in the short 2012 -2014 period and higher temperatures are in accordance with climate change.

Key words: *maize, yield, Croatia, Bosnia and Herzegovina, precipitation, temperature, climatic change.*

INTRODUCTION

Maize is the main field crop on the arable lands in Croatia and Bosnia and Herzegovina (B&H). In the 2001-2010 period, maize was grown on 333,736 ha (average yield 6.50 t ha^{-1}) in Croatia and 195,800 ha (4.42 t ha^{-1}) in B&H. In general, the harvested areas of maize among years in both countries are mainly stabile, while annual yield variations in mentioned period were considerable and in ranges from 3.86 to 7.98 t ha^{-1} and from 2.74 to 5.13 t ha^{-1}, respectively (SY 2005, 2010; FAO, 2016). Weather conditions, particularly precipitation quantity and temperature regimes, are responsible for considerable variation maize yields in the mentioned period. With that regard, low yields of maize are in close connection with the lower precipitation and the higher air temperature in summer months (Shaw 1988; Kovacevic *et al.*, 2013). Impacts of weather conditions on maize yield in Croatia in 2001-2010 period were elaborated in previous study (Kovacevic *et al.*, 2012). Majdancic *et al.*, (2016) reported survey of maize growing in Federation of B&H with emphasis on Tuzla Canton in 15-year period 2000-2014, while Iljkic *et al.* (2014) collected data of maize growing in Croatia and B&H in 2008-2012 period. Phenomenon considerable variation of maize yield among years is also associated with recent climatic change which has often adverse influences on field crop yields. Annual global temperatures have increased by about 0.4 ^{o}C since 1980 (IPCC, 2001). Lobell and Field (2007) estimated that about 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. Aim of this study was survey of maize yield and weather data (precipitation and mean air temperature) in Croatia and B&H in the 2013, 2014 and 2015 growing seasons.

MATERIAL AND METHODS

FAO database and publications of Croatian Bureau of Statistics were used as sources of arable land, maize harvested areas and yields for the tested period.

Eight meteorological stations (Osijek, Bjelovar, Sisak and Varazdin in Croatia; Bijeljina, Tuzla, Banja Luka and Bihac in B&H: Map 1) were selected for elaboration of weather conditions during maize growing seasons because by they cover majority of growing area of maize in both countries. These towns are situated in northern part of Croatia (Panonian region) and northern Bosnia. Meteorological data were collected by courtesy of State Hydrometerological Service in Zagreb, Federal Hydrometeorological Institute in Sarajevo and Hydrometerological Institute of Republic of Srpska in Banja Luka (permitted access in climatologically lists).

Map 1. Situation of the meteorological stations

Meteorological station	Coordinates and elevation (m) above sea level
Croatia	
Osijek (OS)	45°33′03″ N, 18°41′38″ E; 102 m
Bjelovar (BJ)	45°54′36″ N, 16°50′24″ E; 90 m
Sisak (SI)	45°28′48″ N, 16°21′36″ E; 98 m
Varazdin (VZ)	46°18′15″ N, 16°20′16″ E; 154 m
Bosnia and Herzegovina	
Bijeljina (BJ)	44°45′24″ N, 19°12′57″ E; 91 m
Tuzla (TZ)	44° 32′31″N, 18° 41′06″E; 305 m
Banja Luka (BL)	44°46′32″ N, 17°11′08″ E; 158 m
Bihac (BI)	44° 48′31″N, 15° 51′35″E; 246 m

RESULTS AND DISCUSSION

Average maize harvested area in Croatia in decade 2001-2010 period were 333,736 ha, while in the last three year period 2013-2015 it was 268,300 ha or by 20% lower. Decreasing trend of maize growing area were found also in B&H (195,800 ha and 178,590 ha, respectively) but less strong than in Croatia. Average yields of maize in decade period were 6.24 t ha^{-1} (Croatia) and 4.42 t ha^{-1} (B&H). Maize yield in the 2014 growing season in Croatia was for 30% higher and in B&H by 11% higher compared to the 2001-2010 decade average yields. In the remaining two growing seasons maize yields in Croatia were close to decade average, while in B&H yields were about 10% lower. Degree of arable land utilization is a serious problem of agriculture in both countries because about 40% of arable land is unfarmed (Table 1).Average air temperatures for April-September period in eight selected meteorological stations were 18.2 ^{0}C (2013), 17.7 ^{0}C (2014) and 18.8 ^{0}C (2015) and they are higher in comparison with 1961-1990 average (16-9 ^{0}C). These data are in accordance with climate change toward global warming (Allen et al., 2003; Chi-Chung et al, 2004; FAO, 2007; Jolankai and Birkas, 2013). Precipitation in April-September period of 2013 and 2014 (Table 2) in Bijeljina (373 mm and 731 mm), Tuzla (443 mm and 1021 mm), Banja Luka (370 mm and 1228 mm) and Bihac (479 mm and 1135 mm) are in agreement with this opinion. At the same period, average air temperatures were as follows (^{0}C): 19.1 and 18.5 (Bijeljina), 17.4 and 16.6 (Tuzla), 18.9 and 18.0 (Banja Luka), 17.8 and 17.1 (Bihac), respectively. The higher yields of maize in Croatia and B&H in 2014 and considerable lower yields in 2013 and 2015 (Table 1) could be explained by general opinions regarding impact of weather conditions on maize growth and productivity in Corn Belt of USA (Shaw, 1988) and experiences from Croatia and neighboring countries (Kovacevic *et al.*, 2012, 2013; Iljkic *et al.*, 2014; Majdancic *et al.*, 2016).

Table 1. The harvested area and yields of maize in Croatia and B&H (FAO, 2016; SY, 2005, 2010, 2013, CBS 2016)

Harvested area and yields of maize (maize for grain) in Croatia and B&H							
Croatia				Bosnia and Herzegovina			
2001-2010	2013	2014	2015	2001-2010	2013	2014	2015
Harvested area of maize (ha)				Harvested area of maize (ha)			
333 736	**288 365**	**252 567**	**263 970**	**195 800**	**190 000**	**170 000**	**175 770**
Yield of maize (t ha^{-1})				Yield of maize (t ha^{-1})			
6.24	**6.5**	**8.1**	**6.5**	**4.42**	**4,0**	**5.0**	**4.1**
Annual yield variation in 2001-2010 period: **from 3.86 to 7.98 t ha^{-1}**				Annual yield variation in 2001-2010 period: **from 2.79 to 5.13 t ha^{-1}**			
Index of yield (mean 2001-2010 = 100)				Index of yield (mean 2001-2010 = 100)			
100	**104**	**130**	**104**	**100**	**89**	**111**	**91**
Utilized arable land (ha)				Utilized arable land (ha)			
859 839	**874 863**	**811 067**	**841 939**	**1 013 500**	**1 010 000**	**1 011 000**	**1 029 000**
Total arable land (ha)				Total arable land (ha)			
1 460 000 (SLJ, 2005)				**1 589 000** (FAO, 2009)			
Territory: 56 542 km^2				Territory: 51 197 km^2			

Drought and the higher temperatures are responsible for lower yields of maize in 2013 and 2014. With that regard, the eastern parts of both countries were more affected by weather stress conditions (Tables 2 and 3). For example, precipitation in April-September period of 2015 in Bijeljina was only 302 mm (Bijeljina) and 316 mm (Osijek), while in west situated Varazdin and Bihac precipitation was 555 mm and 634 mm, respectively. At the same period, temperatures were 20.2 ^{0}C (Bijeljina), 19.5 ^{0}C (Osijek), 18.2 ^{0}C (Varazdin) and 18.6 ^{0}C (Bihac). Maize crops were affected by drought and high temperature mainly in August.

Absolute maximal temperatures were recorded at the end of July / beginning of August 2013 (Bihac 42.0 ^{o}C, Varazdin 39.4 ^{o}C, Bijeljina 39.2 ^{o}C and Osijek 38.4 ^{o}C) and in July / August 2015 (Bihac 37.9 ^{o}C, Bijeljina 37.8 ^{o}C, Osijek 37.2 ^{o}C and Varazdin 35.6 ^{o}C). However, in favorable 2014 growing season for maize, absolute maximal temperatures were in range from 31.6 ^{o}C in Varazdin to 34.4 ^{o}C in Osijek and Bijeljina (Table 3).

Table 2. Monthly values of precipitation and average air-temperatures

Precipitation and average air-temperatures in 2013-2015 and average 1961-1990 (*61-90*)														
Year	Monthly precipitation (mm)							Monthly average air-temperatures (°C)						
	Apr.	May	June	July	Aug	Sept	Σ	Apr.	May	June	July	Aug	Sept	X
	Bijeljina													
2013	28	182	57	37	18	51	***373***	13.2	17.1	20.7	23.4	24.0	16.4	***19.1***
2014	83	252	67	73	147	109	***731***	13.1	16.1	20.8	22.6	21.4	17.0	***18.5***
2015	57	100	22	11	39	73	***302***	12.5	18.5	21.2	25.7	24.5	18.7	***20.2***
61-90	***68***	***81***	***86***	***68***	***61***	***53***	*417*	***11.0***	***16.3***	***19.8***	***21.7***	***21.1***	***16.8***	*17.8*
	Osijek													
2013	45	119	63	37	33	129	**426**	13.1	16.7	20.2	22.9	22.9	15.9	**18.6**
2014	81	159	91	66	54	69	**520**	13.2	16.1	20.4	21.8	20.8	17.0	**18.2**
2015	13	113	17	26	106	41	**316**	12.1	17.8	20.8	24.6	23.7	17.9	**19.5**
61-90	***54***	***59***	***88***	***65***	***58***	***45***	*368*	***11.3***	***16.5***	***19.5***	***21.1***	***20.3***	***16.6***	*17.6*
	Tuzla													
2013	31	168	74	55	36	79	***443***	12.8	15.7	18.6	20.9	21.6	15.0	***17.4***
2014	187	339	64	112	184	135	***1021***	11.5	14.5	18.5	20.3	19.6	15.6	***16.7***
2015	58	122	93	11	55	81	***420***	10.7	16.6	19.0	23.3	22.9	17.3	***18.3***
61-90	***76***	***92***	***111***	***94***	***84***	***64***	*521*	***10.4***	***14.8***	***17.7***	***19.3***	***18.9***	***15.5***	*16.1*
	Banja Luka													
2013	63	120	54	27	36	70	***370***	13.4	16.6	20.4	23.0	23.5	16.7	***18.9***
2014	214	218	97	139	276	284	***1228***	13.1	15.8	20.3	21.7	20.6	16.4	***18.0***
2015	54	118	61	21	23	75	***352***	11.8	17.4	20.9	25.2	24.0	18.3	***19.6***
61-90	***87***	***98***	***111***	***95***	***93***	***82***	*566*	***10.9***	***15.6***	***18.9***	***20.6***	***19.7***	***15.9***	*16.9*
	Bjelovar													
2013	56	94	53	49	71	103	**426**	13.1	16.5	20.0	23.2	22.4	15.4	**18.4**
2014	*106*	*168*	*80*	*144*	*126*	*204*	***828***	13.0	15.4	20.1	21.6	20.2	16.0	**17.7**
2015	*21*	*145*	*39*	*40*	*51*	*99*	***395***	12.1	17.2	20.8	24.2	23.4	17.3	**19.2**
61-90	***63***	***79***	***96***	***78***	***82***	***65***	*461*	***10.8***	***15.6***	***18.7***	***20.4***	***19.5***	***15.8***	*16.8*
	Sisak													
2013	76	58	35	97	49	149	**464**	13.4	16.5	20.2	23.0	22.3	15.7	**18.5**
2014	124	193	74	153	169	214	**927**	13.1	15.8	20.3	21.7	20.2	16.2	**17.9**
2015	50	171	62	26	117	112	**538**	12.2	17.4	20.8	24.4	23.0	17.0	**19.1**
61-90	***73***	***82***	***91***	***77***	***85***	***76***	*484*	***11.1***	***15.8***	***19.1***	***20.8***	***19.8***	***16.0***	*17.1*
	Varazdin													
2013	62	96	60	34	103	139	***494***	12.2	15.7	19.4	22.4	21.1	15.1	**17.7**
2014	105	109	118	134	153	291	***910***	12.7	15.0	19.3	21.1	19.2	15.8	**17.2**
2015	21	165	79	98	90	102	***555***	11.4	16.4	19.8	23.0	21.9	16.4	**18.2**
61-90	***70***	***84***	***98***	***92***	***98***	***81***	*524*	***10.3***	***15.1***	***18.3***	***19.8***	***18.9***	***15.4***	*16.3*
	Bihac													
2013	88	98	73	36	85	99	***479***	12.5	15.4	19.3	22.0	21.7	15.7	***17.8***
2014	187	199	87	228	105	329	***1135***	12.3	14.9	19.5	20.5	19.8	15.5	***17.1***
2015	91	172	80	44	97	150	***634***	11.6	17.3	20.0	23.8	22.1	17.0	***18.6***
61-90	***115***	***116***	***109***	***107***	***109***	***108***	*664*	***10.7***	***15.1***	***18.9***	***20.0***	***19.2***	***15.9***	*16.6*

Iljkic *et al.*, (2014) reported 5-year data (2008-2012) regarding impact of weather conditions on maize yield in Croatia and B&H. In both countries the lowest maize yields were realized in 2012 (4.30 and 2.90 t/ha in Croatia and B&H, respectively) and they were lower for 48% (Croatia) and 40% (B&H) than in 2008. Precipitation

and mean air temperature in July + August 2012 were as follows: 52 mm and 24.5 ^{o}C (Osijek), 8 mm and 23.5 ^{o}C (Tuzla).

Majdancic *et al.*, (2016) performed 15-year data of maize harvested area and yield in Federation B&H (FB&H) with emphasis on Tuzla Canton. In the 15-year period 2000-2014 maize for grain was grown in FB&H on the area of average 48,208 ha and average grain yield was 3.99 t ha^{-1} with considerable variation among years from 2.18 to 4.92 t ha^{-1}. In three "the poor" years (2000, 2003 and 2012) yield was less than 3.0 t ha^{-1} (average 2.66 t ha^{-1}), while in three "the good" years (2006, 2008 and 2009) it was above 4.5 t ha^{-1} (average 4.74 t ha^{-1}). Precipitation quantity in the April -September period of "the poor" years in Tuzla was 320 mm (3-year average) or 39% of the long-term mean (LTM) 1961-1990, while in "the good" years it was 492 mm. Mean air temperature at the same period of the favorable years was 17.5 ^{o}C or for 1.0 ^{o}C lower than in the unfavorable years.

Table 3. Mean maximal and absolute maximal air temperatures in July and August

Month	Average maximal (AverageM) and absolute maximal (AbsoluteM) air temperature in the 10-days intervals (a = 1- 10; b = 11 – 20; c = 21 – 30/31)											
	Eastern part of the region						Western part of the region					
	AverageM (^{o}C)			AbsoluteM (^{o}C)			AverageM (^{o}C)			AbsoluteM (^{o}C)		
	a	b	c	a	b	c	a	b	c	a	b	c
	The 2013 growing season											
	Osijek						Varazdin					
July	28.9	28.2	32.2	30.5	30.9	38.4	27.9	27.2	32.0	29.4	30.3	37.6
Aug.	34.5	30.2	25.4	38.2	34.3	28.5	33.8	28.0	23.3	39.4	32.6	26.6
	Bijeljina						Bihac					
July	28.9	28.5	32.4	30.2	32.0	39.2	27.4	27.6	33.0	30.6	31.0	39.3
Aug.	35.4	31.0	26.9	39.1	35.8	31.2	35.9	29.3	24.9	42.0	34.2	28.4
	The 2014 growing season											
	Osijek						Varazdin					
July	27.9	28.0	28.0	32.1	31.5	31.7	25.7	28.0	26.2	31.6	31.1	28.9
Aug.	28.0	27.7	24.7	30.2	34.4	28.0	27.6	25.0	23.0	31.1	29.9	25.5
	Bijeljina						Bihac					
July	29.4	28.3	28.8	33.4	32.7	33.0	27.1	26.9	25.4	32.8	33.1	28.6
Aug.	28.3	28.9	26.1	31.4	34.4	29.6	27.4	27.3	24.0	32.5	33.2	27.1
	The 2015 growing season											
	Osijek						Varazdin					
July	31.4	32.2	30.0	37.2	36.4	36.5	29.9	31.0	27.0	34.6	35.6	35.1
Aug.	32.4	31.0	28.7	34.9	36.8	35.2	30.9	28.7	27.2	33.3	35.5	32.5
	Bijeljina						Bihac					
July	32.1	33.5	32.2	37.8	37.6	37.6	31.9	34.3	29.5	37.3	37.9	37.2
Aug.	33.9	32.9	29.1	36.7	37.8	36.3	31.8	28.5	27.7	35.0	35.6	35.0

Alleviation of unfavorable effects of "poor" years for maize yields is possible by irrigation and by adequate soil management practice, as ploughing and addition of majority NPK fertilizers in autumn instead in spring, weed control, growing more drought tolerant hybrids etc. (Kovacevic and Rastija, 2014).

Bancy (2000) reported that in order to counter the adverse effects of climate change in maize production, it might be necessary to use early maturing cultivars and practice early planting. However, under eastern and middle European conditions, appearance of late frost could be limiting factor for wide application of this practice. By late spring frost in night 26th April 2016 (minimal air-temperatures from -2 ^{0}C to -6.0 ^{0}C in northern Croatia) considerably damaged vineyard and orchards and too early sowing of spring crops (CAAS, 2016). For this reason, our recommendation is that majority sowing area of maize could be practiced in the second half of April because early sowing, for example two or three weeks earlier, is accompanied with potential damage caused by late frost. However, combination absence of frost and the earlier sowing is mainly very favorable for maize growth.

CONCLUSION

Weather conditions are considerable factor of maize yield in Croatia and B&H. Lower precipitation and higher temperatures are mainly in connection with lower yields. Alleviation of unfavorable effect of drought for maize yields is possible by irrigation and by correspondingly soil management, for example fertilization, weed control, earlier sowing etc.

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10.7251/AGRENG1601103M
UDC 641

TOWARDS SUSTAINABLE FOOD SYSTEMS: A HOLISTIC, INTERDISCIPLINARY AND SYSTEMIC APPROACH

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ABSTRACT

One of the biggest challenges facing humanity is achieving sustainable food security in the face of population growth, resource scarcity, ecosystem degradation and climate change. Transitioning towards sustainable food systems (SFS) is a must for achieving sustainable development. This review paper highlights the need to adopt a holistic, multidimensional, interdisciplinary and systemic approach for better understanding food systems, which is a prerequisite for fostering transition towards sustainability. A better understanding of food systems means comprehending issues at play from 'farm to fork' *i.e.* production (crop, animal, seafood), processing, trade and distribution, and consumption. For gaining a full awareness also cross-cutting issues such as gender, innovation and technology should be considered. Such a deep knowledge and consequent corrective actions are crucial to address the multiple challenges and dysfunctions of the current global food system such as food insecurity, obesity, food waste, climate change, biodiversity loss, land degradation, water depletion, deforestation, market concentration and food heritage erosion. It is fundamental to foster transition towards sustainable and resilient food systems to achieve sustainable food and nutrition security for present and future generations. All dimensions (environment, economy, society and culture, nutrition and health) of food sustainability should be tackled while considering policy and governance. Different food consumption and production models can help speeding up journey towards sustainability. These include, *inter alia*, organic agriculture and different alternative food systems allowing to link consumption and production such as urban agriculture, community-supported agriculture and short food chains. While the challenge is titanic, there is a menu of options that can be jointly used to foster shift towards SFS such as sustainable and eco-functional intensification, sustainable diets, food loss and waste reduction. Nevertheless, a holistic and systemic approach is necessary to develop a systems thinking for generating interdisciplinary knowledge needed to support transition towards sustainable food systems.

Keywords: *food systems, sustainability, systemic approach, multidimensionality, systems thinking.*

INTRODUCTION

The world faces the challenge to achieve sustainable food security in the face of human population growth, resource scarcity, ecosystem degradation, and climate change (*e.g.* Mathijs, 2012; Gladek et al., 2016). Over recent years, and particularly since the global food price spikes of 2007-2008 (IFPRI, 2008), the scientific and policy communities have trained their attention on multiple problems within global food systems (*e.g.* Ericksen, 2008; FAO, 2009a; Lang, 2009; IAASTD, 2009; Foresight, 2011; FAO, 2012; WWW-UK, 2013; Searchinger et al., 2013; Garnett, 2013; IPES-Food, 2015; Gladek et al., 2016).

The current global food system lies at the center of a nexus of global environmental, economic and social problems, stretching from poverty to climate change and environmental degradation (Gladek et al., 2016). Global food system is having a big impact on the natural environment and resources. Therefore, alternative pathways are needed to provide for the needs of our growing population without compromising human or ecological health (UNEP, 2016). Although sufficient food can be produced, even for a much larger population, structural changes are needed to convert current systems and consumption patterns (Gladek et al., 2016; UNEP, 2016). In fact, about a third of food produced is currently wasted along the food chain (Gustavsson et al., 2011) while a larger percentage of the population is overweight than undernourished (FAO et al., 2015) and land resources are increasingly allocated towards non-food uses (cf. biofuels) (FAO, 2009b). In order to achieve global food security goals, sustainability must be the benchmark of a food systems reform including environmental, nutritional, social, cultural and economic dimensions (IPES-Food, 2015). Nothing less is required than a redesign of the whole global food system to bring sustainability to the fore (Foresight, 2011).

Nevertheless, despite the mobilization of the political and scientific communities around various food systems issues, the task remains incomplete. The challenge, therefore, is to produce a joined-up picture of food systems and their related issues through an integrated approach based on the nexus of different disciplines, sciences, policies, practices and governance tools, trying to understand how they shape global food systems and their ongoing transformations. The present review paper highlights the need to adopt an interdisciplinary, holistic and systemic approach to generate the new types of knowledge and science that can support the transition towards sustainable food systems.

EVOLUTION OF THE GLOBAL FOOD SYSTEM: GENERAL TRENDS AND PERSPECTIVES

A food system is defined as the sum of all the diverse elements and activities which, together, lead to the production and consumption of food, and their interrelations. In July 2014 the High Level Panel of Experts on Food Security and Nutrition (HLPE) provided the following definition for a food system: "*A food system gathers all the elements (environment, people, inputs, processes, infrastructures, institutions, etc.) and activities that relate to the production, processing, distribution, preparation and consumption of food and the outputs of*

these activities, including socio-economic and environmental outcomes". Food system interfaces further with a wide range of other systems (energy, transport, etc.), and faces various constraints. Food system is a "descriptive" concept and does not preclude that a food system will necessarily perform well or generate appropriate food security outcomes, as well as a range of other socio-economic and environmental outcomes (HLPE, 2014). The concept of food systems, or of food and nutrition systems (Sobal et al., 1998), has given way to numerous definitions and conceptualizations. There have also been various attempts to create typologies of food systems. Many of them are constructed on a historical perspective (Malassis, 1996); others refer to the relationships between production and consumption or to distinction between producers and consumers (Esnouf et al., 2013). To a certain extent, most of food systems are interconnected and their sum constitutes "a global food system".

As known, food demand is responding to the growing population size. Global food and agricultural production have increased significantly since the end of WWII. Global yields have steadily increased since the 1950s. There is more food produced today per person than ever recorded. In fact, more than enough food is currently produced for the global population, yet modern agro-food systems failed to resolve the problem of food insecurity (Gladek et al., 2016). While the world currently produces enough food for its citizens, about 795 million people are undernourished (FAO et al., 2015).

Major shifts in dietary patterns are occurring, including a move from basic staples to more diversified diets. Drivers include urbanization, increasing incomes, market liberalization and trade policies (Kearney, 2010; WWW-UK, 2013). These shifts in dietary patterns have considerable health but also environmental consequences (WWW-UK, 2013). Demand for livestock products has increased in the last 50 years and looks set to continue to grow, again with the majority of this increase envisaged to come from developing countries (FAO, 2009c). Over the last four decades fish consumption has been rising in line with the general trends of increased world food consumption (WWW-UK, 2013).

Furthermore, for the last decades food has been cheaper in real terms, and more readily available, than probably at any time in history, which partly explains why food policy has received less prominence in national and international decision-making than in earlier times. Yet, it cannot be said to have a functioning global food system when people today still do not have access to adequate and sufficient food or are over-fed (Godfray et al., 2010).

The global food system is experiencing a significant confluence of pressures. Global population size is increasing from nearly seven billion today to eight billion by 2030, and probably to over nine billion by 2050; competition for land, water and energy is intensifying, while the negative effects of climate change is becoming increasingly evident (Foresight, 2011; Capone *et al*., 2014). These pressures or drivers of change (global population increases, changes in the size and nature of per capita demand, climate change, future governance of the food system, competition for key resources, changes in values and ethical stances of consumers) would present substantial challenges to food security (Foresight, 2011). Delivering

global food security in the face of climate change is one of the greatest challenges facing the shaping of a climate-smart global food system, and increasingly public policy must seek to deliver on a number of different but aligned objectives with less resources (World Bank, 2015).

FOOD SYSTEMS: CROSS-CUTTING ISSUES AND MULTIPLE CHALLENGES

Agriculture (including crop production, animal production, forestry and fishery) is essential for the production of food but it can have a big impact on the natural environment with the potential to damage biodiversity, water quality and soils and to exacerbate climate change. Therefore, it is crucial to balance competing demands and to minimize the food system footprint. In the 21st century, agriculture faces multiple challenges: it has to produce more food to feed a growing population with a smaller rural labor force, more feedstocks for a potentially huge bioenergy market, contribute to overall development in the many agriculture-dependent developing countries, adopt more efficient and sustainable production methods and adapt to climate change (FAO, 2009). Moreover, unsustainable food consumption patterns are putting increasing stress on ecosystems. Food consumption and production patterns are among the most important drivers of environmental pressures (*e.g.* biodiversity loss, land degradation, declining soil fertility, unsustainable water use). There are trade-offs between agricultural output and ecosystem services; increasing yield often comes with an environmental consequence. There are also trade-offs between different ecosystem services (WWW-UK, 2013).

From persistent undernutrition to burgeoning obesity rates, from land evictions to agriculture's soaring environmental footprint, from dwindling fish stocks to mounting food waste, there has rarely been so much attention on the problems within food systems (IPES-Food, 2015). A better understanding of the functioning and governance of food systems is crucial to address the multiple nutritional, environmental, economic and social challenges and dysfunctions of the current global food system including food insecurity, obesity and overweight, micronutrient deficiencies, food loss and waste, climate change, biodiversity loss, land degradation and erosion, water resources scarcity, deforestation, phosphate depletion, market concentration and food heritage and culture erosion. According to Godfray *et al.* (2010), current food and farming systems have succeeded in supplying large volumes of foods to global markets, but are generating numerous negative outcomes: degradation of land, water and ecosystems; high GHG emissions; biodiversity losses; persistent hunger and micro-nutrient deficiencies alongside the rapid rise of obesity and diet-related diseases; and livelihood stresses for farmers around the world.

Food systems are directly dependent on and at the same time have big impact on the natural environment. The global food system is the largest contributor to both environmental and humanitarian impacts. Global food system is the largest user of water and land resources as well as the largest contributor to greenhouse gas emissions (GHE), biodiversity depletion and deforestation thus making it the

primary single contributor to the transgression of many planetary boundaries (Gladek et al., 2016). It is estimated that food system emissions, from production to consumption, contribute 19-29% of global GHE (Vermeulen et al., 2012). However, the agri-food sector is also the world's largest economic sector and is therefore deeply entwined with poverty (Gladek et al., 2016).

To achieve the international targets set by the United Nations Secretary-General Zero Hunger Challenge and Sustainable Development Goals, we must re-think the way in which food system activities are structured and carried out. Ensuring access to nutritious food for all is at the core of this change and this will often depend on the way markets function at the local, national, regional and global levels, on the social safety nets created for vulnerable groups of the population (e.g. the urban poor and smallholder farmers), and on their access to infrastructure, finance, knowledge and technology. In this context, food system governance plays a fundamental role. According to Hopkins et al. (1982), the food arena is characterised by the presence of numerous actors with often different and even competing and contradictory agendas (Hopkins et al., 1982). The governance of global food system is seen to be challenged. Concerns have been raised regarding the exclusion of smallholders and poor countries from market opportunities derived from globalization. However, research has shown that the governance mechanisms are mutually entrenched as a response to policy, social and economic dynamics (Guldbrandsen, 2012; Bernstein and Cashore, 2007). Anyway, globalization will continue exposing the food system to novel economic and political pressures (Foresight, 2011) with implications also in terms of its governance. For that, Foresight (2011) report stresses the importance of crafting food system governance to maximize the benefits of globalization and to ensure that they are distributed fairly

MULTIDIMENSIONALITY OF SUSTAINABLE FOOD SYSTEMS

A transition to sustainability is necessary for a new management of food systems. Since food systems develop within a limited and sometimes shrinking resource base, they need to make use of natural resources in ways that are environmentally, economically, socially and culturally sustainable to conserve the global ecosystem. Growth of food systems must be inclusive, must target objectives beyond production (including efficiencies along the food chains) and must promote sustainable practices and diets (HLPE, 2014).

Food is variably affected by a whole range of factors including food availability, food accessibility and food choice, which in turn may be influenced by geography, demography, disposable income, urbanization, trade liberalization, globalization, religion, culture, transnational food corporations, food industry, and consumer attitude and behavior (Capone *et al.*, 2014).

FAO (2012) pointed out that ending hunger requires that food consumption and production systems achieve more with less resources which encompasses fostering sustainable intensification of food production, encouraging sustainable food consumption and reducing food loss and waste. In order to understand which is the impact of the different factors on the food system, the *Guidelines on Sustainability*

Assessment of Food and Agriculture (SAFA) Systems, elaborated by FAO, provide an international reference for sustainable management, monitoring and reporting in food and agriculture at all levels of the supply chain. SAFA defines what sustainable food and agriculture systems are, including environmental integrity, economic resilience, social well-being and good governance (FAO, 2014).

According to the HLPE (2014) "*A sustainable food system (SFS) is a food system that delivers food security and nutrition for all in such a way that the economic, social and environmental bases to generate food security and nutrition for future generations are not compromised*". The unsustainability of food systems is the main reason for the existence of food insecurity and malnutrition; if food systems do not perform adequately in their environmental, economic and social dimensions, food security and nutrition are threatened.

The definition demonstrates the importance of seeking sustainability in three dimensions —environmental, economic and social — at every stage of a food system, from agricultural production, processing, and retailing, to consumption. A food system's sustainability is also influenced by culture factors interacting with the other three mentioned dimensions; culture should be added as other dimension of sustainability to be adequately explored (FAO, 2009).

It is thus important that policy measures to achieve sustainability in food systems adopt a multidimensional, gender-sensitive and integrated approach in all the stages including transport, storage, processing, wholesale and retail, consumption and food waste management. Also important is to ensure a fair, equitable and inclusive market mechanism at the national, regional and international levels for economic viability of rural livelihoods in general and small-scale farmers in particular (UN, 2016).

The emphasis at an overarching level is therefore to assist in creating the policy-enabling conditions for sustainable food systems approaches to develop. It is important to promote multi-stakeholder dialogue for coordinated action at national level that considers interactions and outcomes across the food system. Political incentives must be shifted in order for these alternatives to emerge.

TOWARDS SUSTAINABLE FOOD SYSTEMS: NEW APPROACHES AND PARADIGMS NEEDED

Creating the enabling conditions for the shift to more sustainable food systems will require systems based approaches that can consider the range and complexity of interactions prevalent in the production, distribution and consumption of food. These links between food production, distribution, consumption, and nutritional health and the underlying social-economic, cultural and institutional elements, ultimately affect the quantity, quality and affordability of food, as well as health and wellbeing. Fostering transition towards SFS implies also gaining a better understanding about multifaceted and complex relations between food systems, diets, and food and nutrition security (Capone et al., 2016). The good news is that agriculture, food security, nutrition and sustainability are increasingly discussed in the same context (Lang, 2009).

Food is strongly linked to health and sustainable development. However, food consumption patterns, which are important drivers for agricultural and food systems, are often neglected in the research and policy areas of food security. Technical fixes alone will not solve the food security challenge and adapting to future demands and stresses requires an integrated food system approach, not just a focus on agricultural practices improvement (Capone et al., 2014). Foresight (2011) stressed the critical importance of interconnected policy-making; not only policy in all areas of the food system should consider the implications for volatility, sustainability, climate change and hunger but also policy in other sectors (cf. energy, water supply, land use, the sea, ecosystem services, biodiversity) outside the food system also needs to be developed in much closer conjunction and coordination with that for food.

Sustainable food systems embrace the interconnectedness of all the food-related activities and the environment within which these activities occur (production, distribution and consumption of food) operating at local, regional, national, and global levels. There is no one model of a sustainable food system, but a set of principles that constitute sustainability. Therefore, approaches to allowing this shift should evolve from the particular contextual conditions of the food system under consideration (UN, 2016). However, there has been a tendency among scientists and policymakers to address the problems related to food systems as individual pieces of the puzzle, and to overlook their interrelations. To address food and nutrition challenges, food systems have to be considered in their entirety, acknowledging the interdependency of consumption and production (IPES-Food, 2015). According to Foresight (2011), substantial changes will be required throughout the different elements of the food system and beyond if food security is to be provided for a predicted nine billion people.

The need for a systems-based approach towards research dealing with food systems has been emphasized in several reports by different bodies (e.g. the third and fourth EU Standing Committee on Agricultural Research - SCAR, Expo 2015 EU Scientific Committee). Meeting the challenges facing the agricultural and food and non-food systems means dealing with complexity and working in an integrated manner (EC, 2016). The system-based and holistic approach implies to go beyond the research undertaken at the level of the components of the system to better understand the interactions between those components. Therefore it is necessary to take due account of the different disciplines and science (IPES-Food, 2015). This implies also the development of knowledge and methods enabling integrated assessments of system performance across, space, time and the full range of dimensions (economic, environmental, social and cultural).

In this context, sustainable diets concept has started to be explored to recommend diets healthier for the environment as well as for consumers. With the food globalization process and the increased industrialization of agricultural systems, the sustainable diets' concept was affirmed in the international debate on sustainable development (FAO & Bioversity International, 2012; Capone *et al*., 2014).

A systems and integrated approach has been applied to organic agriculture where standards regulate production, processing and labelling and market access is

subject to scrutiny (Azadi, 2011) or to the urban food supply chains which include horticulture, livestock, fisheries, forestry, and fodder and milk production increasingly spreading to towns and cities (e.g. UNEP, 2016a). In particular, urban food system is less visible than such other systems, but, despite its low visibility, it nonetheless contributes significantly to community health and welfare (Pothukuchim and Kaufman, 1999).

CONCLUSION

The 2030 Agenda for Sustainable Development clearly shows that transition towards environmentally, socially and economically sustainable food systems is a must for achieving sustainable development. It is of paramount importance to foster transition towards sustainable and resilient food systems that achieve sustainable food and nutrition security for present and future generations. While the challenge is and will remain titanic, there is a menu of options that can be jointly used to foster transition towards SFS such as sustainable and eco-functional intensification (cf. improving productivity sustainably), sustainable diets, food loss and waste reduction, and innovative governance and trade arrangements that improve access to sufficient, nutritious and safe food for all.

A transition is needed towards SFS based on fairness, transparency, integrity and trust. Food production and food processing technology should meet the highest environmental, quality and safety standards and only minimally alter the intrinsic qualities of food. Food loss and waste should be reduced to a minimum and consumers should be better informed about the production processes and their environmental and societal impacts, so that they can make informed choices. The key of this necessary transition is a sustainable systems-based approach to the global food system governance.

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10.7251/AGRENG1601113S
UDC 551.311.21(55)

SOIL LOSS ESTIMATION OF S7-2 CATCHMENT OF THE SHIRINDAREH WATERSHED, IRAN USING THE RIVER BASIN MODEL

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ABSTRACT

This study aims to estimate the soil loss of S7-2 Watershed of Shirindareh River Basin in Iran, using a simple but comprehensive "River Basin" model for erosion classification and prediction of erosion potential. Peak discharge from the S7-2 Watershed was calculated on 65 m^3s^{-1} for the incidence of 100 years; the net soil loss on 4397 m^3km^{-2}, specific 178 m^3 km^{-2} per year. The results of the research and earlier application of the "River Basin" model in the studied area of the Shirindareh River Basin in Iran shown that this approach is a good tool for rapid assessment of erosion risk to support decision-making and policy development.

Keywords: *soil erosion, river basin model, sediment yield, Shirindareh watershed.*

INTRODUCTION

Soil loss is a serious ecological concern (Gholami *et al*., 2016) in various environments worldwide (Kisic *et al*., 2016; Ballesteros-Cánovas *et al*., 2015; Stoffel and Huggel, 2012; Ristic *et al*., 2001). Study of soil erosion and sediment yield in the watershed is one of the basic necessities to achieve integrated land management and soil and water conservation (Khaledi Darvishan *et al*., 2014). Direct measurements of erosion in a watershed are possible with multi-years measurement of solid transport in the closing-section (Behzadfar *et al*., 2014a and Behzadfar *et al*., 2014b). The water and sediment sampling in given intervals need a lot of time and is costly (Khaledi Darvishan *et al*., 2010), assessment of sediment yield using soil erosion models have been used more and more (Spalevic *et al*., 2013a, 2013b, 2013c, 2013d). The modelling of the erosion process has progressed rapidly, and a variety of models have been developed to predict both runoff and soil loss.

We used the computer-graphic "River Basin" model of Spalevic (Spalevic, 2011; Spalevic et al., 2000; Spalevic, 1999) for prediction of soil erosion intensity from the watershed area.

MATERIAL AND METHODS

The study was conducted in the area of the S7-2 Watershed (F = 25 km^2) of the Mountainous area of the Shirindareh River Basin, located in north eastern parts of Iran (Figure 1). The shortest distance between the fountainhead and the mouth, lv, is 10 km; and the total length of the main watercourse with tributaries is 54 km. The average slope gradient in the river basin, Isr, is calculated on 33% what indicates that in the river basin prevailing very steep slopes. The average river basin altitude Hsr, is calculated on 1480 m; the average elevation difference D, on 279 m. Basic climatological data: The volume of the torrent rain; Average annual air temperature; Average annual precipitation; needed for calculation of the soil erosion intensity and runoff from the River Basin were received from the meteorological stations located in North Khorasan province of Iran.

The geological analyses (geological formations of North Khorasan province, including those in the study area of the S7-2 watershed) were based on the research of the National Geological Survey Organization (NGS) of Bolourchi (1987).

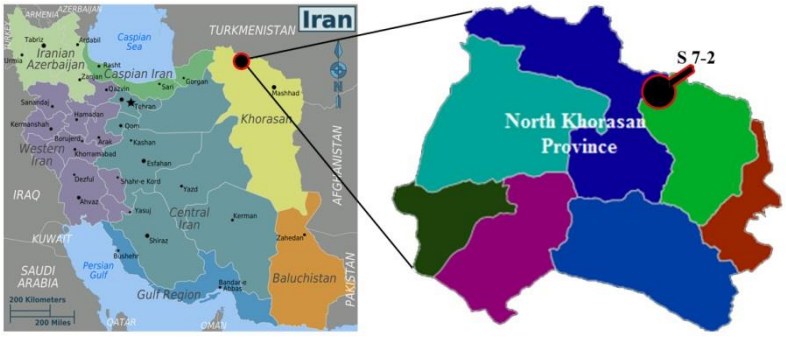

Figure 1. Study area of the S7-2 watershed, the Shirindareh River Basin, Iran

The "River Basin" model (Spalevic et al., 2000; *link to the "River Basin" exe file available on: www.agricultforest.ac.me/Spalevic/River*) as a computer-graphic method, with the Erosion Potential Method – EPM (Gavrilovic, 1972) rooted in the procedure of this model, was used for soil loss estimation from the studied watershed. It gives a quantitative estimation of erosion intensity as well as the estimation of sediment production and transportation. According to the method sediment yield is calculated using the following calculation:

$$G_{yr \times sp^{/1}} = T \times H_{yr} \times \pi \sqrt{Z^3} \times R_u$$

where: $G_{yr\ sp}^{-1}$ – specific annual total erosion-induced sediment yield reaching the confluence, m^3 yr^{-1} km^{-2}; T – temperature coefficient of the watershed; H_{yr} – amount of rainfall, mm; π – 3.14; Z – coefficient of erosion; R_u – coefficient of retention of soil in the watershed.

RESULTS AND DISCUSSION

The climate is continental, with the absolute maximum temperature of 34.6°C and the negative of -24.4°C, respectively. Average annual air temperature, t0, is 9.1°C and the Temperature coefficient of the region, T, is calculated on 1; The amount of torrential rain, hb, on 34.68 mm. The average annual precipitation, H_{yr}, is 317 mm (Source: Data from the North Khorasan Meteorological stations of Iran).

The studied area belongs to the Middle-East of the Kope-Dagh geographical region. The pastures and meadows are predominant and covering the area of 78%. A part under the forests is about 19% and ground without grass and arable land is of about 3% (Figure 2). The coefficient of the river basin planning is calculated on 0.62. The coefficient of the vegetation cover is calculated on 0.77.

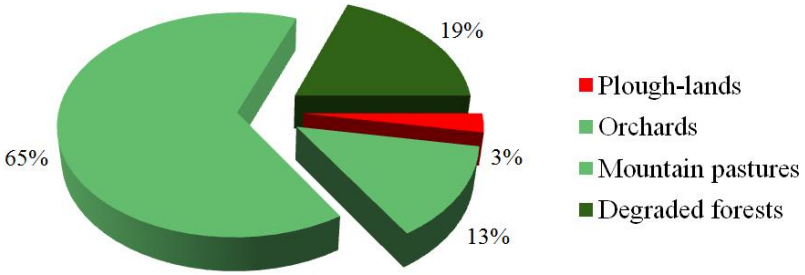

Figure 2. Land use of the S7-2 watershed, the Shirindareh River Basin, Iran

The dominant erosion form in this area is **surface erosion** and is the most pronounced on the steep slopes without vegetation cover. Calculation of Sediment yield of the S7-2 Watershed of the Shirindareh River Basin of Iran is presented at the "River Basin" Report 1.

Report 1. The "River Basin" report for the S7-2 Watershed

Inputs: River basin area, **F**, 24.65 km²; The length of the watershed, **O,** 29.95, km; Natural length of the main watercourse, **Lv,** 9.98, km; The shortest distance between the fountainhead and mouth, **Lm**, 9.48 km; The total length of the main watercourse with tributaries of I and II class, **ΣL**, 53.69 km; The area of the bigger river basin part, **Fv**, 14.27 km²; The area of the smaller river basin part, **Fm**, 10.38 km²; Altitude of the first contour line, **h0**, 1300 m; The lowest river basin elevation, **Hmin**, 1201 m; The highest river basin elevation, $\mathbf{H_{max}}$, 1825 m; A part of the river basin consisted of a very permeable products from rocks (limestone, sand, gravel), **fp**, 0.15; A part of the river basin area consisted of medium permeable rocks (slates, marls, brownstone), **fpp**, 0.18; A part of the river basin consisted of poor water permeability rocks (heavy clay, compact eruptive), **fo**, 0.67; A part of the river basin under forests, **fs**, 0.19; A part of the river basin under grass, meadows, pastures and orchards, **ft**, 0.78; A part of the river basin under bare land, plough-land and ground without grass vegetation, **fg**, 0.03; The volume of the torrent rain, **hb**, 34.68 mm; Incidence, **Up**, 100 years; Average annual air

temperature, **t0**, 9.1 °C; Average annual precipitation, $\mathbf{H_{yr}}$, 317 mm; Types of soil products and related types, **Y**, 1.1; River basin planning, coefficient of the river basin planning, **Xa**, 0.62; Numeral equivalents of visible and clearly exposed erosion process, **φ**, 0.48.

Results: Coefficient of the river basin form, **A**, 0.59; Coefficient of the watershed development, **m**, 0.57; Average river basin width, **B**, 3.08, km; (A)symmetry of the river basin, **a**, 0.32; Density of the river network of the basin, **G**, 2.18; Coefficient of the river basin tortuousness, **K**, 1.05; Average river basin altitude, $\mathbf{H_{sr}}$, 1480.23 m; Average elevation difference of the river basin, **D**, 279.23 m; Average river basin decline, $\mathbf{I_{sr}}$, 32.99%; Coefficient of the region's permeability, $\mathbf{S_1}$, 0.86; Coefficient of the vegetation cover, $\mathbf{S_2}$, 0.77; Maximal outflow from the river basin, $\mathbf{Q_{max}}$, 65.06 m^3s^{-1}; Production of erosion material in the river basin, $\mathbf{W_{yr}}$, 15191.9, m^3 yr^{-1}; Coefficient of the deposit retention, **Ru**, 0.289; Real soil losses, $\mathbf{G_{yr}}$, 4397.7, m^3 yr^{-1}; Real soil losses per km^2, 178.41 m^3 yr^{-1} km^{-2}.

This approach is also in use: Bosnia and Herzegovina, Brazil, Bulgaria, Croatia, Czech Republic, Italy, Macedonia, Montenegro, Morocco, Saudi Arabia, Serbia, South Africa and Slovenia (Al-Turki *et al*., 2015; Gazdic *et al.,* 2015; Spalevic *et al.,* 2015a, 2015b, 2015c, 2015d, 2015e, 2015f, 2015g, 2015h, 2015i, 2015k; Vujacic & Spalevic, 2016; Kostadinov *et al.,* 2014; Spalevic *et al*., 2014a, 2014b, 2014c, 2014d). The provided methodology have been successfully used in Iran in the regions of Chamgardalan, Kasilian, Kermanshah, Razavi Khorasan (Spalevic *et al.,* 2016; Draganic *et al*., 2015a; Draganic *et al*., 2015b; Behzadfar *et al.,* 2015; Barovic & Spalevic, 2015; Sadeghi, 2005) and other regions.

CONCLUSION

Calculation of sediment yield in the S7-2 Watershed showed the following results:
- Production of erosion material in the river basin, $\mathbf{W_{yr}}$, was 15191 m^3 yr^{-1};
- Calculated soil losses are 4397 m^3yr^{-1} and Real soil losses were 178.41 m^3 yr^{-1} km^{-2};
- The peak discharge is 65 m^3s^{-1} (incidence 100yr).

This study confirmed the findings of Barovic *et al.* (2015); Behzadfar *et al.,* 2015, Zia Abadi & Ahmadi (2011); as well as Amiri (2010) in possibility of implementing "Erosion Potential Method" and the "River Basin Model" for the other river basins of the Caspian Sea, when hydrological stations are missing, taking into consideration the fact that the erosion modelling is cheaper than constructing hydrological stations. The results shown that this model is a good tool for rapid assessment of erosion risk to support decision-making and policy development.

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10.7251/AGRENG1601121M
UDC 339.9:061.1(497.6 RS)

EU COMMON AGRICULTURAL POLICY AND AGRICULTURAL POLICY OF THE REPUBLIC OF SRPSKA (BOSNIA AND HERZEGOVINA)

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ABSTRACT

One of the most challenging issues for the countries that are in the process of accession to the European Union is the reform of agriculture, precisely agricultural policy and its compliance with the Common Agricultural Policy of the European Union (CAP). The strategic orientation of the Republic of Srpska and Bosnia and Herzegovina is a full EU member status, which is defined with signatory to the Stabilization and Accession Agreement in 2008 and confirmed with Application for membership in the European Union, submitted in February 2016. Considering the upcoming accession negotiation process, the reformation of agricultural sector is necessary in all areas of development: production, policy and legal framework and institutional development. Until 2015 Republic Srpska made and adopted two key strategic documents that determine the directions, objectives and measures for developing of agriculture and rural areas. Recently the Republic of Srpska adopted a new strategic plan for the development of agriculture and rural areas for the period 2016- 2020. Considering that agriculture budget represents a first indicator of the countries sector priorities, objective of this paper is to provide analysis of agricultural policy through the agricultural budget of the Republic of Srpska and its compliance with Common Agricultural Policy of the EU. Comparative analysis is related to the period 2006 – 2014 using EU methodology for the classification of agricultural measures (pillars and axis). Research results show that the structure of measures and scope of budgetary support, defined within agricultural policy of the Republic of Srpska is not compatible with Common Agricultural Policy of the EU.

Key words: *EU CAP, Republic of Srpska, budgeting.*

INTRODUCTION

The first phase of development of agricultural policy of Republic Srpska refers to the period since 2000, when the allocation of substantial financial resources for the development of agriculture was started, up to year 2006, when first *Agriculture Development Strategy* was adopted, and thus made a shift in strategic targeting of funds for development of agriculture and rural areas (Mirjanic, Rokvic, 2012). With the adoption of Agriculture Development Strategy, Republic of Srpska made first steps towards adaptation to the European strategic framework for agriculture

and rural development, and also the use of EU good practices in policy approach to the development of rural areas. Thereby, one of the primary goals of development of agricultural sector up to 2015 was: *"Harmonization of legal and other administrative regulations in process of food production with production's criteria in the European Union"*. In addition, the European orientation can be recognized in giving of significant importance to rural development as one of the strategic objectives of agricultural development: *"Balanced agricultural development, economical protection of market-oriented producers, integrated rural and regional development, economic and social revitalization of villages"*. This orientation was confirmed by the adoption of a new model of subsidies, whereby the support to rural development has become the *third pillar* of agriculture and rural development policy. In year 2010, Republic of Srpska adopted a Strategic plan for rural development and with this made a shift from purely sectoral to an integrated approach to the development of agriculture and rural areas (Mirjanić, Roković, 2012). Recently, the Republic of Srpska adopted a new strategic plan for the development of agriculture and rural areas for the period 2016- 2020, which represents the continuity of the two previous strategies. The increasing of production volume, improving of production technology and increasing of productivity, reducing of trade deficit and creation of conditions for the export of agro-food products for which Republic of Srpska has comparative advantages, gradual harmonization of agricultural policy to CAP EU, improvement of social, economic and environmental conditions for development of rural areas, are basic strategic guidelines of agricultural development in Republic of Srpska, defined in this document.

Considering that agriculture budget represents a first indicator of the countries sector priorities, objective of this paper is to provide analysis of agricultural policy based on the analysis of agricultural budget of the Republic of Srpska, and its compliance with Common Agricultural Policy of the EU. For comparative analysis is used EU concept for the classification of agricultural measures.

MATERIAL AND METHODS

This paper presents a comparison of measures of agricultural policy at Republic of Srpska and EU level, respectively for the period from 2006 to 2014 (Republic of Srpska) and 2007-2013 (European Union). The classification of measures of agricultural policy and analysis of budgetary support to agriculture is made using EU methodology. The EU concept is based on a three pillars of policy support:

Pillar 1. Market and direct producer support measures;

Pillar 2. Structural and rural development measures;

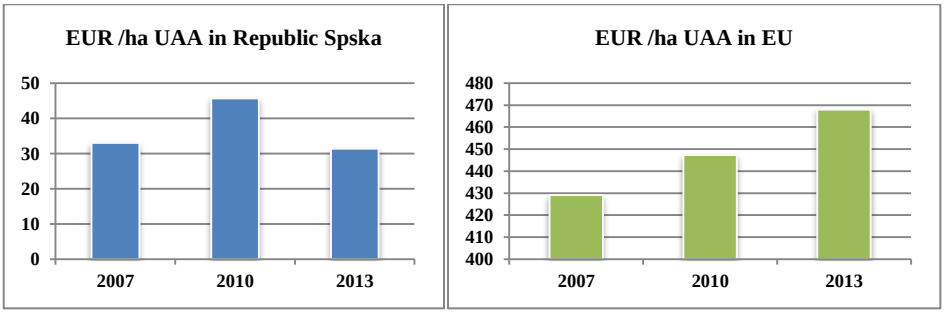
Pillar 3. General measures related to agriculture.

In addition to these three pillars, EU concept of classification includes the section Miscellaneous transfers to agriculture (budget transfers for which there is not enough information available to allocate them to appropriate categories). **The first pillar** includes measures which affect the price level of agricultural products, as well as measures which contribute to increasing of income of agricultural producers through different forms of direct budgetary payments. The measures of

first pillar are divided into two main groups: (1) *Market support measures* and (2) *Direct producer support measures.* Budgetary expenditures for market support measures incorporate measures by which the policy influences the supply and demand on the domestic market, and thereby indirectly also the prices of agricultural products *(Volk et all, 2014).*The budgetary expenditures related to market support measures are divided into following groups: *export subsidies, market interventions and consumer support.* Direct producer support measures are divided into two groups: (1) *Direct payments to producers and variable input subsidies*, and (2) *Disaster payments and other compensation to producers.* **The second pillar** measures are aiming to increasing of efficiency and competitiveness of agricultural producers, to developing of food processing industry and market organization, as well as contribute to integrated rural development. The measures are grouped into three axes: Axis 1. *Improving the competitiveness of the agricultural sector*, Axis 2: *Improving the environment and countryside* and Axis 3: *Supporting rural economy and population*. The axes more or less follow the structure of the 2007-2013 EU rural development policy frameworks, though in a broader sense regarding the substance of measures and with quite a few modifications *(*Volk *et al.*, 2012). The first axis is divided into three groups of measures: (1) *On – farm restructuring support;* (2) *Agri-food restructuring support*; (3) *Forestry support*. On – farm restructuring support is future divided into two groups of measures: (1) *On – farm investment support* and (2) *Other on – farm restructuring support*. Agri-food restructuring support is composed of two groups of measures, aimed to support the restructuring of agriculture in general, as well as support to food processing, marketing and promotion. To the second axis belong the measures aimed at improving the environment and countryside. The third axis gathers measures aimed to support to rural economy and population, and is divided into three groups: (1) *Support to rural population directly linked to farms*; (2) *General support to rural economy and population*; (3) *Building local capacity (LEADER)*. Measures classified within **third pillar** relate to the support for public services to agriculture, such as research, advisory and expert services, food safety and quality control and others. The analysis of the total budgetary support to agriculture and rural development on the level Republic of Srpska using EU concept is based on data of agricultural budgetary transfers for period 2006 – 2014 by Ministry of Agriculture, Forestry and Water Management. For the EU level, analysis of total budgetary expenditures for agriculture and rural areas are used OECD PSE database in 2016 year, as well as EU Commission reports.

RESULTS AND DISCUSSION

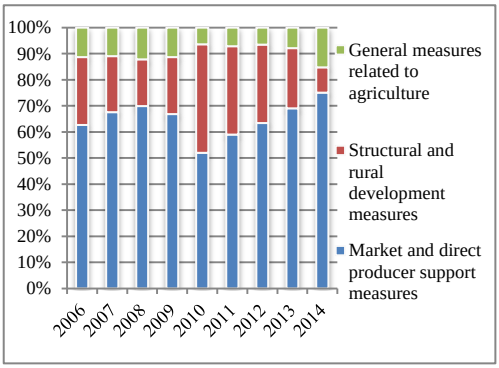
The level of budgetary support to agriculture in Republic Srpska and EU is compared by using the absolute value of budgetary support to agriculture in EUR divided by the total utilized agricultural area *(Graph.1.).* This indicator provides an important first insight into the availability of budgetary funds for agriculture in a country and is indicative of the capacity of agricultural policy to influence agricultural development (Volk *et al.*, 2014).



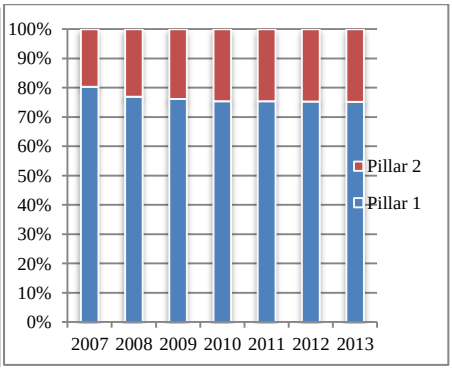
Graph 1.Total budgetary expenditure for agriculture and rural areas in Republic of Srpska and EU in EUR per ha UAA.

**Source: Calculation by authors based on data of Ministry of Agriculture and Institute of Statistics of Republic Srpska, OECD PSE database for EU28 and Eurostat*

In Republic Srpska, the level of total budgetary support to agricultural per hectare of utilized agricultural area (UAA) is lower in compare to EU level, and amounted between 31 – 46 EUR. This indicates a very low budgetary support considering the agricultural land area in Republic Srpska. In EU, budgetary support to agriculture expressed through hectare of UAA is much higher, and recorded increasing in time period 2007, 2010 and 2013. In addition to the total amount of support, the structure of support is also an important indicator of agricultural policy (Volk *et al.*, 2012). In the structure of budgetary support to agriculture in Republic Srpska by policy pillars, the most dominated is market and direct producer support *(Graph 2.)*. During the observed period, the share of funds related to the first pillar measures is on average 65% in compare to the total budgetary support for agriculture. The second place occupied structural and rural development measures, with an average share of 25%. Budgetary support for public services related to agriculture had an average share of 10%. In EU, analysis of structure of CAP expenditures by policy pillars shows that the market related expenditure and direct payments dominated in period 2007-2013 with an average share of 76% *(Graph.3)*.

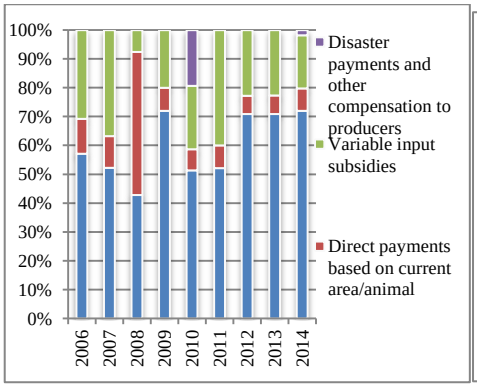


Graph 2. Structure of agricultural budget at the level Republic Srpska
**Source: Calculation by authors based on data of Ministry of Agriculture*

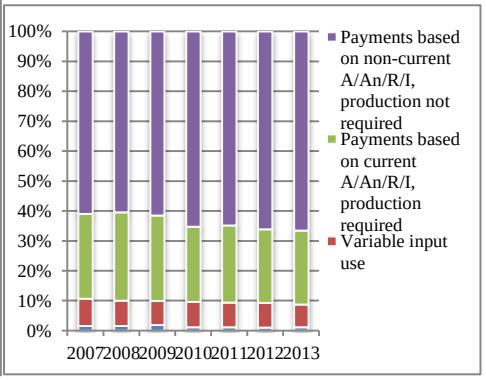


Graph 3. Structure of CAP EU expenditures by policy pillars.
**Source: EU Commission.*

At the level of Republic Srpska, market support was mostly operationalized through the agricultural budget for intervention buying. The intervention measures have been used on the grain market (wheat and corn) as well livestock (pigs, cattle and broilers). Since 2013 the part of budgetary support are transfers directed to food processing industry for buying of domestic products. Dominated group of measures within the first pillar of support to agriculture in Republic Srpska are measures of direct producer support. The share of the budget for direct producer support is significantly higher (an average share of 96%) in relation to total budgetary expenditures for market and direct producer support. This group includes measures, which implementation has direct impact on production. Direct producer support in the form of direct payments based on outputs had the highest share with 60%, followed by variable input subsidies with 25% *(Graph 4.)*.Direct support based on output benefited mostly to producers of milk, wheat, tobacco and fruit seedling. Variable input subsidies comprised subsidies for plant production, fuel and insurance. In compare to RS, in EU the prevailing direct producer support form were direct payments based on non – current A/An/R/I production non required with an average of 64%. Payments based on current A/An/R/I, production required occupied an average share about 27% *(Graph 5.)*. The highest share of direct payments based on non – current A/An/R/I production non required was result of introduction of *Single Farm Payment* through *Fischler reform* from 2003, which presented one of three payment models based on Single Payment Scheme (SPS) – *model based on historical rights.*

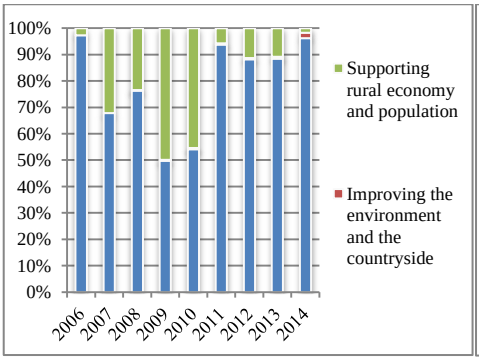


Graph 4. Direct producer support by group of measures at RS.
**Source: Calculation by authors based on data of Ministry of Agriculture RS.*

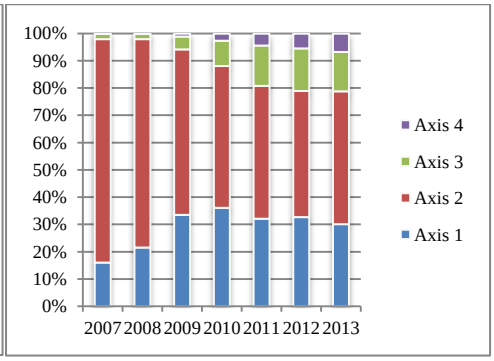


Graph 5. Direct payments and variable input subsidies at EU
**Source: Calculation by authors based on PSE database*

On the other side, payments based on output, variable input subsidies and commodity linked payments per area or animal remind till today the main instrument to support current production in Republic of Srpska. Disaster payments and other compensation to producers at level of Republic Srpska have appeared periodically. The strategic objectives of rural development policy in Republic of Srpska are largely aligned with the strategic framework at EU level, especially for Axis 1 and 3, while Axis 2 at Republic of Srpska level doesn't recognize any of the EU instruments for support of environment and countryside. The existing low input and low intensity agriculture practiced in the countries like entity of Republic of Srpska (BH) can be perceived in certain respects as an opportunity for environmental sustainability in the agricultural sector. However, in view of future EU membership and accompanying policies, the question is to what extent the requirements of environmental protection and nature conservation will be taken into account in the countries policy formation (Zellei, 2001). Generally, in Republic Srpska rural development policy was subordinate to direct producer support, and mainly includes measures aimed to improving the competitiveness of agricultural sector. Investment support and other measures within Axis 1, precisely on–farm investment support aiming to increasing of technological efficiency of production, followed by investments in modernization of agri-food processing sector and improving of marketing and promotion activities, represented the highest share of funds for second pillar, an average about 79%. On –farm investment support comprised investments in machinery and equipment, land improvement, investments in livestock and plant production. The proportion of budgetary expenditures for the development of rural areas including the rural economy and population was about 20% in compare to total budgetary support for second pillar support *(Graph 6).* In EU, measures aimed to improving the environment and the countryside represented the highest share of funds for rural development, ranging about 59%.The second place occupied measures of Axis 1 with an average share of 29% *(Graph 7.).*

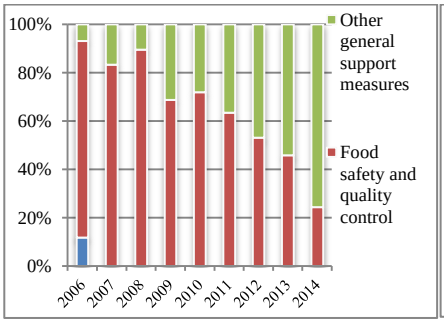


Graph 6. Structure of second pillar support by group of measure at RS.
**Source: Calculation by authors based on data of Ministry of Agriculture.*

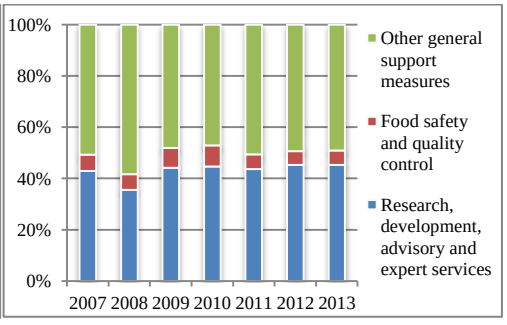


Graph 7. Structure of second pillar support by group of measure at EU.
**Source: EU Commission.*

Public services related to agriculture have important place in strategic framework for development of agriculture of Republic of Srpska. The available instruments such are plant protection measures, animal health protection measures, anti–hail protection measures, institutional support for Veterinary and Agriculture research Institutes, support for farm register and development of policy programs are extensive than the one at the EU level. They are more oriented to institutional support by providing grants, and less to the programs oriented by providing payments for services these institutions are producing. During the observed time period, in Republic Srpska the higher attention is given to veterinary and phytosanitary areas, which is confirmed through an average share of 65% of budgetary expenditures related to public services in agriculture. Budgetary support earmarked for other general support measures represented an average 34% of total funds related to third pillar support. Very low attention is given to research, development advisory and training activities.



Graph 8. Structure of third pillar support by groups of measures at RS
**Source: Calculation by authors based on data of Ministry of Agriculture.*



Graph 9. Structure of third pillar support by groups of measures at EU.
**Source: Calculation by authors based on OECD data basa.*

In the EU many of these measures belong to state aid and are not financed by the Community budget *(*Volk *et al., 2014).* In EU, the measures such as development and maintenance of infrastructure, marketing and promotion of agricultural products received the largest part of funds within this policy pillar, with an average proportion about 50%. The share of funds for supporting food safety and quality control in EU was an average 34% related to total funds aimed to general support measures.

CONCLUSION

In recent years, Republic Srpska adopted three mid-term strategic documents, in which were strategic goals and priorities for agriculture and rural development set. The general impression in the creation of agriculture and rural development policy in the Republic of Srpska is that it made a positive shift in the strategic targeting of resources, and in a systematic and numerous types of support measures. Budgetary support measured per hectare of utilized agricultural area is much lower compared with level in EU. In the structure of total budgetary support for agriculture in Republic Srpska, the highest share had direct producer support. In relation to total budgetary expenditures for first pillar support, direct producer support had an average share of 96%. The dominated form of direct producer support were payments based on output. In EU direct producer support also dominated. Direct producer support in form of payments based on non – current A/An/R/I production none required had the highest share of 64%. In Republic Srpska, the level of budgetary support for structural and rural development measures was below of budgetary expenditures for first pillar measures. These funds were mainly intended for the improving the competitiveness of the agricultural sector through support on–farm investments. Very small proportion of funds was related to measures of second axis of rural development policy. In the EU, environment and countryside measures had the highest proportion of funds under second policy pillar. The smallest share of total agricultural budget in Republic Srpska is referred to financing of public services related to agriculture. Mostly high attention is given to veterinary and phytosanitary measures. Generally, at the level RS the analysis of agricultural policy based on analysis of agricultural budget indicated an orientation of this policy towards production. Some of measures in support system for development of agriculture in Republic Srpska, like predominantly output supports, and input subsidies, are not allowed in EU, which indicates a lack of compatibility with the reformed CAP. A strategic piece of advice would be that the policy gradually focuses on per head and area payments for those sectors which have been gaining support in the EU since 1992 (Volk *et al., 2012).* Regardless of the need for increasing competitiveness in agricultural sector of Republic Srpska and prevalent production –oriented agricultural policy, in future more attention should be given to on-farm and agri-food restructuring support. Also, one of the main topics to be addressed is defning a strategic framework for environmental protection measures and conservation of natural resources and in this sense, increase the level of funds allocated for the sustainable management of natural resources.

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10.7251/AGRENG1601130A
UDC 633.11:551.577.38(55)

ANATOMICAL STUDIES OF DROUGHT TOLERANCE RELATED TRAITS OF 26 WHEAT VARIETIS IN IRAN

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ABSTRACT

Wheat (*Triticum aestivum* L.) is known as a drought semi-tolerant species. Reduction in wheat growth and yield are the most common responses to drought or salt stress mainly caused by an inhibition of leaf expansion and stem elongation. One of the important abiotic stress factors limiting wheat production in semi aridregions is drought. Recent climate changes such as temperature changes and decreasing rainfall in different regions of Iran have had significant impact on agro-ecosystems and have caused drought stress to become a severe limiting factor in wheat production. This research was conducted for evaluation of leaf anatomical and cytological traits of 26 wheat varieties in Golestan province (Iran) over 40 years in order to identify the most effective traits in determining maximum yield potential. The width and length of vascular bundles, diameter of meta xylem, distance between vascular bundles to upper and lower epidermis, fiber bundles diameter and width of midrib and lamina were measured. Finally, based on the anatomic results, wheat varieties with the highest adaptation ability to drought stress were identified and introduced.

Keywords: *waterless stress, wheat, anatomical study, Iran*.

INTRODUCTION

Wheat (*Triticumaestivum* L.) has been cultivated by many civilizations for over 9,000 years. It is a cereal grain belongs to Poaceae family, which has been known as semi-tolerant plants to drought. Wheat is believed to have originated in Mediterranean region, especially in Syria and Palestine and then spread out to the rest of the world (Jenkins, 1996).

Wheat is grown on more than 250,000,000 hectares and its world production is 500 million tons (FAO, 2016). The top wheat producer countries in the world are Denmark, Netherlands, France, Belgium and Germany. Iran is the eleventh most producer country in the world. FAO's latest forecast for 2016 world cereal production stands at 2521 million tons, 0.2 percent lower than the 2015

estimate due to low rainfall and drought stress. Wheat plays a pivotal role in proving food for Iranians. The Iran's per capita use of wheat stood at 194 kilograms per year making it the seventh most consumer country in the world. Iran is an arid and semi-arid country located on world's desert belt. About 30 per cent of the total cropped area in the country is under wheat cultivation (Mohammad, 2006). Drought stress and high temperature during growing seasons are the most important limiting factors that influence the wheat production (Islamian, 2010). In these areas, farmers do not obtained optimal results in high need varieties to irrigation due to lack of adequate water in spring and/or lack of enough irrigation as a result of consumption of irrigation water for summer agricultures, consequently the wheat agriculture suffered from drought in end of season (Mahfuzi, 2009).

A large volume of researches in the world have been focusing on the effects of environmental conditions on wheat growth and development. Scientist are expecting to produce wheat cultivars for cultivation in arid lands (Mollasadeghi, 2011; Khan, 2015; Mousavi, 2008; Hamam, 2014). Studying on superior genotypes such as drought and cold tolerant genotypes is crucial to take advantages from highlands where water deficit stress is responsible for reducing leaf area and changing leaves cytological characteristics and finally yield loss (Richards, 2004).

of photosynthetic rates and high transpiration efficiencies (Evans *et al*. 1994). Cuticle thickness (Rojas *et al*. 1983), stomatal frequency (Rebetzke *et al*., 2010), length (Bohnert and Jensen, 1996), movement and sensitivity (Drake *et al*., 2013) are among anatomical characteristics which are believed to be useful for breeding water stress tolerant genotypes. Leaf morphological characters including leaf area (Zagdanska an Kozdo, 1994), shape (Reddy *et al*., 2004), duration (Verma*et al*., 2004) and developing behavior (Hu *et al*., 2000) Considering the world's population growth, global water shortages and drought stress in arid and semi-arid regions, the current study was aimed to highlight the role of anatomical and cytological characteristics of wheat cultivars in improving wheat tolerance against rough climate conditions.

For this purpose, 26 wheat cultivars (release over 40 years) were studied in terms of leaf anatomical and cytological characteristics to introduce the most compatible cultivars to be grown under stressful conditions.

MATERIALS AND METHODS

Physiological aspects

In this study, 26 wheat cultivars (Table), which have been released over 40 years, were evaluated in terms of physiological and anatomical aspects in Gorgan Agricultural Research Station (Iran). The field was prepared using moldboard plough and disk. Chemical fertilizers were applied according to the soil analysis results. The experimental design was a randomized complete block design with thee replicates. The plots were 1 × 6.5 m consist of 5 rows. The wheat seeds were sown in early January based on seed weight at 350 seeds per square meter. During growing season data were collected and finally crop was harvested in June.

Anatomical aspects

In order to study leaves anatomical chrematistics, leaf samples were fixed in alcohol-glycerin solution (1:1 v:v) for one month. In all cultivars, middle part of basal leaves was chosen to collect the samples. The Green methyl and Carmen stain were used for staining. Stained cross sections were studied under Olympus optical microscope equipped with digital camera and 40x lenses. The Measurement software was used to measure different parameters. The results were statistically analyzed using SAS software.

Table 1: name, origin and pedigree of genotypes of *Triticumaestivum* L.

Number of genotypes	Name of cultivar	Origin of cultivar	The date of introducing	pedigree
1	khazra	Gorgan	1973	(P4160(F3)*Nr69)LR64
2	Tajan	Simit	1995	Bow″s″/Nkt″s″
3	Naz	Simit	1978	Jupateco 73
4	Alborz	Simit	1978	Fn-Md*k117/Cofin2
5	Hyrmand	Zabol	1991	Byt/4/Jar//Cfn/Sr70/Jup″s″
6	Shirodi	Simit	1997	Attila
7	Golestan	Simit	1986	Alondra″s″
8	Inia 66	Simit	1968	Lr64/Sn64
9	pastor	Simit	1997	Pastour
10	Arta	Simit	2007	(HD2206/Hork//Bul…
11	Darya	Simit	2007	SHA4/CHIL…
12	Moghan 3	Simit	2007	Luan/3/V763.23/V879.c8//Pvn
13	Morvarid	Simit	2009	MILAN/SHA7
14	Atrak	Simit	1995	Kauz″s″
15	Falat	Simit	1990	Kvz/Buho″s″//Kal/Bb=Seri82
16	Rasol	Simit	1992	Veery″s″=Kvz/Buho″s″//Kal/Bb
17	kohdasht	Ecarda	2000	TR8010200
18	Gondad	Gorgan	2011	ATRAK/WANG-SHUI-BAI
19	N-80-19	Simit	2005	SW89.3064/STAR…
20	N-87-19	Gorgan	2002	MILAN CM75118/KA…
21	N-87-20	Gorgan	2003	SABUF/7/ALTAR…
22	Zagros	Simit	1995	TAN″s″/V″s″
23	Line A	Simit	2005	IRANA/BABAX//PASTOR
24	Karim	Ecarda	2011	HAMAM4
25	N-87-21	Simit	2012	BABAX//PASTOR
26	N-87-22	Simit	2013	SH1/CHV2

RESULT AND DISCUSSION

In this study two groups of traits were evaluated. The first group traits, which are equally found in all cultivars, included uni-cellular epidermis, mesophylla type, vascular bundles sheet, proto and meta xylems, proto and meta phloem, simple stomata in upper and lower epidermis and fiber in primary and secondary vascular bundles. The second group traits, which differ from cultivar to cultivar, included width of fiber in lower epidermis, length and width of vascular bundles, phloem width, phloem length, the maximum diameter of xylem, distance between vascular bundles and adaxial leaf surface, midrib widthand lamina width.

Fiber width

In all cultivars fiber was observed under epidermis of abaxial surface. There is no report stating fiber thickness change due to drought stress. It seems that increase in fiber accumulation not only increase leaf stability and conserve midrib, but also improve water holding capacity in parenchyma cells under drought stress conditions. As shown in Table 1, the maximum fiber width was observed in 14 and 16 genotypes. In addition, number 2 genotype showed the minimum fiber width compared with the other genotypes(Fig8& Fig 10; B, N,P)

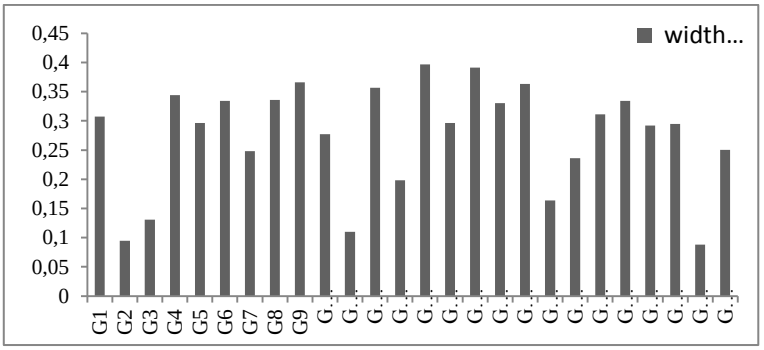

Figure 1: fiber width in different wheat genotypes

Width and length of central vascular bundles

Midrib anatomy consists of central large vascular bundles by large metaxylem vessels on either side of protoxylem. Phloem well developed. Bundle sheaths have extended to upper and lower epidermis. Vascular tissue system are completely surrounded by chlorenchymatous bundle sheath and involved in transportation of the different compounds. Changes in vascular bundles is known as a response to water deficit stress (Claudio and Andrea, 1998). There was significant difference between cultivars in terms of width of vascular bundles. The maximum and minimum width was observed in genotypes number 16 and number 2 (Fig 2), respectively (Fig8; B,Fig 10; P). Furthermore, significant difference was found between wheat cultivars in relation to length of vascular bundles. The maximum and minimum length was observed in genotypes number 16 and number 2, respectively (Fig 3) and (Fig8; B,Fig 10; P). The biggest vascular bundles were observed in number 16 genotype (Rasool) (Fig 8; P). Bigger vascular bundles improve leaf efficiency under drought stress conditions.

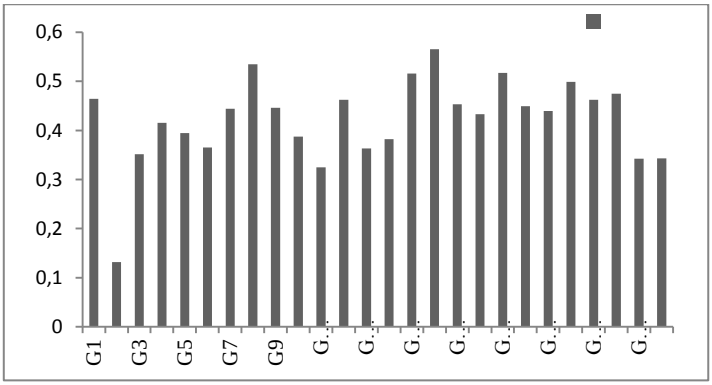

Figure 2. comparing between width of vascular bundle in several genotypes

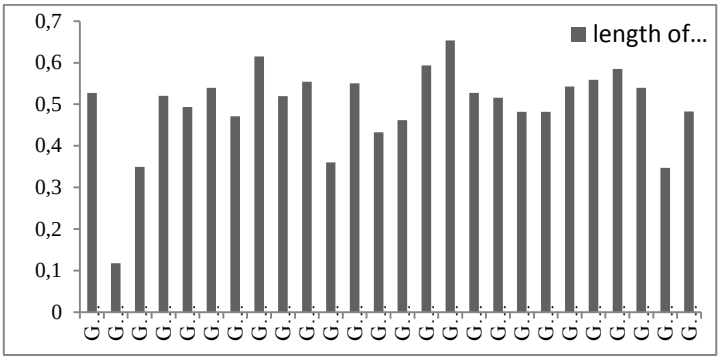

Figure 3. comparing between length of vascular bundle in several genotypes

Width of Phloem: has been shown the phloem diameter in wheat leaves that was affected by water stress condition were not changed in accordance with their corresponding grain size (Jafarian et al., 2012). This is in contrast with what is expected from the phloem sieve tubes diameters implying that there may be other limiting factors affecting grain size in these cultivars.In addition, significant difference was obtained when phloem width of different genotypes was compared. The maximum and minimum width was related to number 8 and number 2 genotypes, respectively (Fig 9; H, Fig 8; B). It should be noted that different phloem lengths were observed in different genotypes. According to Figure 4, the maximum and minimum phloem length was related to number 9 and number 2 genotypesrespectively (Fig8 ;B, Fig 9; I).

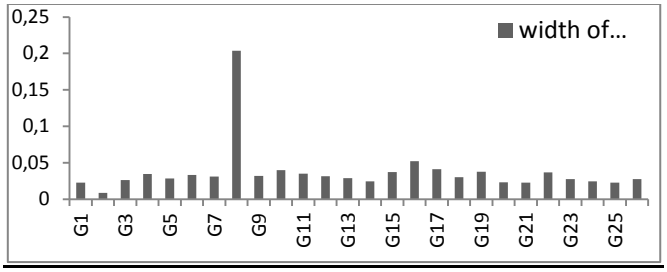

Figure 4. comparing between width of phloem in several genotypes

Xylem vessel diameter

the xylem vessel diameter in wheat leaves is under the effect of genotype, water stress and their interaction indicating thatsmall size vessels, if desired, could be selected for, depending on the water availability.The theoretical xylem hydraulic conductivity computed from the diameter of individual vessels using the Hagen–Poiseuilleequation has been shown to be proportional to the observedvalues (Altus *et al*. 1985). Decreasing xylem diameter may play a role inadaptation of plants to water stress condition since smaller diameter decreases the hydraulic conductivity of the xylem (Martre*et al*. 2001). In addition, significant difference was obtained when phloem width of different genotypes was compared. The maximum and minimum width was related to number 8 and number 2 genotypes, respectively (Fig 8; B, Fig 9; I).

It should be noted that different phloem lengths were observed in different genotypes. According to Figure 5, the maximum and minimum phloem length was related to number 9 and number 2 genotypes, respectively (Fig 9; I, Fig 8; B).

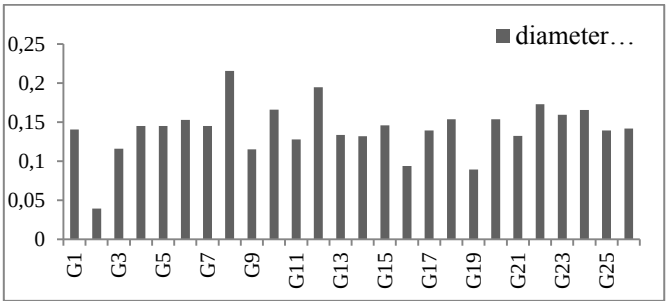

Figure 5. Comparing between xylem vessel diameter in several genotypes

Width of Lamina and Midrib

Environmental stresses were shown to change mesophyll cells dimensions in other crop plants. For example high temperature stress increased the thickness of palisade and spongy cell layers and lower epidermal cells in soybean leaves (Djanaguiramana*et al.* 2011) . In this study, there was significant difference between cultivars in relation to lamina width so that the maximum lamina width was observed in number 16 genotype (Rasool), the genotype that showed the

maximum tolerant against water deficit stress (Figure 7) and (Fig 10; P). The number 15 genotype showed similar results. The minimum lamina width was related to number 18 genotype (Figure 7) and (Figure10; R). In case of midrib width, the number 16 genotype showed the widest midrib among other genotypes(Figure 6). By contrast, the narrowest midrib was related to number 25 genotype (Figure 6) and (Figure11; X).

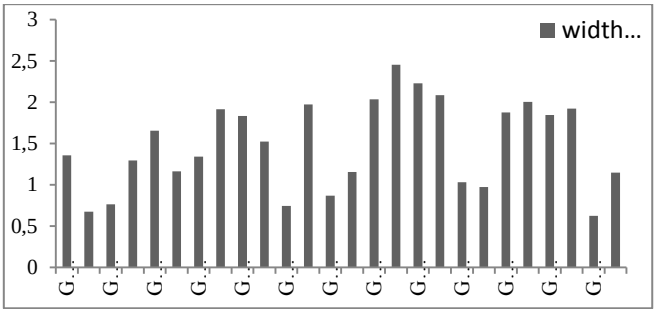

Figure 6. comparing between widths of midrib in several genotypes

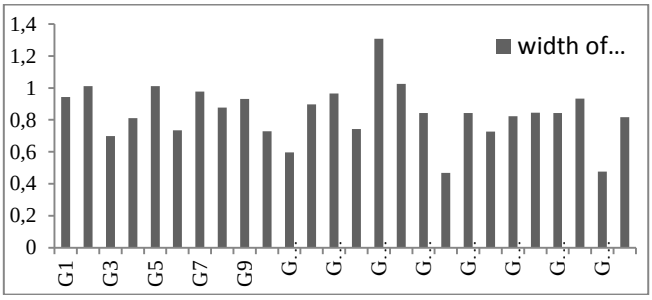

Figure 7. comparing between width of lamina in several genotypes

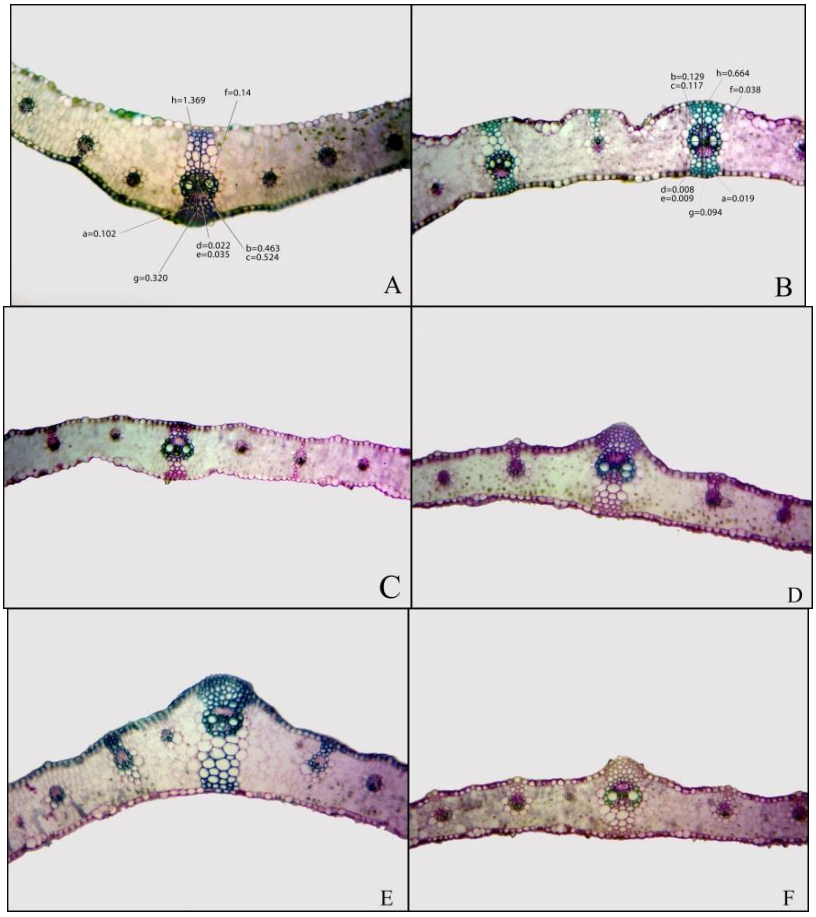

Figure 8. Cross- section of genotypes of *Triticum aestivum* L.leaf (µm), A : G1, B: G 2, C: G 3, D: G 4, E: G 5 , F: G6. **a**: width of fiber, **b**: width of vascular bundle, **c**: length of vascular bundle, **d**: width of phloem, **e**: length of phloem, **f**: diameter of xylem, **g**: distance between V.S. to epidermis, **h**: width of lamina.

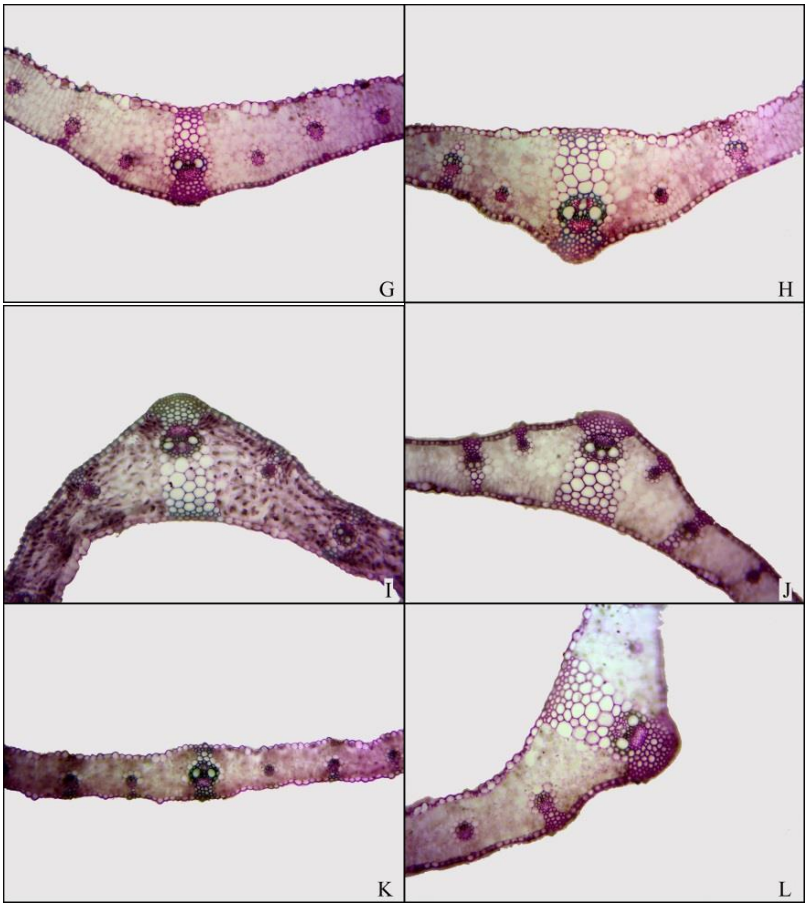

Figure 9. Cross- section of genotype of *Triticumaestivum* L. leaf (µm), G : genotype 7, H: genotype 8, I: genotype 9, J: genotype 10, K: genotype ,genotype 11, L: genotype 12.

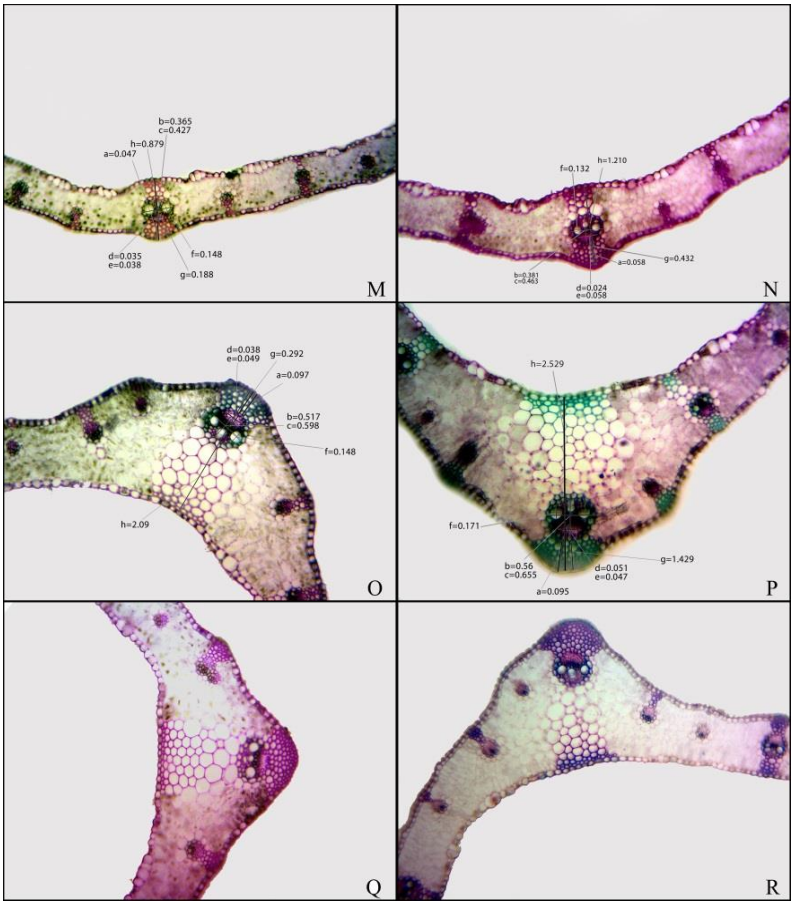

Figure 10. Cross- section of genotypes of *Triticum aestivum* L. leaf (µm), M : G 13, N: G14, O: G15, P: G16, Q: G17 , R: G18, **a**: width of fiber, **b**: width of vascular bundle, **c**: length of vascular bundle, **d**: width of phloem, **e**: length of phloem, **f**: diameter of xylem, **g**: distance between V.S. to epidermis, **h**: width of lamina.

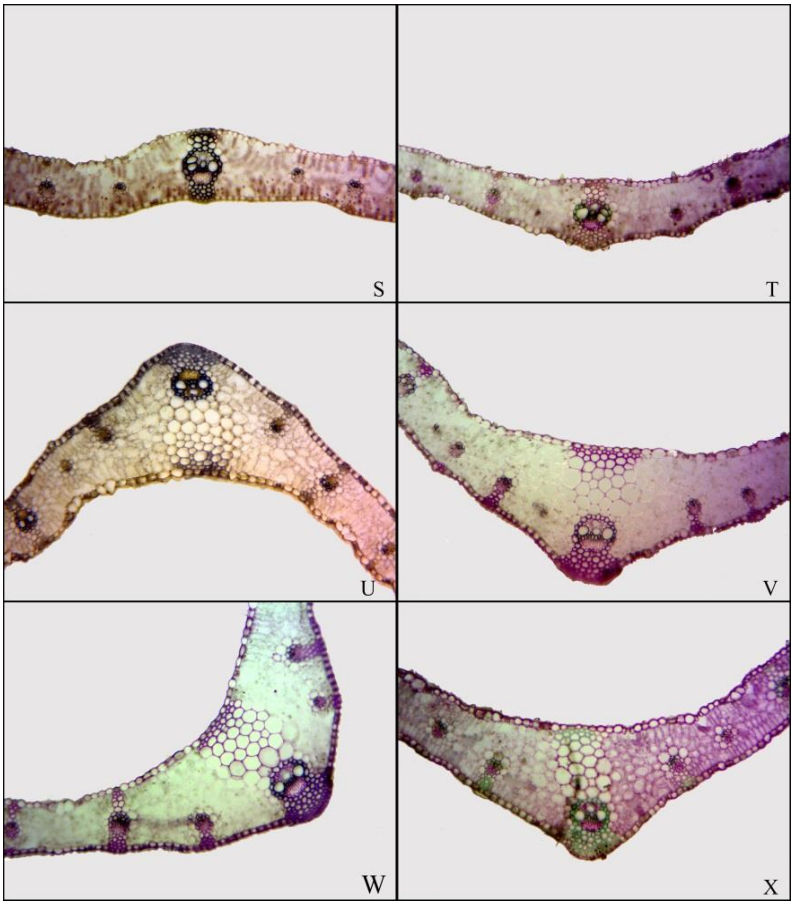

Figure 11. Cross- section of genotypes of *Triticumaestivum*L. leaf (µm), S : genotype 19, T: genotype 20, U: genotype 21, V: genotype 22, W: genotype 23 , X: genotype 24.

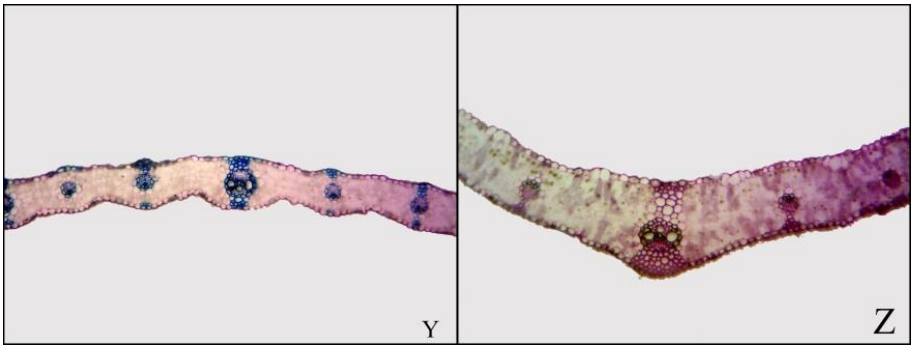

Figure 12. Cross-section of genotype of *Triticum aestivum* L. leaf *(*µm), Y: genotype 25, Z: genotype 26.

CONCLUSIONS

In general, anatomical comparison between 26wheat cultivars indicated that number 16 genotype (Rasool) has more complex vascular bundles and more evaluated sieve elements compared with the other cultivars. The Rasool genotype is originated from CIMMYT, which is produced by hybridization between previous generations with high level of fiber in abaxial surface of midrib and thick vascular bundles in the midribs. In addition, Rasool genotype is high temperature tolerant genotype. These characteristics help plants by reducing water loss under drought stress conditions. By contrast, number 2 genotype (Tajan) was less evaluated in terms of vascular bundles properties. In sum, Rasool genotype is highly recommended to be cultivated in central regions of Iran, where drought stress is the most limiting factor for wheat production in drylands.

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10.7251/AGRENG1601143L
UDC 632.95:634.232

DISSIPATION RATE AND RESIDUES OF ACETAMIPRID AND IPRODIONE IN SWEET CHERRY FRUITS

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ABSTRACT

A neonicotinoid insecticide acetamiprid and dicarboximide fungicide iprodione, are used in sweet cherry for control of the major pest (*Rhagoletis cerasi* L.) and pathogen (*Monilia laxa)*. For the purpose of the safe consumption of agricultural products after pesticide application, studies on their dissipation kinetics are essential to work out their half-lives (DT_{50}) and pre-harvest intervals (PHI). However, there is a lack of information on the persistence of acetamiprid and iprodione in sweet cherry fruits in different climatic conditions of production. Therefore, the objectives of this study were to investigate the dissipation and residues of acetamiprid and iprodione in sweet cherry fruits, as well as to evaluate the validity of prescribed PHI for these pesticides. Field experiments were conducted in a sweet cherry orchard, near Novi Sad, where acetamiprid and iprodione were applied at a recommended concentration. At various time intervals, from treatment to harvest, having in mind PHI (14 days for acetamiprid and 7 days for iprodione) representative samples of sweet cherry fruits were collected. Extraction of pesticides was carried out by QuEChERS method, followed by HPLC-DAD analysis. The method was validated in accordance with the SANCO/12571/2013 document and was used the determination of pesticides in real sweet cherry samples. During the study period, the concentration of acetamiprid and iprodione decreased from 0.52 mg/kg to 0.11 mg/kg and from 0.29 mg/kg to 0.07 mg/kg, respectively. The dissipation of acetamiprid and iprodione residues over the time fitted to the equation $C_t=0.52^{-0.22t}$ and $C_t=0.29^{-0.20t}$, with DT_{50} of 3.15 and 3.47 days, respectively. Finally, the content of acetamiprid and iprodione in sweet cherry samples, at the end of PHI, were below the maximum allowed level specified by the Serbian (1.5 mg/kg and 3 mg/kg) and EU MRLs (1.5 mg/kg and 10 mg/kg).

Keywords: *sweet cherry, Acetamiprid, Iprodione, dissipation rate.*

INTRODUCTION

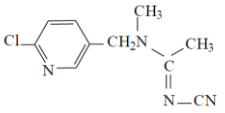
Pesticides use in agriculture is necessary for control a variety of pests in order to ensure higher yields and to improve the quality of agricultural products (Lazić et al., 2016). Monitoring of pesticide residues and check of the accuracy of the required pre-harvest interval (PHI) proved to be necessary. This is especially

important for fruits and vegetables that are mostly consumed fresh, such as sweet cherry. For the control of sweet cherry's major pest (*Rhagoletis cerasi* L.) and pathogen (*Monilia laxa)*, a neonicotinoid insecticide acetamiprid and dicarboximide fungicide iprodione, are used.

Management of pests in sweet cherry orchards largely depends on the use of conventional, neurotoxic, broad-spectrum, synthetic chemical pesticides, such as organophosphates. However, good agricultural practice requires use of products with shorter PHI and more convenient ecotoxicological properties than previously used insecticides (Lazić et al., 2012), such as neonicotinoids.

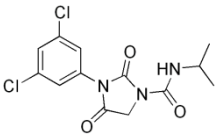
A neonicotinoid insecticide acetamiprid has been introduced as an alternative to organophosphate insecticides for control of major sweet cherry pests (Table 1). In recent years, a number of researches have dealt with the behavior of acetamiprid in different plant (Pramanik et al., 2006; Gupta et al., 2008; Sanyal et al., 2008; Park et al., 2011; Shams El Din et al., 2012; Wu et al., 2012; Romeh et al., 2013). To the best of our knowledge, there is no information related to acetamiprid behaviour in sweet cherry fruits.

Table 1. Physico–chemical properties of acetamiprid

Common name/ molecular formula/CAS No.	**IUPAC name**	**Structure**
Acetamiprid $C_{10}H_{11}ClN_4$ (160430-64-8)	(E)-N1-[(6-chloro-3-pyridyl)methyl]-N2-cyano-N1-Methylacetamidine	

On the other hand, for the control of one of the major sweet cherry pathogen, *Monilia laxa*, the causal agent of blossom and brown rot of stone fruit, iprodione based fungicides are used (Table 2). Iprodione was first manufactured in the 1990s. In cherry orchards, it is used usually in a single pre-harvest application (Savčić-Petrić, 2015). Nowadays, iprodione residues are one of the commonly detected residues in agricultural products (Lentza-Rizos, 1995; Lopez and Riba, 1999; Stensvand and Christiansen, 2000).

Table 2. Physico–chemical properties of iprodione

Common name/ molecular formula/ CAS No.	**IUPAC name**	**Structure**
Iprodione $C_{13}H_{13}Cl_2N_3O_3$ (36734-19-7)	3-(3,5-dichlorophenyl)-*N*-isopropyl-2,4-dioxoimidazolidine-1-carboxamide	

With the aim of consumer's protection, it becomes necessary to know the residual level, the rate of dissipation and half-lives (DT_{50}) of pesticides in agricultural products. However, there is a lack of information on the persistence of these pesticides in sweet cherry fruits in different climatic conditions of production.
Therefore, the objectives of this study were to investigate the dissipation rate and residues of acetamiprid and iprodione in sweet cherry fruits, as well as to evaluate the validity of prescribed PHI for these pesticides.

MATERIAL AND METHODS

Field trials

The field trials were carried out in the orchards in the surrounding of Novi Sad city (Vojvodina province, Serbia). The trials were designed according to OEPP standard for experimental design and data analysis (Anonymous, 2004; Anonymous 2006). Acetamiprid was applied as aqueous solutions of commercial formulation Mospilan 20 SP with 200 g/kg a.i., with a hand sprayer at the manufacturer's recommended concentration of 0.025%. Iprodione was applied as a suspension of commercial formulation Dional 500-SC with 500 g/l a.i. with a hand sprayer at the manufacturer's recommended doses of 1.5 l/ha, during ripening (Savčić-Petrić, 2015).
Sampling was performed by randomly collecting from various places of the experimental plots according to the FAO/WHO recommendations. Around 0.5 kg of the sweet cherries fruit was collected from each replicate and brought to the laboratory. Samples were collected immediately before and after acetamiprid application (when the spraying mixture has dried), and 2, 4, 6, 8, 10, 12 and 14 days after the application. For the iprodione residue analysis, samples were taken immediately before and after fungicide application (when the spraying mixture has dried), and 2, 3, 4, 5, 6 and 7 days after the application.
Every single analytical sample was considered in triplicates. The untreated sweet cherry trees were the sources of the blank sweet cherry samples, used for method validation.

Extraction and determination

Extraction and determination of acetamiprid and iprodione residues from sweet cherry fruits were performed using previously validated QuEChERS-based methods (Lazić et al., 2014; Lazić et al., 2016), followed by HPLC/DAD analysis. Applied methods were completely fulfilled SANCO/12571/2013 criteria. Chromatogram of iprodione from sweet cherry fruit is presented at Figure 1.

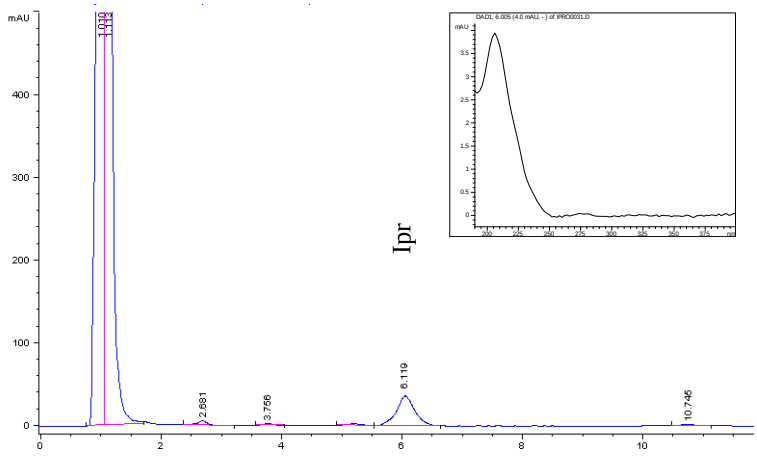


Figure 1. Chromatogram and UV spectra of iprodione in sweet cherry fruit samples

RESULTS AND DISCUSSION

These pesticides provided many obvious benefits in agriculture their inappropriate use can result in unacceptably high levels of these compounds in fruits and vegetables. Although in cases when applied in accordance with good agricultural practices, pesticides may leave residues (Lazić et al., 2014). Since the presence of pesticide residues in fruits and vegetables can affect consumer health, the regulatory authorities have established maximum residue levels of pesticides for most common vegetables and fruits. The European Union and Serbian legislation have specified a maximum residue levels (MRLs) for acetamiprid in sweet cherries of 1.5 mg/kg. From the other hand, till 2015, MRL for iprodine in sweet cherry fruits was 3.0 mg/kg (149/2008), while now it is 10.0 mg/kg (2015/400). Iprodione residue in sweet cherry allowed by Serbian legislation (Official Gazette 29/2014) is 3.0 mg/kg.

The results of the field studies conducted in our research are shown in figure 2 and 3.

The initial deposit of acetamiprid in sweet cherry fruits was 0.52 mg/kg. In this case, as well as during iprodione application, immediately after drying deposit the concentration of acetamiprid in sweet cherries was lower than the MRL of 1.5 mg/kg, according to EU and Regulations of the Republic of Serbia from 2014 (Official Gazette 29/2014). The average content of acetamiprid residues determined in samples collected on the second day after its application was 0.36 mg/kg with standard deviation of 0.01 mg/kg. Subsequently, residues decreased slowly and at the intervals of 4, 6, 8, 10, 12 and 14 days after treatments, the estimated residues were from 0.31 mg/kg to 0.11 mg/kg.

Acetamiprid content below the maximum permitted level of 0.2 mg/kg, defined by Regulations of the Republic of Serbia from 2010 (Official Gazette 25/2010), was established in samples collected eight days after the insecticide application.

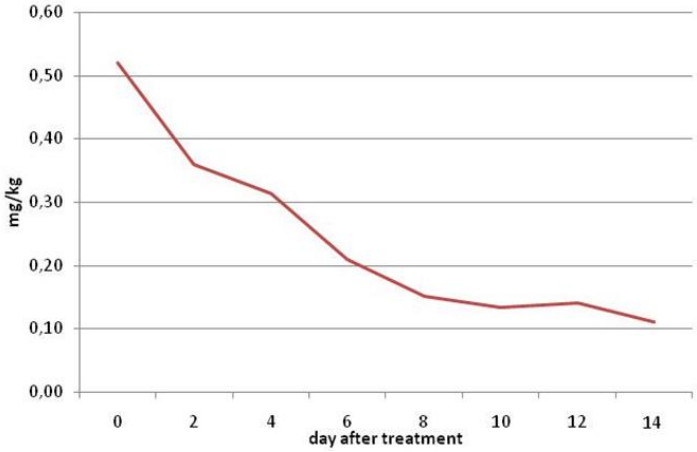


Figure 2. Residues of acetamiprid in sweet cherry fruits during PHI

The highest residue level of iprodione was found in samples taken in the first sampling time, 1 h after the fungicide application. Throughout the experiment residue levels of iprodione had been decreasing, reaching levels below 0.29 and 0.09 mg/kg.

Having in mind newly prescribed, as well as the previous MRLs, the highest quantity of the present iprodione was significantly below these values. In samples collected on the first day after the treatment, the average value of iprodione residues in sampled sweet cherries was 0.23 mg/kg. Further analysis established reduction in iprodione content in sampled fruits, and after the PHI, iprodione quantity was reduced for 0.07 mg/kg.

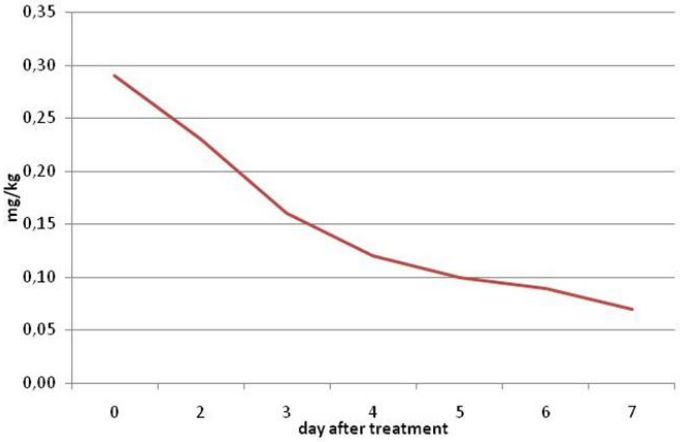


Figure 3. Residues of iprodione in sweet cherry fruits during PHI

The dissipation kinetic of the acetamiprid and iprodione in sweet cherry was determined by plotting residue concentration against time. The half-life of pesticides calculated using the first order rate equation:

$C_t=C_0e^{-kt}$

where Ct represents the concentration of the pesticide residue at time t, C_0 represents the initial concentration and k is the rate constant per day. Half-lives (DT_{50}) were determined from the k value, $DT_{50}=ln2/k$ (Gupta et al., 2008).

The dissipation of acetamiprid residues over the time fitted to the equation $C_t=0.52^{-0.22t}$, with DT_{50} of 3.15. In recent years, a number of researches have dealt with the behaviour of acetamiprid in plant products, with lack of information about acetamiprid in sweet cherries. Pramanik et al. (2008) established that acetamiprid half-life in mustard plants is 1.02 days, while acetamiprid half-life in made tea was 1.84–2.33 days (Gupta et al., 2008). Half-lives of acetamiprid determined in tomato and cucumber fruits were 1.04 and 1.18 days, respectively (Shams El Din et al., 2012). Analysis of acetamiprid residues in zucchini grown under greenhouse conditions were performed by Park et al. (2010). DT_{50} of acetamiprid achieved in this experiment was 1.9 days.

In this study, the first-order kinetic equations determination coefficient (R^2) for iprodione in sweet cherry was 0.929 ($C_t=0.29^{-0.20t}$). The change in iprodione residue concentrations in cherry samples indicated half-life of 3.47 days. Wang et al. (2012) established that the half-life of iprodione in green tobacco leaves was 5.64-8.80 days. In the study performed by Salghi et al. (2013), iprodione residue levels in the peach fruits ranged between 0.52 and 0.06 mg/kg and after the PHI were below the legal limits. Analysis of iprodione residues in tomato grown under greenhouse conditions was performed by Omirou et al. (2009), with DT_{50} of 6.8 days.

CONCLUSIONS

In this study, dissipation rates of acetamiprid and iprodione in sweet cherry fruits were evaluated under field conditions, after pesticides application at recommended doses. The highest residue levels of iprodione and acetamiprid, found in cherry samples taken in the first sampling time, 1 h after pesticides application, was 0.29 mg/kg and 0.52 mg/kg, respectively and were far below established MRLs. In addition, the results showed that the insecticide acetamiprid and fungicide iprodione in sweet cherry fruits declined rapidly, and had relatively short half-life values.

ACKNOWLEDGEMENTS

The authors acknowledge the financial supports received from the Ministry of Education and Science, the Republic of Serbia, grant TR31038.

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10.7251/AGRENG1601151N
UDC 636.4:539.16(497.7)

DETERMINATION OF NATURAL RADIONUCLIDE IN PIG PRODUCTION CHAIN IN MACEDONIA BY GAMMA SPECTROMETRY

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ABSTRACT

Exposure of animals to ionizing irradiation may be a important pathway for transfer of radionuclides to human food chain, thereby adding to the exposure burden. Therefore, radiation control of animal feeds and animal products will reduce risk for radioactive hazards to human health. The study was carried out in order to detect the natural radioactivity in edible parts of pigs, excrements and feeds in one commercial pig breeding farm in Macedonia. Therefore, ^{40}K, ^{212}Pb, ^{214}Pb, ^{228}Ac, ^{235}U, ^{241}Am, ^{212}Bi, ^{214}Bi, ^{232}Th, ^{7}Be and ^{226}Ra were measured using gamma spectrometry. Gamma spectrometer Canberra Packard with a high-purity germanium detector and Marinelli beakers (1 l capacity) were used for the samples measurement. The most prominent gamma energies observed in the spectra belonged to the naturally occurring radionuclides ^{40}K, ^{235}U and ^{232}Th. Other nuclides if present occurred infrequently at low levels. The result show that ^{40}K made the largest contribution to the specific radioactivity in all the samples. The mean activity concentration of the ^{40}K in edible organs (kidney and liver), muscle, excrements and feeds was: 73.39±9.109 Bq/kg; 111.26±3.88 Bq/kg; 298.80±38.51 Bq/kg; 83.60±10.279 Bq/kg, respectively. The ^{235}U and ^{232}Th were detectible only in feed samples (0.53±0.293 Bq/kg; 163.69±23.791 Bq/kg, respectively) and samples from excrements (0.25±0.021 Bq/kg; 58.17±1.062 Bq/kg, respectively). The other radionuclides were detected only in few samples and the measured activities were below the detection limit. If we take in consideration the activity concentration of the most frequently occurred ^{40}K found in all samples, than there was statistical significant difference between radioactivity concentration in organs, muscle, excrements and feeds ($p<0.001$).

Key words: *gamma spectrometry, pig production, radioactivity*.

INTRODUCTION

Numerous sources of ionizing radiation can lead to human exposure: natural sources, nuclear explosions, nuclear power generation, use of radiation in medical industrial and research purposes, and radiation-emitting consumer products. Before assessing the radiation dose to the population one requires a precise knowledge of the activity of a number of radionuclides. In different amounts, natural radioactivity has great contributions in ionizing radiations to the world population due to its natural presences in environment (Rahman and Faheem, 2008). Environmental pollution is a global problem arising from rapid industrialisation and modern technological practices. Human activities such as agricultural practices and livestock production are among the leading factors that enhance increased environmental pollution.

Radionuclides are present in the environment either naturally or artificially due to atmospheric nuclear weapon testing and to a series of nuclear accidents. Therefore, radionuclides which can be found in the environment can be divided into three groups: naturally occurring nuclides of very long half-life, naturally occurring nuclides which have short half-lives and radionuclides released into the environment owing to man's activity and accidents. As radioactive materials transfer from the environment to agricultural, livestock and fishery products, radioactive contamination of foods and its health effects have become great concerns for the people (Ramasany et al., 2006; Kaplan et al., 2011).

Plants, in general, may accumulate radionuclides depending on many factors including species, tissue type, soil-water-plant relationships, soil type, and the chemical nature of the radionuclide in the soil. Based on study by Arogunjo et. al. (2005) contamination of the food chain is resulting from direct deposition of these radionuclides on plant leaves, root uptake from contaminated soil or water and animals that ingesting contaminated plants, soil or water. In any accidental releases of radioactivity cases into the environment, a potential of widespread and long-term contamination on the agricultural land need to be suspected and consequently a potential long-lasting impact on food. This situation required the development of the monitoring network in the agricultural field especially in the contaminated area to maintain a safe food produced. A method that describes this accumulation in a plant is called the "*concentration ratio"* (CR) (Mortvedt, 1994).

Consumption of food is usually the most important route by which natural and artificial radionuclides can enter the human body. The foods of animal origin are largely represented in the human diet and the key transfer pathway to animals is ingestion of contaminated feed. Fortunately, the gastro-intestinal tract of humans and animals excludes 80% or more of radionuclides (Roessler et al., 1991). Within animals and humans, certain tissues tend to accumulate selected radionuclides. This information can help with dietary choices (e.g. avoiding the consumption of animal organs that accumulate radionuclides) and as in the calculation of dose, as well.

Recently, there has been a growing concern about the effect of low level radioactivity on human health. There is a current lack of information on activity concentrations in animal feed and edible tissues from pig body. Additionally,

analyzing the animal excrements is giving an opportunity to determinate the circulation of natural radionuclides in environment.

MATERIAL AND METHODS

In order to measure the specific activity of natural radionuclides in edible tissues of pigs body (kidney, liver and muscle) and moreover excrements and feeds in pig production chain, there was performed a survey in one commercial pig breeding farm in the eastern part of Macedonia. The samples were collected from died animals on-farm and from feed used on farm. The fresh pig manure from the farm was collected for analyzing the activity concentration of natural radionuclides. The collected samples were weighed individually (weight 1 kg) and the measurement of radioactivity was done on fresh samples in Marinelli-beakers containers from 1 liter. A total of 23 samples were analyzed.

The spectral analysis of the radionuclides of these samples was conducted by applying a γ-ray spectrometer with high purity germanium (HPGe) detector with 30% relative efficiency and energy resolution (FWHM) of 1.8 keV for 1.33 MeV reference passage of ^{60}Co (Verdoya et al., 2009).

The detector was protected with 9 cm-thick lead with an internal line with a 0.5 cm-thin copper panel covered by 1 mm aluminum in order to absorb the x-rays from the lead and the copper. The internal size of the cavity of the shell was 30 x 30 x 30 cm. The detector was given a high voltage through a preamplifier which was then connected to an amplifier with a computer based channel analyzer through an ADC (analogue to digital converter). The software used for obtaining the data is Canberra software package Genie-2000, including search of maximum value and modules for identification of nuclides. The system was regularly calibrated for energy and efficiency. The prepared Marinelli glasses (samples) were placed on a final detector at a distance of approximately 10 mm. Every sample was measured within a period of around 62000s in order to get good statistics and the constant time was lower than 10%. The measurements with an empty Marinelli glass, in identical conditions were also conducted in order to determine the basic recounts. Then they were deducted from the measured spectrums of every sample in order to obtain the net activities of the radionuclides.

The data were grouped according to the type of sample and redionuclide (each sample for similar edible tissue, feed or excrements represent separate group). Statistical analysis was carried out using descriptive methods and ANOVA.

RESULTS AND DISCUSSION

The results of the natural radioactivity measurements on the above samples are given in Table 1. All the concentrations are reported in Bq/kg for the samples from the different edible tissues of pigs (kidney, liver and muscle) and moreover the samples from the excrements and feeds for determination of natural radionuclides distribution. The concentration activity is reported as arithmetical mean and the relevant standard deviation.

Table 1. Activity concentration of natural radionuclides (Bq/kg)

	time (sec)	^{40}K	^{235}U	^{232}Th	^{212}Pb	^{214}Pb	^{228}Ac	^{241}Am	^{212}Bi	^{214}Bi	^{7}Be	^{226}Ra
Liver and kidney	64288.67± 10339.291	73.39± 9.109			4.441				1.700			
Muscle	80146.00± 10343.168	111.26± 3.88										
Excrement	78231.65± 4867.182	83.60± 10.279	0.25± 0.021	58.17± 1.062	0.512	0.400	1.043			0.486	2.200	
Feeds	41587.86± 27268.966	298.80± 38.51	0.53± 0.293	163.69± 23.791	0.632	0.56± 0.883	1.321	0.283	1.372	0.585	1.498	8.957
Total	61872.94± 21957.474	148.71± 104.411	0.45± 0.275	121.48± 60.195	1.86± 2.235	0.50± 0.109	1.18± 0.196	0.283	1.54± 0.231	0.54± 0.070	1.84± 0.496	8.957

In all examined samples, the ^{40}K made the largest contribution to the specific radioactivity. Their activity concentration ranged from 73.39±9.109 in liver and kidney up to 298.80±38.51 in feeds. Similar fundings were published by Ban-nai et al. (1997), Ventiru and Sordi (1999) and Badran et al. (2003). Akinloye et al. (1999) reported that the pork meat has the highest mean activity concentration of ^{40}K in comparison with beef and poultry meat. The same authors reported that the highest mean activity concentration of ^{226}Ra was recorded in goat meat while wasn't detectible in pork and beef meat. Further, certain animal organs do not accumulate radium (Ra-226) or lead (Pb-210) (e.g. kidney and muscle), while other tissue may (e.g. bone). Thus, humans consuming pig muscle tissue (pork) will be exposed to lowered concentrations of radionuclides than actually ingested by the pig simply because the radionuclides accumulated in the bone.

Recent research published by Meli et al. (2013) reported that the mean ^{40}K activity concentration was 415±55.9 Bq/kg and ranged from 207±12.4 Bq/kg (pig) to 578±34.7 Bq/kg (deer). ^{214}Pb and ^{214}Bi, indicators of ^{226}Ra, have been detectable in the 33.1% of examined samples. The ^{235}U and ^{232}Th were detectible in feed samples and activity concentration was 0.53±0.293 Bq/kg; 163.69±23.791 Bq/kg, respectively. The activity concentration of ^{235}U and ^{232}Th in excrement samples was 0.25±0.021 Bq/kg and 58.17±1.062 Bq/kg, respectively. The other radionuclides detected only in few feed samples, has the following measured activity: 0.632 Bq/kg for ^{212}Pb, 0.619 Bq/kg for ^{214}Pb, 1.321 Bq/kg for ^{228}Ac, 0.283 Bq/kg for ^{241}Am, 1.372 Bq/kg for ^{212}Bi, 0.585 Bq/kg for ^{214}Bi, 1.498 Bq/kg for ^{7}Be and 8.957 Bq/kg for ^{226}Ra. The measured activity concentration of the other radionuclide found in excrements sample was: 0.512 Bq/kg for ^{212}Pb, 0.400 Bq/kg for ^{214}Pb, 1.043 Bq/kg for ^{228}Ac, 0.486 Bq/kg for ^{214}Bi and 2.200 Bq/kg for ^{7}Be. If the activity concentration of the most frequently occurred ^{40}K that is found in all samples is taken into account, it can be concluded there is statistical significant difference between radioactivity concentration in organs, muscle, excrements and feeds ($p<0.001$). The highest statistically significant difference in activity concentration of ^{40}K was found between excrements samples and other examined samples (Table 2).

Table 2. Bonferoni test for difference in mean values of activity concentration of ^{40}K in samples

	Muscle	**Feeds**	**Excrement**
Liver and kidney	37.874	225.416*	10.210
Muscle		187.542*	27.663
Feeds			215.205*

The figure 1 represents the chart of activity concentration of radionuclides in samples.

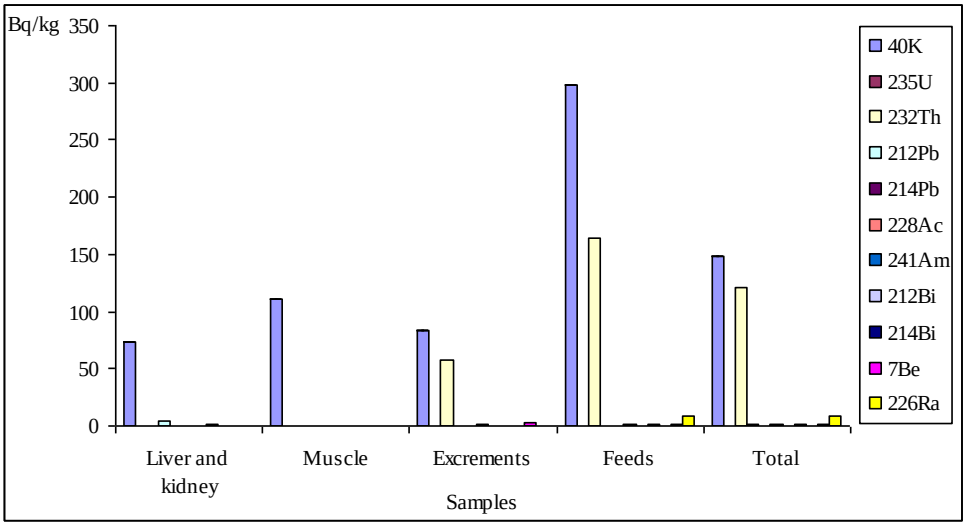

Figure 1. Activity concentration of naturally occurred radionuclides in pig production chain

Recently, more attentions have been focusing on the concept of "from farm to fork" adapted into researches as an effort to reduce the contamination of foods by concentrating on source-directed measures. Preventing contaminated raw materials from entering the food chain are more effective to ensure the food safety compared to conventional market control. In a radiation situation, the availability of uncontaminated food and food raw materials to consumers and to the entire production chain is a challenge, especially during the growing season (Rantavaara et al. 2005).

CONCLUSION

Radiometric control of products involved in the food chain is an important part of ongoing quality control of products related to food and feed. The data obtained from our analyses provide information on the background activity concentration of natural radionuclides in pig production chain. The ^{40}K made the largest contribution to the specific radioactivity in the pig production chain. The other radionuclides, ^{212}Pb, ^{214}Pb, ^{228}Ac, ^{241}Am, ^{226}Ra ^{214}Bi, ^{7}Be ^{212}Bi, were detected only in few feed samples. The radionuclide found in excrement samples were ^{212}Pb, ^{214}Pb, ^{228}Ac, ^{214}Bi and ^{7}Be.

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10.7251/AGRENG1601157S
UDC 632

AMMI VERSUS NONPARAMETRIC ANALYSIS FOR INVESTIGATION OF GE INTERACTION OF PLANT DISEASE EVALUATION

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ABSTRACT

In breeding for plant disease resistance programs, a large number of new improved genotypes are tested over a range of test pathogens or environments and the underlying statistics used to model this system may be rather complicated. Due to ordinal nature of most measured traits of disease responses, some nonparametric methods used for analyzing genotype × environment (GE) interaction in two datasets for disease severity of gray leaf spot of maize (with ten genotypes planted in 10 and 11 environments). Usually, the presence of the GE interaction effect complicates the selection of the most favorable genotypes and there are several statistical procedures available to analyze these dataset including a range of univariate, nonparametric and multivariate procedures. Present analysis separated nonparametric methods based on dynamic concept from those which are based on the static type indicated that RS statistic following to S6, NP2, NP3 and RS statistics were found to be useful in detecting the non-complicated phenotypic stability in disease severity dataset. In complicated GE interaction, the ability of AMMI stability parameters especially SPC1, SPCF, D1, DF, EV1, EVF and ASV statistics were high in the detection of stability in complicated GE interaction. In general, nonparametric methods are useful alternatives to parametric methods and allow drawing valid conclusions with considerably better chances of detecting the GE interaction in experiments of plant pathology. Also, in some cases the GE interaction structure is too complex to be summarized by only one parameter and so, it is essential to use multivariate statistical methods like AMMI.

Keywords: *stability analysis, disease severity, ranked based dataset, principal components analysis.*

INTRODUCTION

Plant breeders investigate yield performance of new genotypes in various referred to as multi-environmental trials, so as to determine not only whether or not the environment affects the magnitude of the target trait of the host genotypes, but also differences of the values in the corresponding magnitudes to various genotypes (Flores et al., 1998). These trials can focus on characterizing properties of the host genotypes or environments as host genotype × environment (GE) interaction is considered to be among the major factors limiting response to selection and

efficiency of evaluation programs in plant pathology. Yan and Falk (2002) emphasized the importance of the nature of host × pathogen interaction and the fact that it be difficult and challenging to investigate the interaction. There are numerous statistical methods to characterize the GE interactions which require dataset of normal distribution while the characterization of the host genotypes across pathogens is performed mostly by ranking and ordinal scales (Sabaghnia et al., 2006). Nonparametric statistical methods are independent of any assumption about the distribution of observations and thus can be useful alternatives to routine classical statistical methods (Sabaghnia et al., 2014). These methods need fewer assumptions about the data and in many cases, allow one to grasp valid conclusions with considerably better chances of detecting differences among host genotypes, environments or GE interactions. The characterization of host genotypes across pathogens requires the use of nonparametric methods which proposed by Huehn (1979).

The above statistics belongs to univariate parametric methods while multivariate methods such as additive main effects and multiplicative interactions (AMMI) model analysis which introduced by Zobel et al. (1988). According to significant number of PCAs, different AMMI parameters could be computed for stability analysis including EV1 and EVF (Zobel, 1994) as the averages of the squared eigenvector values, SPC1 and SPCF which describe the contribution of environments to GE interaction (Sneller et al. 1997), D1 and DF as the Euclidean distance from the origin of significant interaction PCAs axis as D parameter (Annicchiarico, 1997), and AMMI stability value (ASV) that derived from first two PCAs of AMMI model to quantify and rank genotypes according their yield stability (Purchase, 1997). The number of investigations which have used AMMI and nonparametric statistics have increased sharply in plant breeding. What is yet to be produced, however, is an evaluation and comparison of various AMMI stability parameters with several nonparametric statistics for the GE interaction analysis in plant pathology. This study combines theoretical considerations with empirical studies to provide such a comparison will enhance pathologists as well as breeders' understanding of nonparametric analysis of the GE interaction.

MATERIAL AND METHODS

The dataset contained data on disease severity for gray leaf spot of maize for 10 northern-adapted maize genotypes in 10 environments was used. Also, disease severity for gray leaf spot of maize, caused by *Cercospora zea-maydis,* for 10 southern-adapted maize genotypes in 11 environments was used. The disease severity of gray leaf spot was recorded at dough-dent growth stage on a 0 to 100% scale. Corresponding experiments are described in detail by Madden et al. (2007). Huehn (1979) developed firstly six nonparametric measures by using rank of genotypes in environments. Huehn (1990) used corrected ranks by removing genotype main effect to obtain independence from genotypic effects for the $S_i^{(1)}$ and $S_i^{(6)}$ and a new nonparametric statistics as $S_i^{(2)}$ while we use term $S_i^{(7)}$ with

this formula for discrimination from the previous $S_i^{(2)}$. Kang's (1988) rank-sum (RS) is another nonparametric stability statistic where both mean performance and stability variance (Shukla, 1972) are used as selection criteria. This statistics assigns a weight of 1 to both mean yield and stability and enables the identification of highly yielding and stable genotype. Thennarasu (1995) proposed the use of these nonparametric statistics based on the classification of genotypes in various environments.

In these methods, genotypes of low NPs values are considered as stable genotypes with the low GE interaction. The model AMMI analysis was used to investigate GE interactions. Zobel (1994) suggested the two EV1 and EVF stability parameters of AMMI and for EVF, the number of significant PCs via F test were used. The lower the PC scores, the more stable a genotype is to environments and so SPC1 and SPCF stability parameters of AMMI are sums of the absolute value of the PC scores for each genotype. Another stability parameter of AMMI according to the blow equation was proposed by Annicchiarico (1997). AMMI's stability value (ASV) was calculated using as suggested by Purchase (1997). The AMMI stability parameters were compared using their ranks for each genotype via calculating Spearman's rank correlation.

Table 1. The AMMI and nonparametric stability statistics of disease severity for gray leaf spot of maize (10 southern-adapted maize genotypes in 11 environments)

	DS	EV1	D1	SPC1	EVF	DF	SPCF	ASV	S1	S2	S3	S4	S5	S6	S7	NP1	NP2	NP3	NP4	RS
G1	37.8	0.376	26.3	4.02	0.821	31.8	8.0	5.2	0.45	0.12	0.89	0.33	0.35	2.9	0.31	0.32	0.32	0.29	0.33	14.3
G2	33.9	0.397	27.0	4.13	0.780	31.7	0.3	5.3	0.78	0.58	3.11	0.73	0.51	3.02	1.03	0.5	0.25	0.41	0.27	13
G3	18.7	0.017	5.5	-0.85	0.532	14.5	-6.5	2.3	2.96	5.95	11.29	2.33	2.16	4.5	2.51	2.09	0.35	0.45	0.56	6.2
G4	21.5	0.003	2.4	-0.37	0.349	19.7	1.6	3.2	1.6	1.95	3.8	1.33	1.02	2.18	1.75	0.95	0.19	0.26	0.3	8.4
G5	21.2	0.038	8.4	-1.28	0.289	17.5	-0.1	2.8	2.05	2.73	5.36	1.57	1.46	3.16	1.69	1.45	0.29	0.33	0.41	8.8
G6	21.6	0.038	8.4	-1.28	0.176	12.2	-2.4	2.0	1.71	1.82	3.74	1.29	1.1	2.49	1.5	1	0.22	0.28	0.33	9
G7	20.5	0.008	3.9	-0.59	0.284	16.2	-1.0	2.6	1.71	2.16	3.47	1.4	1.07	1.9	1.83	1	0.15	0.23	0.25	9.4
G8	18.7	0.013	5.0	-0.76	0.049	6.3	0.4	1.1	2.42	3.79	5.52	1.86	1.63	2.61	2.11	1.55	0.21	0.28	0.34	8.8
G9	7.7	0.038	8.3	-1.27	0.541	10.5	1.0	1.9	1.33	1.71	1.88	1.25	0.88	1.07	1.76	0.77	0.08	0.14	0.14	2.4
G10	6.0	0.071	11.5	-1.75	0.180	12.8	-1.3	2.3	1.02	0.46	0.49	0.65	0.61	0.73	0.68	0.59	0.06	0.07	0.09	1.9

Table 2. The AMMI and nonparametric stability statistics of disease severity for gray leaf spot of maize (10 southern-adapted maize genotypes in 11 environments)

	DS	EV1	D1	SPC1	EVF	DF	SPCF	ASV	S1	S2	S3	S4	S5	S6	S7	NP1	NP2	NP3	NP4	RS
G1	40.0	0.040	15.8	-1.78	0.481	25.6	1.9	5.9	0.7	0.38	2.21	0.59	0.47	3.03	0.73	0.45	0.3	0.39	0.8	14.6
G2	40.2	0.059	19.2	-2.16	0.131	20.8	-3.6	5.8	0.87	0.56	2.81	0.71	0.6	3.33	0.84	0.6	0.34	0.4	0.82	14.8
G3	22.1	0.061	19.5	2.20	0.201	22.6	4.3	6.1	2.32	3.79	7.5	1.85	1.75	3.85	1.95	1.75	0.44	0.42	0.69	8.1
G4	22.6	0.015	9.7	-1.09	0.061	11.7	-2.3	3.1	2.32	3.45	6.54	1.76	1.65	3.47	1.88	1.65	0.37	0.39	0.59	8.9
G5	19.5	0.026	12.7	-1.43	0.104	15.3	-3.0	4.0	2.06	2.97	4.42	1.63	1.45	2.4	1.84	1.45	0.23	0.27	0.55	7.8
G6	20.7	0.029	13.3	-1.50	0.029	13.3	-1.6	3.9	2.19	2.5	4.46	1.5	1.36	2.69	1.66	1.35	0.27	0.35	0.47	7.0
G7	17.4	0.082	22.5	-2.54	0.185	24.6	-4.3	6.8	2.82	5.02	6.84	2.12	2.0	3.03	2.26	2.0	0.3	0.35	0.59	4.7
G8	16.0	0.040	15.7	-1.77	0.130	18.1	-0.1	4.9	1.94	2.59	3.09	1.53	1.55	2.05	1.5	1.55	0.21	0.21	0.43	5.6
G9	13.7	0.366	47.6	5.37	0.373	47.7	4.9	13.9	1.8	2.47	2.64	1.49	1.24	1.48	1.79	1.1	0.12	0.18	0.67	4.0
G10	13.6	0.281	41.7	4.71	0.306	42.0	3.9	12.2	1.76	2.61	2.7	1.53	1.2	1.38	1.96	1.2	0.13	0.18	0.68	5.2

RESULTS AND DISCUSSION

Table 1 reports 7 AMMI stability parameters and 12 nonparametric statistics based on original dataset including as well as mean of disease severity (DS) of gray leaf spot of the first dataset. In most of the above statistics, the genotype G10 was the most stable genotype (with low magnitude of the GE interaction) followed by the genotype G9, while their disease severity was relatively low. In contrast, according to most of the AMMI stability statistics, the genotypes G6 and G8 were the most stable genotypes with their disease severity been low or moderate. Most of the nonparametric statistics succeed to recognize low disease severity performance genotypes as the most stable ones, while most of the AMMI stability statistics failed to recognize the most favorable genotypes corresponding to low-performance GE interaction (Table 1). Similar to the first dataset, the results of corresponding nonparametric statistics as well as the AMMI stability parameters and mean of disease severity of gray leaf spot are given in Table 2. Considering all of the statistics, the genotype G6 followed by the genotype G8 exhibited low GE interaction with relatively moderate and low disease severity performance. Considering most of the nonparametric statistics, the genotype G9 followed G1 exhibited the highest stability with relatively low to moderate disease severity performances (Table 2). Also, according to the AMMI stability statistics, the genotype G4 followed by the genotype G6 were found to be the most stable genotype with its disease severity been high or moderate (Table 2).

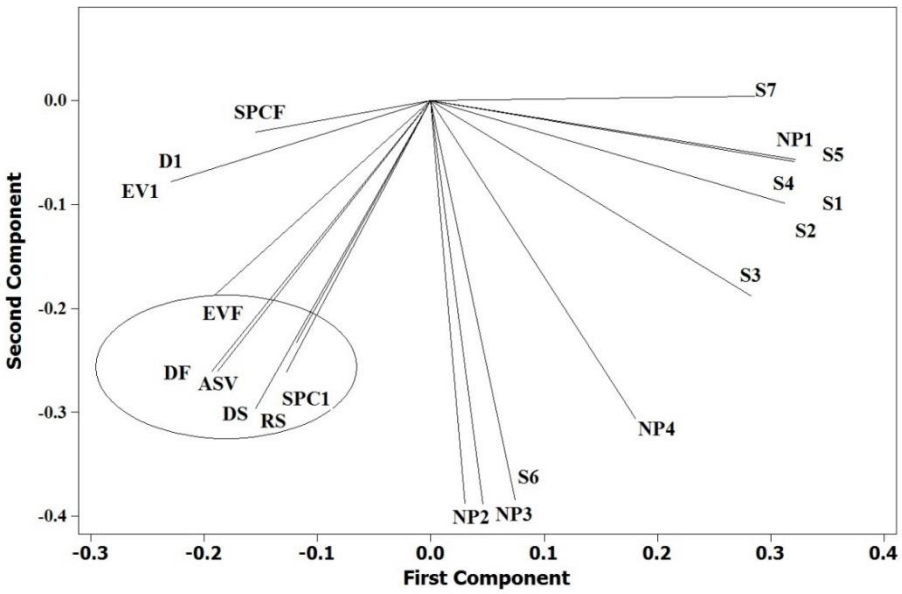

Figure 1. Plot of the first two principal components of ranks of host genotype × environment interaction for disease severity, estimated by AMMI and nonparametric methods using yield data from gray leaf spot of maize (10 northern-adapted maize genotypes in 10 environments)

With each AMMI and nonparametric measures producing a unique genotype, the Spearman's rank correlations were performed between each pair of the measures (results are not shown). Results demonstrated a highly significant positive rank correlation between disease severity performance with RS, ASV and DF measures at the first dataset (10 northern-adapted maize genotypes in 10 environments), while there was highly significant positive rank correlation between disease severity performance and NP2, NP3, RS, and S6 measures at the second dataset (10 southern-adapted maize genotypes in 11 environments). To better understand the relationships among the nonparametric measures, a principal component analysis (PCA) was performed on the rank correlation matrix. When applying the PCA, the two first factors explained 70.9% (40.1 and 30.8% by PC1 and PC2, respectively) of the variance of the original variables in the second dataset and 75.9% (46.7 and 29.2% by PC1 and PC2, respectively) of the variance of the original variables in the second dataset. The relationships among different nonparametric statistics are graphically displayed in a plot of PC1 and PC2. In this plot which is drawn based on the first dataset, the PC1 axis mainly distinguishes other stability methods from the SPC1, SPCF, D1, DF, EV1, EVF, ASV and RS in the first dataset (Fig. 1). Mean of disease severity performance (DS) is grouped near the above mentioned statistics. In the second dataset, the PC1 axis mainly distinguishes other nonparametric methods from SPC1, SPCF, D1, DF, EV1, EVF, and NP4 statistics (Fig. 2). Also, the PC2 axis mainly distinguishes the RS, NP2, NP3 and S6 statistics, as the one group from other nonparametric methods (Fig. 2). Mean of disease severity (DS) grouped near them statistics in the second dataset (Fig. 2).

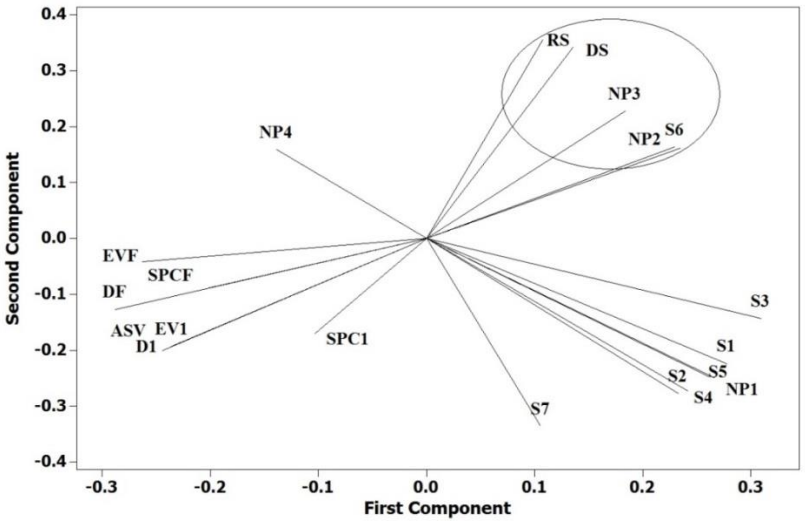

Figure 2. Plot of the first two principal components of ranks of host genotype × environment interaction for disease severity, estimated by AMMI and nonparametric methods using yield data from gray leaf spot of maize (10 southern-adapted maize genotypes in 11 environments)

The phenomenon of significant GE interaction can reduce the usefulness of subsequent analyses, and limit the significance of inferences especially in quantitative or multi-gene controlling traits such as disease tolerance. Fig. 1 indicated the first PC separates the SPC1, SPCF, D1, DF, EV1, EVF, ASV and RS statistics as well as mean of disease severity (DS) from other methods in the first dataset while Fig. 2 showed the first PC separates the S1, S2, S3, S4, S5, S6, S7, NP1, NP2, NP3 and RS statistics as well as mean of disease severity (DS) from other methods in the second dataset. The nature of GE interaction in the fist dataset is relatively more complex due to significance of four PCs while in the second dataset, the nature of GE interaction is relatively simple because only first two PCs were significant. Therefore, it could be conclude that in non-complicated GE interaction of ranked data, S6, NP2, NP3 and RS stability statistics are suitable for detection of GE interaction but in more complex complicated condition it is better to use AMMI stability parameters like SPC1, SPCF, D1, DF, EV1, EVF and ASV statistics. It is interesting that, in both conditions, RS could discriminate the most stable genotypes ignoring the complicated or non-complicated GE interaction. There are two major forms of GE interaction including additive and crossover types. Truberg and Huehn (2000) recommended for an analysis of additive GE interactions, nonparametric procedures of Hildebrand (1980) and Kubinger (1986) are suitable while for exploring crossover GE interaction, the method proposed by de Kroon and van der Laan (1981) is proper. Such data analysis can indicate differences in pathogen populations (or aggressiveness) or weather conditions among environments were great or not great enough to affect rank order of genotypes in terms of disease responses.

The nonparametric rank-based procedures serve as convenient tools to detect situations where the ranks do change with environment and can be used for any study where the same set of treatments are tested in various environments. The AMMI stability parameters were as an effective tool in understanding complex GE interactions. Also, besides differences in crops and regions (climatic conditions, soil properties etc.), the observed GE interactions may be partly explained by the structure of the dataset that was considered and by the selection of the genotypes (Sabaghnia et al. 2013), because multivariate techniques are most appropriate for explaining the multidimensional nature of GE interaction. Application of AMMI or nonparametric procedures can overcome to the problems dealt in univariate parametric methods when data is more or less problematic. Main features of nonparametric procedures include their simplicity, ease of computation and the development of a well understanding on the meaning of the GE interaction and main benefits of AMMI stability parameters include their ability to detection of complicated GE interaction.

CONCLUSION

Followed by RS measure, S6, NP2, NP3 and RS statistics were found to be useful for the detection of phenotypic stability in disease severity dataset in simple GE

interaction while SPC1, SPCF, D1, DF, EV1, EVF and ASV statistics were found to be useful for the detection of stability in complicated GE interaction.

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10.7251/AGRENG1601167Z
UDC 631.51(47)

INFLUENCE OF TILLAGE TECHNIQUES FOR OLD-AGE GALEGA ORIENTALIS GRASS STAND ON AGRO-PHYSICAL AND MICROBIOLOGICAL INDICATORS OF SOIL IN MIDDLE PREDURALIE (RUSSIA)

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ABSTRACT

The paper presents the results of investigations conducted in 2013 on the experimental and training field of the Perm State Agricultural Academy with the aim to reveal the influence of rejuvenation agro-techniques for perennial grass stands on thickening processes in sod-podzolic soils of Middle Preduralie (Russia). The authors consider dependence of grass stand thinning on different tillage techniques, give data on calculating illumination, light brightness and air temperature in ground surface layer. As investigation object was used partly thinned 13 year old galega orientalis grass stand which is considered to be inapplicable for large scale production. Conducted investigations revealed the dynamics of root system recovery of old-age galega orientalis grass stands for subsequent involvement of degraded grass stands into production with sustainable green mass yield and to produce seeds. Under influence of different rejuvenation techniques the illumination of grass stand changed and as a result growth conditions altered. That leads to alteration in agro-physical and agro-biological factors that favor yield formation. Implemented techniques improved illumination and permeability of sun radiation to the soil surface that increases soil temperature and favorably influences the symbiosis of legumes with resistant microorganisms and root system growth. Root system entirely covers arable layer structuring it, increases the area for nutrition as well as decreases heavy clay soils overcrust creating optimal conditions for growth of nitrogen fixing microorganisms and development of perennial legume grasses. This technology is energy saving and leads to cost reduction and increase of profitability.

Keywords: *old-age grass stands, galega orientalis, rejuvenation, illumination, soil temperature*

INTRODUCTION

In Middle Preduralie, perennial legume grasses take large areas and play a significant role in increase of productivity of arable land and in increase of production of fodder with high protein content and balanced nutritional qualities.

Traditional for the Urals grasses are meadow clover and lucerne which represent the only source of plant protein in the region. Scientific research and best production practices already proved possibility to cultivate in Middle Preduralie soboliferous grass – galega orientalis, which as ecologically flexible plant easily fits to regional agro-climatic conditions and forms high yields (Ganzhara et al., 2002; Zubarev, 2003). In Permskii krai there exist lots of areas of old-age perennial legume grasses and their grass mixtures with cereals that can be rejuvenated (Zubarev et al., 2003). However, this issue requires more detailed study and development of a practical rejuvenation technique of grass stand in production and in science in general.

MATERIALS AND METHODS

In the field experiment, rejuvenation of perennial legume grasses was implemented mechanically on the experimental and training field of the Perm State Agricultural Academy in 2013. Agro-technique in the experiment complies with scientific system of agriculture recommended for Middle Preduralie. Disking of soil was done by the heavy disc harrow BDT-3, subsurface cultivating – by the combined subsurface unit APK "Leader – 4" in the beginning of vegetation in 2013. Partly thinned 13 year old grass stand of galega orientalis was used as investigation object. The experiment was on sod-not deep podzolic middle loamy soil with the arable layer 0-24 cm. The experiment scheme was as following: 1 – control (untapped grass stand); 2 – one-track disking; 3 – two-track disking; 4 – one-track subsurface cultivating at 10 – 12 cm; 5 – two-track subsurface cultivating at 10 – 12 cm; 6 – one-track subsurface cultivating at 16 – 18 cm; 7 – two-track subsurface cultivating at 16 – 18 cm.

RESULTS AND DISCUSSIONS

Immeasurably huge amount of light energy provided for the earth by the sun enables presupposing that plants do not lack for it. However, some investigations show that plants are not always provided with enough light, and light energy is partly used by plants and not always reaches soil surface (Shein, 2006; Kholzakov, 2006). It is possible to influence this factor and develop appropriate technological methods to reveal optimal illumination, volume of sun light at soil surface and in rhizosphere of old-age grass stands (Revut, 1964, Doyarenko, 1966). Thus, various agro-techniques of rejuvenation of old-age galega orientalis grass stand affected agro-physical soil properties differently (Table 1).

Table 1. Influence of tillage techniques for old-age galega orientalis grass stand on agro-physical and microbiological properties of soil in the Middle Preduralie (First mowing – 25 June, phenological phase – blossoming)

Tillage	Air temperature in rhizosphere, °C		Air humidity in rhizosphere, %		Illumination of grass stand in rhizosphere, Lux		Microbiological activity of soil, % (June)	
	°C	Deviation, %	%	Deviation, %	Lux	Deviation, %	0-10 cm, %	10-20 cm, %
Control	25.6	-	42.3	-	2520	-	17.07	20.67
BDT, one track	25.8	+0.2	40.8	-1.5	7100	+4580	28.35	47.03
BDT, two tracks	25.7	+0.1	47.4	+5.1	5800	+3280	38.88	53.00
Leader, one track, at 10 – 12 cm	26.0	+0.4	43.8	+1.5	7070	+4550	26.38	36.48
Leader, two tracks, at 10 – 12 cm	26.5	+0.9	51.6	+9.3	5800	+3280	31.16	47.41
Leader, one track, at 16 - 18 cm	25.8	+0.2	51.8	+9.5	7100	+4580	20.01	37.94
Leader, two tracks, at 16– 18 cm	26.5	+0.9	51.8	+9.5	5070	+2550	39.44	54.14

In the control variant the temperature in rhizosphere constituted 25.6 °C, while air temperature on the open part of the field constituted 26.5 °C. According to the data of a number of authors, it is supposed that loose soil reflects sun rays in a less degree than smooth soil thanks to bigger surface and smaller reflection ability (Doyarenko, 1966). Based on the data it can be concluded that double subsurface cultivating of grass stand by means of the unit "Leader-4" at different depths had maximum temperature in rhizosphere – 26.5 °C that is by 0.9 °C higher than control. However, all tillage implemented in one track at different depths by means of different units varied from 25.8-26.0 °C that is by 0.2 – 0.4 °C higher. Soil temperature quite complicated affects the velocity of water income into soil, plants, roots and rate of transpiration. It is the result of the fact that at temperature decrease fast water income into plant is impossible, as at 0 °C ability to abstract water constitutes from $^1/_3$ to $^1/_2$ of this value at 25 °C. Water viscosity increases and as a consequence of this water income decreases not only from soil into roots but also its movement in root decreases while temperature decreasing (Revut, 1964; Doyarenko, 1966). Considering air humidity in rhizosphere we revealed that due to better penetration of sun radiation and light soil temperature decreases to 26.5 °C, and as a consequence evaporative ability of soil increases, as well as transpiration – thanks to bigger water income, that increases air humidity in rhizosphere to 51.8 % by tillage with the unit "Leader – 4" at a depth of 16 – 18 cm with different intensity. High air humidity was also at double tillage of grass stand by the unit BDT-3 and subsurface cultivator "Leader-4" at a depth of 10 – 12 cm, 47.4 and 51.6 %, respectively. Thus, it can be concluded that bigger depth of arable layer and increase in number of tillage raise humidity of rhizosphere of grass stand by

5.1 – 9.5 %. Tillage affected illumination of grass stand in rhizosphere. At one-track tillage by different units, illumination amounted 7100 lux. When the number of tillage at lower depths raises, illumination decreases to 5800 lux due to more intensive growth of above ground mass and increase in the number of stalks. However, two-track tillage at a depth of 16 – 18 cm decreased illumination to 5070 lux in comparison with other variants but had twice higher illumination of grass stand in comparison to control 2520 lux. Thus, application of different tillage techniques increases illumination in rhizosphere and as a consequence determines optimal grass stand density.

Biological activity of organisms play an important role in soil, mainly for decomposition of organic matter in soil and especially of plant rests. Thus, in June 2013 cellulose activity of arable horizon in soil layer 0 – 10 cm varied from 17.07 до 39.44 %. The highest tissue decomposition percentage was in variants with two-track tillage by means of the unit BDT and the unit "Leader – 4" at a depth of 10 – 12 cm and 16 – 18 cm and varied from 31.16 to 39.44 %. In variants with single tillage, microbiological activity was 20.01 – 28.35 %. The lowest cellulose activity constituted 17.07 % in the variant with untapped grass stand. In the layer 10 – 20 cm the highest cellulose activity was from 47.41 to 54.14 % in the variants with double tillage at different depths. Activity of microorganisms in the layer 10 – 20 cm is by 15 – 17.93 % higher in comparison with the layer 0 – 10 cm. The variants with one-track tillage at a different depth varied from 36.48 to 47.03 %.

The lowest percentage of activity of microorganisms was observed in untapped grass stand and constituted 20.67, that is by 3.6 % higher than in the layer 0 – 10 cm. Microbiological activity in the layer 20 – 20 cm is higher than in the layer 0 – 10 cm in all variants of tillage; microbiological activity is observed in variants with bigger number of tillage and bigger depth of tillage.

CONCLUSIONS

To recover the productivity of old-age galega orientalis grass stand it would be recommended to implement two-track tillage by means of different units with various working elements (disks, subsurface blade) that provides more intensive cutting and loosening of furrow slice. The tillage enable forming more favorable agro-physical conditions, optimal intake of sun radiation into soil and illumination of grass stand generally, hence microbiological activity of nitrogen fixing microorganisms increases. From economical point of view the most profitable is the variant with the two-track tillage of grass stand by means of the unit "Leader – 4" at a depth of 10-12 cm, that enables creating mentioned above conditions with least expenditures.

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10.7251/AGRENG1601172S
UDC 641:17(611)

FOOD WASTAGE BY TUNISIAN HOUSEHOLDS

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ABSTRACT

Food waste (FW) is seen as an obstacle to achieving food and nutrition security and food systems sustainability. It is known in literature that households are significant contributors to the total amount of FW. This paper reports on results of an online survey that was conducted from February to April 2015 with a random sample of 281 Tunisian adults. The aim of the survey is to assess the knowledge and relative importance of FW; attitudes towards FW; impacts of behaviors regarding food and food management; quantity and value of FW; as well as barriers and willingness to behavioral change. The sample was not gender-balanced (71.2% female and 28.8% male). The majority of the respondents was young (70.8% aged between 18 and 34 years) and has high education level (95.4% having university and PhD degrees). Food waste is prevalent in Tunisia as about the half of respondents declare that they throw food. The most wasted food products are fruits, vegetables, and cereals and bakery products. Only 42.7% of respondents declared that the economic value of food waste generated each month is more than 6US$. Most of Tunisian respondents have a good understanding of food labels that is probably due to the high education level of the sample. About 37% of respondents throw weekly at least 250 g of still consumable food. To reduce FW in Tunisia it is important to set a strategy at all food chain levels. There is also an urgent need to raise people's and organizations awareness towards this problem. This article provides a basis for the development of other more context specific investigations and interventions for the prevention of household FW in Tunisia.

Keywords: *household food waste, consumer behavior, online survey, Tunisia.*

INTRODUCTION

Food security has become a global concern in recent years following the climate change conditions and global food security challenges and consequently food price volatilities. The Near East and North Africa (NENA) region, including Tunisia, relies on food imports to meet over 50% of its total food requirements and still experiences a food deficit. At the same time, the region loses and wastes a significant amount of food, up to 250 kg per person each year, a figure that is higher than the global average (FAO, 2014). Moreover, according to the Food and Agriculture Organisation (FAO) almost a third of all food produced globally, or 1.3 billion tons of food, is lost or wasted every year (Gustavsson et al., 2011). In Tunisia there is very little data on food losses and waste. The figures for food loss and waste are hard to quantify and are dependent on the types of foods. Municipal solid waste is characterized by a strong presence of biodegradable organic matter (68%) with a specific production of 0.815 kg/capita/day in urban areas and 0.150 kg/capita/day in rural areas. Only 5% of food waste gets composted (ANGed, 2014). Fruit, vegetables, meat, fish and dairy products are inherently perishable and without proper transport and storage, their shelf life is dramatically low. The lack of access to cold chain systems and reliable energy sources required to power them is therefore the major cause of food loss in Tunisia (Kader, 2005). Other causes include harvesting practices (e.g. poor harvesting methods where food is left in the field, substandard harvesting equipment and poor sorting-where pests or diseases are not detected or the mixing of good and bad quality products together during grading which lowers the overall quality); supply chain management (e.g. lack of quality control in managing post-harvest collection and storage, lack of sufficient systems controls in processing/packaging of food and failures in operation and maintenance of storage facilities); and government and policy regulations (e.g. poor regulations that impede innovation and trade, lack of unified and coherent national policies and lack of market mechanisms to reward cold chain investments). Such as the case for the majority of countries in NENA region, reducing food loss and waste is critical for Tunisia that faces limited possibilities to increase its food production, and that depends on food imports to meet the food needs of its population (Barre, 2013). Indeed, food loss and waste reduction is the most feasible and quick win approach to increasing food availability and security in contrast to increasing food production. To address and reduce food loss and waste, a strategic approach is required that emphasizes coordination between all relevant actors, including public institutions and private sector agencies, food producers and handlers, and civil society institutions, through responsible and sustainable policies and effective compliance mechanisms. In order to help achieving food security in Tunisia, the Tunisian government must develop a strategic framework in close collaboration with international organizations such as FAO, civil society organizations and private sector to reduce food loss and waste within the coming years.

This preliminary paper summarizes findings from an exploratory survey to investigate the causes of food waste and identify solutions to reduce it in Tunisia.

MATERIALS AND METHODS

During the last years, the Department of Sustainable Agriculture, Food and Rural Development of the Mediterranean Agronomic Institute of Bari (IAMB), that is one of the four institutes of the International Centre for Advanced Mediterranean Agronomic Studies (CIHEAM) - in collaboration with FAO and other Italian, Mediterranean and international institutions - has undertaken different activities on the sustainability of the Mediterranean food system. In the framework of these activities, a particular attention was devoted to the issue of food waste in the Mediterranean region. In the Mediterranean area, precise and accurate data regarding food waste and losses should be enhanced. In the final declaration of the 10th meeting of the CIHEAM member states' agriculture ministers held in Algiers in February 2014 the relevance of food waste issue in the Mediterranean countries was strongly stressed (CIHEAM, 2014).

The present paper is based on a review of literature and the results of a voluntary survey carried out in Tunisia using a questionnaire that was adapted to the Tunisian context from previous questionnaires and studies on food waste carried out by the Office of Environment and Heritage in 2011 in the State of New South Wales (NSW), Australia (OEH, 2011), and by the University of Bologna (Last Minute Market, 2014).

The tool used to conduct the food waste survey is a self-administered questionnaire. It was designed and developed in French language in December 2014 and was made available from January until the end of March 2015 through the *Survio* website (http://www.survio.com/survey/d/K2O7B2J5Y7J9N8N9A). Participation was entirely on a voluntary basis and responses were analysed only in aggregate.

Survio online survey service (survio.com) began as a start-up in the Czech Republic and was launched formally in April 2012. It provides a free and easy tool for any type of online survey. The product provides plenty of ready-made survey templates, layouts and styles. It helps to easily create a new survey with professional content and viewing the collected responses in real-time, using tables, charts, PDF reports and data files for most file types.

Various communication channels were used for survey dissemination, such as institutional websites (e.g. http://www.inrat.agrinet.tn), social media (e.g. Facebook) and emails.

The questionnaire consisted of 26 questions. It included a combination of one option and multiple-choice questions. It was developed into six sections: Food purchase behavior and household food expenditure estimation; Knowledge of food labeling information; Attitudes towards food waste; Extent of household food waste; Economic value of household food waste; Willingness and information needs to reduce food waste.

In the introductory part of the questionnaire, the concept of food losses and waste was introduced to inform the respondents.

Data were analysed using descriptive statistics (*e.g.* means, max, min), in order to get a general picture of frequencies of variables, using Microsoft Excel.

From 289 questionnaires received, 8 were not considered because there were missing data. Therefore, the total number of the sample is 281 adult Tunisians. The majority of the respondents were female (71.2%) compared to 28.8% of males; they were quite young since 70.8% aged between 18 and 34 years old. About 44% of the respondents are living with parents. The respondents present high level of education with 95.4% having university and PhD degrees. Three, four or five person-households have the highest share (89.7%). The number of households with six and more persons is almost negligible. About 50.9% of the respondents are employees (full time or part time work) and 39.1% are students (Table 1).

Table 1. Respondents' profile (n=281).

Items		Percentage (%)
Gender	Female	71.2
	Male	28.8
Age	18-24	31.3
	25-34	39.5
	35-44	18.5
	45-54	5.0
	55 and over	5.7
Family status	Single person household	2.8
	Living with parents	43.8
	Partnered	7.5
	Married with children	33.1
	Shared household, non-related	11.4
	Other	1.4
Level of education	Primary school	0.4
	Secondary school	0.7
	Technical qualification	3.2
	University degree	48.4
	Higher degree (MSc, PhD)	47.0
	No formal schooling	0.4
Household composition	1 to 3	32.3

(number of members)	4 to 6	57.4
	7 to 10	10.3
	> 10	0
Occupation	In paid work (full time or part time)	50.9
	Student	39.1
	Unemployed and looking for work	8.2
	Home duties	0.7
	Retired/ Age pensioner	1.1

**Source: Authors' elaboration based on the survey results.*

RESULTS AND DISCUSSION

To estimate the proportion of food waste in households waste, methodologies such as enquiries or waste sorting analyses have been used. The results of enquiries give qualitative information like kind and frequency of wasted food and reasons for wasting it based on self-reported behavior of the respondents. Furthermore, information about interrelated conditions (e.g. level of employment, age of household members) and behaviour (e.g. buying, cooking and diet habits) have been gathered. The collected data are also important for monitoring and planning of waste management systems.

There are large differences concerning shopping behaviors between respondents. More than thirty-nine percent of the respondents reported that they exclusively shop in large supermarkets. Thirty-seven percent of the respondents purchase food also in small shops and 23.5% visit local markets in addition to other shopping facilities. Supermarkets and hypermarkets have marketing strategies to attract consumers and increase their purchase, thus increasing the possibility to wasting food. The answers to the question "*Do you think you are drawn to special offers?*" (e.g., "*buy one get one free*", "*three for the price of two*", *etc.*) revealed that 46.3% of households are attracted by special offers. Surprisingly, no person among all respondents declared to produce own food, to shop online or to use home delivery.

Interestingly, most households purchase groceries every day (34.5%), every two days (14.6%) or twice a week (18.9%). It is known that there are specific amounts of food thrown away in relation to shopping frequency. In general, a decreasing in food waste generation with decreasing shopping frequency could be observed. Only 29.2% of households use a shopping list. According to Jörissen et al. (2015), the amount of food waste is higher when no shopping list is used.

In general, the highest percentage (more than 30%) of foods that are thrown away sometimes or often relates to fruit, vegetables, cereals, legumes, milk, bread, fish, roots and tubers.

With respect to the reasons why food is wasted, "food conserved in fridge for too long time", "food is out of date", "food is moldy" and "food smelled/tasted bad" (63.3%, 51.2%, 35.9% and 34.2%, respectively) are mentioned much more frequently as reasons for discarding food (Figure 1). All other reasons were mentioned less frequently (less than 25%), which suggests that they are of minor importance.

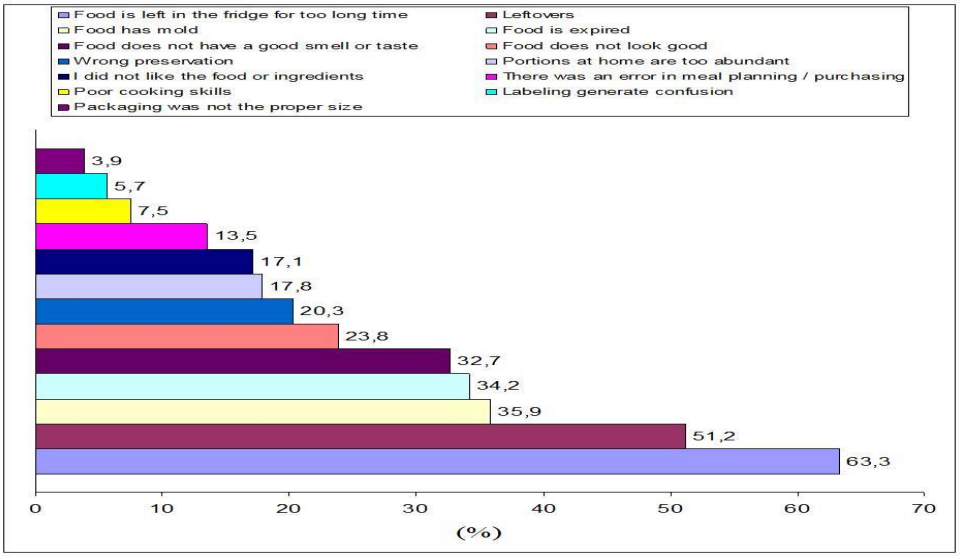

Figure 1. Reasons that lead to food being wasted (percentage of respondents who ticked the given reasons).

**Source: Authors' elaboration based on the survey results.*

The respondents were asked to estimate the amount of edible food they dispose off in their households per week based on predefined categories, ranging from throwing away nothing up to more than 2 kg at highest (the specified categories were: nothing, less than 250 g, 250-500, 500-1000, 1000-2000, and more than 2000 g per household/week). More than thirty-nine percent of the respondents stated that they do not throw away any edible food, whereas only 1.8% of households conceded that they dispose off more than 2 kg (Figure 2). A simple extrapolation of these figures to the entire Tunisian population results in 292,000 tons of food waste per year for Tunisia. Compared to the quantities estimated in the GIZ study (ANGed , 2014) of 4,033 million tons per year for Tunisia, the amounts of food waste calculated based on our survey are very small.

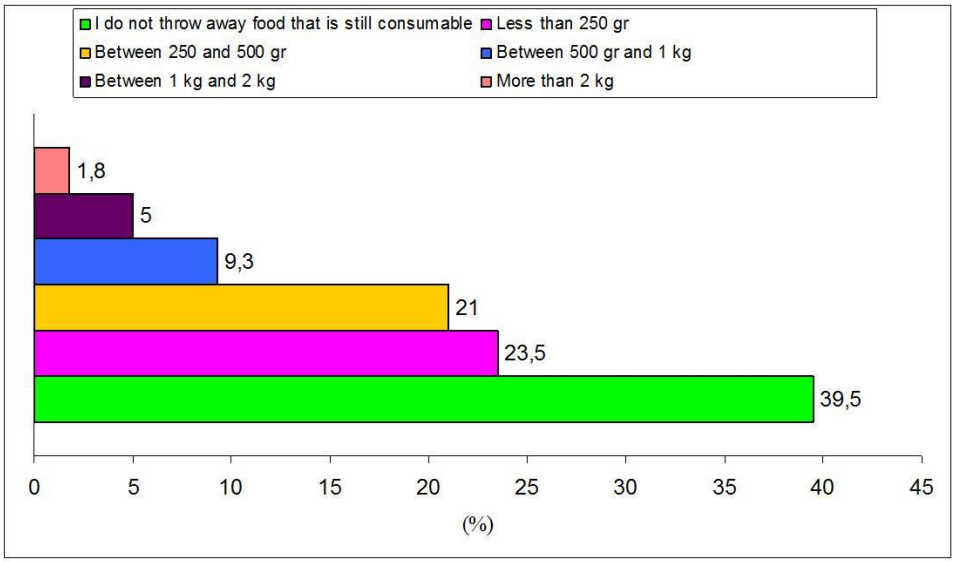

Figure 2. Average amount of household food waste per capita and per week.
**Source: Authors' elaboration based on the survey results.*

The majority of respondents indicated that they already strive towards reducing food waste (64.4%). The most mentioned activities referred to organizational improvements, like optimized planning of meals according to needs, tailored food purchases, consumption of perishable food items in time, adequate storage and reuse of leftovers.

Information that would be needed to reduce food waste by households is primarily knowledge on the freshness and durability of a product. With similar significance, advice is required about how to share or donate food, how to store food correctly and recipes for how to use leftovers. Respondents would like to receive further information. Further ideas for the distribution of information are related to the products themselves, supermarkets, and websites of local authorities. A considerable share of respondents needs and wishes no further tips.

As mentioned above, the population of the survey presented in this study is not representative for Tunisia. The main reason is that the survey was limited to an academic environment. Moreover, the questionnaire was distributed via Internet and the response to it was voluntary. Due to the method used and the circle of addressees, lower income classes, households with a lower educational level, young people (below 18 years) and the elderly (persons aged 60 years and above) were not adequately represented in the sample. Thus, the results cannot be reliably extrapolated to the entire population of Tunisia. Nevertheless, they provide some interesting insights into households' behaviors.

Surprisingly, the survey revealed that the generation of food waste per capita per week is higher than 250g for 37.1% of respondent households and less than 250g for the 23.5%, far below the level found in other studies (Monier et al., 2010; Kranert et al., 2012) such as in Germany (1500g) and Italy (from 884 to 2000g).

We suggest that among the reasons for the low waste rates in the survey might be that the predefined choices for food waste generation offered in the questionnaire were scheduled too low. This may have misled respondents to specify their real waste rates at the lowest limit. Moreover, it is possible that households in general tend to underestimate their food wastage. Interestingly, 39.5% of respondents testify in the interview that they throw away nothing, while Ventour (2008) reports that households testifying in the interview that they throw away nothing actually generated 88 kg of avoidable food waste a year. Another reason could be that the survey was restricted to an academic milieu. Furthermore, the food waste generated by the respondents out of home in hotels, restaurants, canteens, take away, coffee shops, etc. was not subject of the survey. Moreover, it is likely that people who have completed the questionnaire were mostly already sensitized to the issue of food wasting or are at least more aware of the problem than other people. This assumption is backed up by the fact that more than 72.2% of the respondents stated that they care very much about food waste and try to avoid it whenever possible. According to Williams et al. (2012), the participants who have a high environmental consciousness waste less food.

Concerning the food items wasted, survey data revealed that cereal and bakery products such as bread, rice and pasta followed by vegetables, milk and dairy products are the largest contributors to food waste. The present data are not in agreement with previous results of Langley et al. (2010) and Quested et al. (2013) who reported that, the largest contributors to food waste are easily perishable items like fresh fruit and vegetables, followed by bakery, dairy products and eggs. Several studies investigated the reasons for the generation of food waste (Graham-Rowe et al. 2014) and have come to quite similar results. The most common reasons that lead to food wastage are: Food is out of date; Food looked, smelled, tasted bad/moldy; Food conserved in fridge/cupboard for too long; Wrong planning of meals; No need-based shopping; Wrong packaging size; Insufficient cooking skills; Incorrect storage; Food is served in high quantity; Household member did not like ingredients.

Looking at the findings of the survey with respect to previous researches, the most commonly cited reason to discard food in Tunisia was “In fridge/cupboard too long” (63.3%), “Served too much, leftovers, did not like ingredients” (51.2%), “Looked, smelled, tasted bad/moldy” (35.9%) followed by “Out of date” (34.2%). This indicates that respondents in Tunisia seem to trust more in their sensory perception.

In accordance with previous studies, the survey endorses the finding that households’ shopping practices have a huge impact on the level of food wasting. The most frequented stores for purchasing groceries in Tunisia are large supermarkets and mini-markets (39.5 and 37%, respectively) and only 23% for local markets. Previous studies found that the amount of food thrown away is highest when people exclusively shop in large supermarkets, decreases when purchasing takes place in different shopping facilities, and is lowest when people also grow their own food (Jörissen et al., 2015). This would suggest that people

who spend a lot of time shopping in small shops or local markets attribute a higher value to foods than people who prefer the quick and convenient large supermarkets.

Next to the type of shopping facility chosen, the shopping frequency also could affect the amount of food waste. Here the survey shows that 34.5% of respondents do shopping every day. According to Williams et al. (2012), an increasing shopping frequency allows for a better matching with the daily needs. The purchase of large quantities for the whole week in contrast, would increase the probability of spoilage, especially of perishable products, such as vegetables, bread and milk. Graham-Rowe et al. (2014) provide another rather psychological foundation.

In Tunisia, only 29.2% of the households surveyed use a shopping list. Previous studies revealed that when using a shopping list, the amount of food thrown away per capita is lower (Lyndhurst et al., 2007).

CONCLUSION

The available studies show that there are great discrepancies between the amounts of food waste calculated based on statistical data on food supply or municipal waste and the amount of food waste measured in household surveys. The results of statistical estimates are in general higher than the results of household surveys. This observation indicates that great efforts are required to improve the methods for statistical data collection and processing. Lower income classes, households with lower education level, and the elderly (persons aged 65 years and above) are not adequately represented in this study. Further considerations are much needed on how to overcome these barriers.

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10.7251/AGRENG1601182C
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THE EFFECT OF MYCOTOXIN ADSORBENTS ON SOME SELECTED PARAMETERS OF BOAR SEMEN

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ABSTRACT

The studies were carried out at the State Enterprise for Pig Selection and Hybridization "Moldsungibrid" (Republic of Moldova), from 18.03.2014 till 06.08.2014, using boars of Landrace, Yorkshire, Duroc and Pietrain breeds in order to understand the impact of the enterosorbent "Primix-Alfasorb" on breeding boars' semen production. During the first period of the experiment the adsorbent was not added to the boars' diet; during the second period of the experiment (60 days) the basic compound feed (BF) was supplemented with the preparation "Primix-Alfasorb" at the level of 300 g/t; during the final (third) period (40 days) the animals were again fed to basic feed. It was observed that, when the breeding boars were fed on compound feed supplemented with the additive «Primix-Alfasorb» at the level of 300g/t, the ejaculate volume increased, namely: during the second period of the experiment – in the boars of Landrace breed ($p < 0.05$), and during the third period – in the boars of Pietrain breed ($p < 0.1$). The total number of spermatozoa in the ejaculate was 139,54 milliard in Duroc boars, and up to 201,39 milliard in the boars of Pietrain breed. During the third period of the experiment, this index was high in the boars of all the breeds. As to the concentration of the spermatozoa, it was higher in Yorkshire boars by 13.52, 14.14 and 0.58%.

Keywords: *breeding boar, sperm production, sperm dose, sow, adsorbent.*

INTRODUCTION

The intensification of pig production requires extensive implementation of artificial insemination of animals as a highly effective method of reproduction and genetic progress. A significant number of boars do not manifest their potential due to the specificity of the industrial technology – lack of walks, solar insolation, shortage of fresh air and unbalanced feed diets on a number of components (Pohodnya *et al.*, 2004; Pohodnya, 2005; Pohodnya and Moroz, 2007; Narijny, 2003; Narijny *et al.*, 2006).

A promising way to increase the boars' reproductive functions under the conditions of industrial technology is the utilization of a number of environmentally friendly

biologically active preparations, which do not negatively affect the animals. The antifungal effect is one of the diverse effects of these preparations. Of all the possible contaminants of the feed for pigs, mycotoxins pose the highest risk. The contamination of agricultural produce with fungi toxins is observed in all agricultural regions of the world, and it is almost impossible to avoid. The average concentration of harmful fungi increased from 33 parts per billion in 2013 to 64 parts per billion in 2014; i.e. their concentration has almost doubled (http://www.agritimes.ru/ news/15554/mirovye-korma-zagryazneny-mikotoksinami, 2015).

The contamination of raw materials with fungi and their metabolic products is a serious problem of livestock farms, which causes considerable economic damage (Kotik, 1999). Mycotoxins affect the feed quality, health and productivity of animals. Many mycotoxins which have mutagenic and carcinogenic properties pass into animal products (Akhmetov *et al.*, 2000; Tremasov, 2001; Hamidullin *et al.*, 2004). In this connection, special measures should be used to save raw materials from mold, first of all, to introduce in feed diets special feed additives – adsorbents – which can adsorb mycotoxins, control the growth of mold in feed and prevent the occurrence of mycotoxicosis in animals (http://mitgroup.by/index.pl?act, 2016).

Recent experimental studies have proved that the reproductive potential of livestock can be increased by using adsorbents of mycotoxins. It has been found that different adsorbents have different effects on mycotoxins (Brylin, 2008).

Multi-effect preparations that have passed special multi-stage processing neutralize mycotoxins, endogenous and exogenous toxic substances of different nature without binding vitamins and elements essential for animals' life. These chelators have an expressed bacteriostatic effect against opportunistic pathogenic microorganisms, and do not adversely affect the composition of the intestinal commensal flora, due to the imperfection of the crystal lattice of sorbents (http://globusp.com/rentabelnoe-zhivotnovodstvo.html, 2016). One of these adsorbents is the preparation «Primix-Alfasorb» produced by the LTD "Ariadne" (Ukraine).

MATERIALS AND METHODS

The studies on the effectiveness of the impact of the enterosorbent "Primix-Alfasorb" on the semen production of breeding boars were carried out at the State Enterprise for Pig Selection and Hybridization "Moldsungibrid", using boars of Landrace, Yorkshire, Duroc and Pietrain breeds (Ovsyannikov, 1976), from 18.03.2014 till 06.08.2014.

The boars were kept for a year in the same conditions, making them to walk permanently. During the first period of the experiment the adsorbent was not added to the boars' diet; during the second period of the experiment (60 days) the basic compound feed (BF) was supplemented with the preparation "Primix-Alfasorb" at the level of 300 g/t; during the final (third) period (40 days) the animals were again fed to basic feed (Table 1).

Table 1. Scheme of the experiment

The breed of the boars	no	Periods		
		Preliminary (without the preparation) 18.03 – 27.04.14	Control (with the use of the preparation) 28.04 – 27.06.14	Final (without the preparation) 28.06 – 06.08.14
		40 days	60 days	40 days
Landrace	3	BF	BF + 300 g/t «Primix-Alfasorb»	BF
Yorkshire	3			
Duroc	3			
Pietrain	3			

** "Primix-Alfasorb" is a mycotoxin adsorbent for animals. It consists of extruded bran, lignin, cellulose, hemicelluloses and pectin – not less than 700 mg. The additive has been developed by the LTD "Ariadne" (Odessa, Ukraine).*

The male pigs' semen was collected in disposable sperm devices by manual method, using an artificial vagina of a stuffed animal on the walk ground twice a week (Kononov, 2002; Eskin *et al.,* 2007). When assessing the quality of boars' sperm using the program Porcine Semen Analysis Systems – ISAS PSUS, the following indices were taken into account: the volume of ejaculate (ml), its concentration (million/ml), its mobility (%) and the total number of spermatozoa in the ejaculate (million). Two hundred and twenty-nine ejaculates of twelve boars (3 heads in each group) were examined.

The obtained data was processed using the methods of variation statistics (Cucu, *et al.*, 2004; Plohinsky, 1969].

RESULTS AND DISCUSSION

It is well known that boars' metabolism occurs quite intensively. This is due to the fact that, when properly fed, a boar secretes a large enough volume of semen per one mating, and in order to form this quantity, as well as to regain the energy spent during the process of mating or semen collection, a lot of energy and nutrients are necessary.

During the experiment, the need of boars in energy and nutrients was determined in relation to their age, body weight, individual features and the intensity of their use (Kalashnikov A. et al., 2003). The compound feed was supplemented with traditional feeding ingredients (in %): corn grain – 18.0, wheat – 20.0, barley – 27.8, peas – 16.8, wheat bran – 11.0, fish meal – 5.0, premix – 0.1, salt – 0.4 and chalk – 0.9. The diets were balanced using the Hybrimin program (Table 2).

Table 2. Nutritional value of the compound feed for breeding boars

Nutrients	in 1 kg
Energetic feed units	1.14
Exchange energy, MJ	12.2
Crude protein, g	144.89
Crude fiber, g	5.72
Lysine, g	7.76
Meteonin + cystine, g	5.07
Calcium, g	8.07
Phosphorus, g	6.51

The studies have found that the boars of Pietrain and Landrace breeds have had the greatest volume of ejaculate, on average over the period of experience, namely 267.80 ml and 252.50 ml. The ejaculate volume of the Duroc boars was significantly lower (by 37.8 – 41.2 ml or by 27.97 – 52.72 ml) than of the boars in other experimental groups, due to their breed characteristics. The quantity of the obtained ejaculates from these boars were lower compared with other breeds, namely by 1.41 – 1.87 doses. Significant differences in the ejaculate volume were observed during the experimental periods: during the second period – in the Landrace boars ($p < 0.5$; $p < 0.05$), and during the third period – in the Pietrain boars ($p < 0.1$).

Table 3.Number of examined ejaculates of breeding boars of different breeds when fed to the preparation "Primix-Alfasorb», pieces

n = 3	Breeds of breeding boars			
	Yorkshire	Landrace	Duroc	Pietrain
I period	15	11	12	14
II period	30	28	25	15
III period	22	20	19	18

The sperm concentration in the animals of Yorkshire and Pietrain breeds was higher than in the boars of other breeds. The highest concentration was observed in the Yorkshire boars (755,54 million/ml), which was by 13.52, 14.14 and 0.58% higher than the value of the similar index in the boars of Landrace, Duroc and Pietrain breeds, respectively (Table 5).

Table 4. Total amount of the ejaculate of breeding boars of different breeds when fed to the preparation "Primix-Alfasorb"($\bar{X}\pm S\bar{X}$), ml

n = 3	Breeds of breeding boars			
	Yorkshire	Landrace	Duroc	Pietrain
I period	243,533±14,298	240,24±15,550	225,33±19,648	259,28±7,926
II period	251,640±18,920	220,487±14,120*; (**)	201,13±23,392	238,92±24,050
III period	236,050±14,916	296,778±19,400	218,79±19,44	305,19±19,283*

*Note: * p <0.1; ** p <0.05 – by the I period; (**) p <0.05 – by the final period*

Table 5. The indicators of sperm production of the breeding boars, when the preparation "Primix-Alfasorb" was used, ($\bar{X}\pm S\bar{X}$)

n = 3	Breeds of breeding boars			
	Yorkshire	Landrace	Duroc	Pietrain
Number of sperm doses, doses (1:4)				
I period	12,117±0,715	12,012±0,777	11,27±0,982	12,96±0,396
II period	12,582±0,946	11,024±0,706(**)	10,06±1,170	11,95±1,203*;(*)
III period	11,803±0,746	14,839±0,970*	10,94±0,972	15,28±0,964
The total number of spermatozoa in the ejaculate, billion				
I period	186,578±14,879	165,933±26,145	138,4±14,886	183,58±12,42
II period	182,778±12,944	148,773±8,469(*)	133,22±17,38	182,2±19,167
III period	183,546±21,403	175,507±6,660	147,01±13,11	238,39±31,838
Concentration, million/ml				
I period	765,299±30,106	682,964±61,705	614,44±35,412	706,53±26,29
II period	728,740±37,25	681,210±60,818	659,82±10,942	774,21±104,62
III period	772,576±39,754	595,966±40,172	671,88±4,015	772,71±58,073

*Note: * p <0.1; ** p <0.05 – by the I period; (**) p <0.05 – by the final period*

The highest number of normal spermatozoa, during the control, the first and the final periods, was observed in the group of the Yorkshire boars (705,51, 691,02, and 739,56 million/ml, respectively). The same tendency was observed in relation to the spermatozoa's motility, which, during the whole experiment, was generally higher in Yorkshire boars in comparison with the animals of Landrace, Duroc and Pietrain breeds. It should be noted that, during the final period, the sperm motility in the boars of this breed was the highest (678,13 million/ml), i.e. by 25.68, 12.06 and 1.92%, respectively, higher in comparison with the indices of the boars of other breeds (Table 6).

Spermatozoa's suitability was among the indices studied in the experiment. During the control period the lowest suitability of spermatozoa in the sperm was observed in Duroc boars (554,11 million/ml). The semen of Yorkshire boars was stable, which indicates the possibility of obtaining the same amount of semen doses.

The main index of the quality of breeding boars' sperm is its fertilizing ability. This ability was the highest in the boars of Landrace breed (77.53%). The animals of Pietrain and Duroc breeds surpassed the boars of Yorkshire breeds in this index by 10.2 % and 8.88 %, respectively (Table 6).

Table 6. The indicators of sperm production of breeding boars, when fed with the preparation "Primix-Alfasorb", ($\overline{X}\pm S\overline{X}$)

Indices	Breeds of breeding boars			
	Yorkshire	Landrace	Duroc	Pietrain
	The first period			
Normal, million/ml	705,51±28,945	600,51±16,901	556,73±39,712	650,37±30,027
Motile, million/ml	643,13±34,194	595,11±62,857	546,02±29,717	600,52±8,598
Motile and normal, million/ml	597,16±31,175	522,77±22,734	494,69±33,579	552,59±9,414
Good, million/ml	625,6±38,340	582,93±62,285	536,59±26,491	569,55±24,322
The second period				
Normal, million/ml	691,02±28,551	634,71±71,768	603,91±32,886	685,21±69,159
Motile, million/ml	629,96±30,370	573,2±45,370	565,01±23,086	635,56±70,782
Motile and normal, million/ml	598,20±23,522	533,92±55,132	531,13±28,982	563,50±42,633
Good, million/ml	615,58±28,255	556,12±39,884	554,11±23,150	599,64±46,421
The third period				
Normal, million/ml	739,56±39,515	577,50±34,616	639,75±13,028	736,05±57,533
Motile, million/ml	678,13±29,415	503,99±31,432	596,35±9,805	665,10±46,330
Motile and normal, million/ml	649,24±29,104	488,49±26,510	568,21±19,028	633,82±46,159
Good, million/ml	654,49±24,377	489,73±30,268	582,37±12,841	637,98±40,358

It is known that the quantity and quality of offspring, their economic-useful signs depend on the reproductive ability of breeding boars. During the experiment, the number of piglets per sow varied, on average, depending on breed, from 10,17 to 10,94 head, with no significant differences. It has been found that the addition of

the adsorbent to the compound feed for boars does not affect the insemination and the farrowing of sows**.**

CONCLUSION

– A promising way to increase the reproductive functions of boars in the conditions of industrial technology is the use of some adsorbents which have mycotoxins decontaminating properties.

– When boars are fed with feed supplemented with 300 g/t of the preparation "Primix-Alfasorb", the quantitative and qualitative indicators of sperm increase, and the effectiveness of artificial insemination improves.

– The utilization of the preparation "Primix-Alfasorb" in the compound feed for breeding boars increases the ejaculate volume of the boars of Landrace breed ($p < 0.5$; $p < 0.05$) during the second period of the experiment, and that of the Pietrain boars ($p < 0.1$) during the third period. The total number of spermatozoa in the ejaculate varies depending on breeds – 139,54 milliard in Duroc boars, and up to 201,39 milliard in the boars of Pietrain breed; this index increases in boars of all breeds during the third period of the experiment. As to the concentration of spermatozoa, it was higher in Yorkshire boars in comparison with other breeds by 13.52, 14.14 and 0.58%.

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10.7251/AGRENG1601190F
UDC 582.583:631.86(669)

INFLUENCE OF PROPAGULE SIZE AND ORGANIC MANURE ON THE GROWTH AND YIELD OF GINGER (*Zingiber officinalis*).

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ABSTRACT

Ginger is grown majorly in the derived savannah of Nigeria for its potential health benefits, this health related usefulness of ginger have also stimulated farmers concern for the growing of the plant having realized its efficacy in life changing ailments as a result of this the availability of the propagule for planting became so scarce and not within the reach of farmers. Its cultivation has recently been introduced to the South western Nigeria. A field trial was carried out at the National Horticultural Research Institute, Ibadan (Nigeria) to study the influence of propagule size and organic manure on the vegetative growth and rhizome yield of ginger in the rainy season of 2008. Propagule size had significant effect on plant height and number of tillers. 10g propagule size of 28.2 was highest while the organic manure control was the least for all the vegetative parameters considered. As the rate of organic manure increases, there was an increase in all the vegetative parameters reaching its peak at 15t/ha and decreased again at 20t/ha. The interaction between the propagule size and organic manure was significant for the number of rhizomes, number of tillers and the yield. 10g propagule size and 15t/ha organic manure produced optimum growth and yield of ginger.

Keywords: *planting material, size, propagation, organic manure.*

INTRODUCTION

Ginger is the rhizome of *Zingiber officinale* Rosc. a herbaceous perennial belonging to the family Zingiberaceae. India is the largest producer and exporter of dry ginger in the world, contributing about 30 per cent of the world's production.
Although the country of origin is not known with certainty, it is presumed to be either India or China. The other ginger producing countries are Jamaica, Sierra Leone, Nigeria, Southern China, Japan, Taiwan and Australia. It is grown in many countries of the tropics and subtropics and is used widely in food, beverages, confectionery and medicines (Egbuchua*et al.* 2013).

The mature roots of ginger are fibrous and the juice from old ginger roots is extremely potent and often used as spices and a quintessential ingredient of Chinese, Korea, Japanese and many South Asian cuisines for flavouring dishes (Jakes, 2007). It is also used largely as recipes such as ginger bread, cookies, crackers, cakes, ginger-ale and ginger beer (Asumugha *et al*., 2006; Jakes, 2007). The medicinal values of these great ancient spices are widely recognized across the continents to contain a number of unique organic phytochemical ingredients that can take care of some human ailments. Recent studies on health related effects of ginger which have also stimulated farmers concern on the growth of the plant have shown the efficacy of the plant in some life changing ailments such as entero toxin induced diarrhea, diabetic nephropathy, nausea, plasma antioxidant, vomiting, high cholesterol, high blood pressure and inflammation (Egbuchua*et al.*, 2013).

The availability of raw material especially during planting time makes determination of the optimum propagule size important to avoid wastage. Like any other plant, ginger requires the right kind of nutrients to sustain its growth and maximum yield especially in the humid environment where rainfall is high and nutrient reserves are low due to leaching, and erosion effects. Plant nutrients usually supplied by the soil in most Sub-Saharan environment are often inadequate and sometimes in plant unavailable form hence, they need to be augmented with other sources that are cheap and environmentally friendly. The use of organic manures is one technology that has been exploited overtime and across ages because of its ability to restore soil fertility, supply major plant nutrients, such as N. P. K., Ca, Mg and also stabilizer soil pH (Sanchez and Miller, 1986). Increase in soil chemical properties which are quite essential in crop growth and yield have also been associated with organic manures (Adetunji, 1990). Organic manures however are without their limitations. These include inadequate availability, transportation and handling problems, slow nutrient release, high C: N ratio and sometimes heavy metal pollution (Ayeni*et al*., 2010). Now that emphasizes are gradually shifting to organic agriculture to maintain soil productivity and limit the use of synthetic fertilizers some of which have contributed to the changing climate, the objective of this study therefore was to evaluate the influence of different propagule size and poultry manure on the growth and yield of ginger.

MATERIALS AND METHODS

The experiment was carried out between May and December 2008 at the National Horticultural Research Institute, Ibadan, Nigeria (07^0 24'N, 03^0 35'E, and 213m above sea level).Ibadan lies in the rainforest agro-ecological zone of South Western Nigeria. The trial was laid out in a split plot design replicated three times. The main plot was the propagule size (5gm and 10gm) while the poultry manure rates (0, 5, 10, 15,20t/ha) were in the sub-plot. The plot was manually cleared, ploughed and made into 10 beds of 2 × 3 m dimensions. From each bed, composite soil samples were collected for pre-planting soil analysis. The poultry manure was applied two weeks before planting using incorporation method. Seed pieces of ginger rhizomes were cut to contain at least two buds and weighing about 5g and10

g respectively. Each was planted on the beds at a spacing of 30 × 20 cm at a depth of 5 cm. Data on morphological characters which includes plant height, number of leaves, number of tillers and number of rhizomes were taken fortnightly while the yield components was recorded at harvesting.

RESULTS AND DISCUSSION

The chemical composition of the poultry manure used is presented in Table 1 while the soil physico-chemical properties before the experiment are presented in Table 2. The latter showed that the fertility status is average especially for the major elements.

Table 3 shows the main effect of propagule size and poultry manure on vegetative parameters, yield components and yield of ginger. Planting propagule had a significant on plant height, number of tillers and number of rhizome but on the number of leaves and the yield. Propagule size of 10 gram was better than 5gram propagule size producing significantly higher plants, number of tillers and number of rhizomes. This suggests that the amount expended on planting material of ginger can be halved with no significant different in the resultant yield. The effect of poultry on vegetative and yield parameter was significant. Plant height, number of leaves, number of tillers, number of rhizome and the yield increased with increasing poultry manure reaching its peak at 15t/ha and decline again suggesting the optimum of poultry manure application is at 15t/ha(table 3). This is in agreement with the findings of Egbuchua*et al*. (2013) that most ginger morphological characters increased with the application of treatments compared to the control with poultry manure given the best performance in terms of growth parameters and yield indices. Similar studies by Hsieh and Hsieh (1990) and Ojeniyi (2011) showed the potency of poultry manure in improving crop quality, quantity and yield when incorporated into cultivated soil. Ayeni et al. (2010) have equally reported that organic manures when properly used have proven to be very efficient in increasing soil nutrient contents, ensuring positive residual effects and enhancing soil's physico-chemical properties. Interaction was significant for number of tillers, number of rhizomes and the yield(table 3).

Table 1. Chemical composition of the Poultry manure

Element	Absolute % chemical composition
N	1.56
P	2.62
K	0.10
Ca	3.62
Mg	1.17
Na	0.65
Organic Carbon	35.6

Table 2. Soil Physico-chemical properties before the experiment

pH	6.5
Organic C (g/kg)	0.88
Total N (g/kg)	0.94
Available P (mg/kg)	5.82
Exchangable bases (Cmol/kg)	
Ca	0.39
Mg	0.15
Na	0.04
K	0.09
Micronutrients	
Mn (mg/kg)	28.58
Fe (mg/kg)	8.87
Cu (mg/kg)	0.60
Zn (mg/kg)	2.63
Particle size	
Sand	810
Silt	120
Clay	70

Table 3. Effect of propagule size and poultry manure on the vegetative parameters and yield of Ginger.

Treatment	Plant Height(cm)	Number of leaves	Number of Tillers	Number of Rhizomes	Yield (t/ha)
Propagule size					
5grams	24.6	14.4	3.2	15.2	14.9
10grams	28.2	15.6	3.7	20.4	16.6
LSD (0.05)	1.55	NS	0.32	2.20	NS
Poultry manure (t/ha)					
0	20.8	13.3	2.5	11.5	7.7
5	23.2	14.4	3.1	20.5	16.7
10	26.4	15.1	4. 0	19.3	13.5
15	31.0	16.9	4. 0	23. 0	23.9
20	30.7	15. 4	3.8	14.8	17.2
LSD(0.05)	2.51	2.45	0.51	3. 48	5. 02
P.S X P.M	NS	NS	*	*	**

*Significant at P< 0.05, **Significant at P<0. 01, NS- Not Significant, P.S-Propagule size, P.M-Poultry Manure

CONCLUSION

From the experiment, it was deduced that the use of 10 gram size of ginger propagule was better during the vegetative growth of ginger compared to 5gram size and for the different rates of poultry manure used, the least yield was obtained from the control with no poultry manure (7.7 t/ha) and the highest yield obtained from 15t/ha therefore 15t/ha rate of poultry manure will give the optimum yield of ginger.

ACKNOWLEDGEMENTS

The Executive Director of National Horticultural Research Institute, Ibadan, Nigeria is appreciated for the financial support and enabling environment for this research work. Mr P.A Kayode, MrsAkinlolu H.T., Bolodeoku P.O. and the other teams on the field for giving all the necessary technical support for the actualization of this project.

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10.7251/AGRENG1601195K
UDC 332.3:63(662.6 Tahoua)

LAND ISSUE AROUND THE LANDS RECOVERED IN THE REGION OF TAHOUA IN NIGER

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ABSTRACT

The present reflection analyzes the situation of farmlands and pastoral lands in the region of Tahoua in Niger in connection with the environmental conditions in a context marked by considerable regional demographic growth of 4.6% in 2012. These hinder the efforts of the country in the wrestling against food insecurity. It also analyzes the land stakes in this particular case, the intervention of the programs of recoveries of lands and the strategies developed by actors to guarantee their food security. It results from the synthesis of direct observations and from the inquiries on ground. The investigation realized in 2010 concerned 420 households distributed in twenty selected villages following a reasoned sampling and according to demographic weight of eight (8) departments of the region. The objective is to measure the impact of the land dynamics in fighting against the food insecurity and poverty of women in the region of Tahoua. It emerges from this study that 3% of the households without land; in spite of the average of nine (9) individuals by households, or approximately 2.62 hectares by field. The surfaces of fields vary from 0.11 to 17 hectares. Fields are located on trays, in the slum and at the level of dunes in agricultural zone. We attend an emergence of fields beyond the north end of the cultures. Most of the forest lands were transformed into areas of pasture, then into fields of culture after the development interventions.

Keywords: *land tax, lands got back, Tahoua, Niger.*

INTRODUCTION

In Niger, the potential arable land is estimated about 14.5 million hectares among which only 270,000 hectares of land are irrigable. Within this, around 6.2 million hectares are cultivated during rainy season and 85,700 hectares are irrigated. To sum up, 43% of the lands are used for farming (Aquastat in CILSS and CSAO, 2008). Tahoua region is located in the center of Niger; it is part of the zone called *Ader Doutchi maggia*, which is a vast plateau gashed with valleys. This plateau was covered with vegetation that almost disappeared during these last years as a

result of cyclic droughts and the rapid transformation of the areas to agricultural zones. The structure of the soils is that, without water and land conservation measures, any drop of rain water can flow, reducing the possibility of infiltration. That process turned to an intense ravening in fertile valleys, thus stopping the seasoning expansion of the rise in water used to restore by the deposits of thin alluviums the fertile soils (Abdou Hassane et al., 2000). That was a challenge to face, considering the agricultural expansion lays in some ways over a good property determining the agricultural production.

That is, the property is a crucial concern for the economics and the societies, because it is the major part of the gross domestic product (GDP) and employment in most of the countries that constitute the source of subsistence for the population. In many regions, otherwise, the valuable soils are rare, due partly to the weight of growth expansion (Lorenzo and Camilla in Moussa 2001). The property situation in Tahoua region is characterized by a strong degradation and a significant reduction of agricultural lands. The necessity of acquiring farming lands, forces the peasants to excel physically in restoring lands; generally at the cost of the corridors or pasture areas. This search of lands often generates conflicts between rural actors. Agriculture constitutes the main economic activity of the populations of Tahoua region. The farming land surfaces, estimated to 3,072,265 hectares and representing approximately 28% of the total surface of the region, are located in the southern part of the region between isohyets 3.00 mm and 6.00 mm (DRDA, 2008). The rainy season farming is of extensive type. These activities participate to secure the agro-sylvo-pastoral production systems in obtaining monetary incomes substantial to rural populations thus helping to keep them in their respective zones (domains), a *sine qua non* condition of fighting against rural exodus and poverty. Wooding actions especially over recovered lands, such as planting in blocks or in lines permitted to recover 43,765 ha of lands within 2000 and 2010. Eight (8) protected forests covering a surface of 11,615 ha exist; forest-trainings especially based on acacia are located in the northern part of the region. The region is constituted by Abalak and Tchintabaraden departments (local states) covering 28,000 ha. Towards the south and in the center (Birni Konni and Illéla local states), we find mixed forest galleries and other types of bush known as looking like tiger forms of 117,000 ha surface; and many superficial plantations done by the State, local governments and mainly by development projects. Tahoua region is vulnerable to food insecurity these recent years because of edaphic-climate constraints and anthropic action, the pressure over natural resources and demographic growth. Related to the pastoral lands, the nomads, who are victims of the decapitalization of the herd due to repetitive droughts and monopolizing of productive lands by the installation of ranches, occupy important favourable areas. The occupation of this property of those zones is under legal regulations enrolled in the rural code.

The objective of the present paper is to measure the impact of the land dynamics in fighting against the food insecurity and poverty of the women in the region of Tahoua.

MATERIALS AND METHODS

The investigation realized in 2010 concerned 420 households distributed in twenty selected villages following a reasoned sampling and according to demographic weight of eight (8) departments of Tahoua.

RESULTS AND DISCUSSION

It emerges from this study that 3% of the households have no ground with an average of nine (9) individuals by households, or approximately 2.62 hectare by field. The surfaces of fields vary from 0.11 to 17 hectares. Fields are located on trays, in the slum and at the level of dunes in agricultural.

Property issues in Tahoua region

Tahoua region benefited of environmental policies resulting from destructions caused by several droughts occurred in the country. These policies target the food security by controlling degraded lands and regenerating natural resources. They contribute to the access and control of the available property resources. Unfortunately, the region has to tackle important challenges among which the demographic growth, the food sufficiency of the population, good leadership and appropriate behavior of the actors. Property, agro-pastoral and food issues needs constitute the major issues in Niger. To tackle the challenges of land management and natural resources, and fight food insecurity and environmental degradation, Niger adopted an experimental original and innovative tool: the rural code. For that reason, it is recommended to consider and reinforce that original experience of property and natural resources' management in West Africa (Jamart, 2010). "*Land ownership is acquiered by tradition or by means of the written law* (*Article 8 enactment N °93-015/02 March 1993 fixing orientation principles of the rural code*). Thus, the various ways or methods of accessing to the land have improved according to The Permanent Secretary of Niger Rural Code. Tahoua region is particular in the presence of wide areas of valley and recovered lands. To that, we can add the vast pastoral zone occupied by herd of animals and grass resources. We also encounter many fixed and transhumant herd men exploiting pastoral property resources.

This region faces constraints related to the high demographic pressure, water and wind erosion, extreme destruction of green wood, sand recovering water points and bush fire. In fact, the acquisition of lands in that region of Niger is related to the customary and religious (Muslim) rights despite the existence of the modern regulations. This is the consequence of the current contradiction in terms of owning the property in Niger compared to other West African countries where the acquisition of lands is related to two sources of regulations (customary and modern rights). Property laws deriving from modern right have many obstacles in experimentation and do not generally consider the rights of the people over lands inherited from the ancestors. The State (Authority) is supposed to be owner of the land. The farmers only have the right to exploit it; i.e. they work and exploit the land but it does not belong to them. Therefore, they live in precarious and insecure property conditions. This is currently what occurs in whole West Africa, except in

few countries (Burkina Faso, Benin, Niger) that recently modified their regulations (Sylvie, 2013). In Tahoua region, the frequent methods of land acquisition are: inheritance, sale, loaning, renting and leg. For instance, in acquiring the first field, inheritance is above all other forms in 84% of concerned households. It is then followed by the sale in about 7.6%, loaning and leg with 1.19% each and finally renting/hiring with 0.23% of the households. The remaining farms were owned through sales.

We also notice that cutting bush, renting under no conditions and loaning do not exist; they occur in the kind of exploitation under condition and hiring. This is the reason why it is almost rare to find total property resources victims of colonization and social chain solidarity disruption. In olden days, these property belongings were pertinent. We assist to some kinds of changes in the space and in social relations. The number of farms owned through inheritance decrease more and more while the number of households' farms increase. This is a source of conflict according to the chief of the village of Danfan where cases were settled. According to that community leader, the farmers well aware of the property in the rural areas, they conclude their business ignoring the social weight excluding their relatives and the chief of the village setting agreement generating conflicts. It sometimes needs the presence of the community leader in case the deal does not succeed and then taken as a special case to the court. So, the average of the areas per farm is 2.62 hectares. The size of agricultural exploiting fields is 2.62 ha against 5 ha for about 12 people among who 6 agriculturally active nationwide (Jamart, 2010). This pathetic size of the areas cannot produce a sufficient food to households which consequently drops up to 0.11 ha for a household of approximately nine (9) people to feed. And these families make extensive farming with rudimentary tools and limited means. To that is added edaphic and climatic conditions related to feeble soil fertility, naturally inappropriate to the agriculture, considering the lack of rain and its poor distribution within the time and the space? Otherwise, the average farming surface per worker is 0.98 hectares. So that the agricultural production does not cover the food needs of people. This potential, considered to satisfy the food needs depending on embalmed areas cannot guarantee the food security of these population victims of high demographic growth and poor investments in modernization of the agricultural sector. After each agricultural campaign, several villages of the region are in the list of deficit. The villages chronically in deficit constitute the real vulnerable food insecurity ones. In fact, to solve this problem related to property and food insecurity, Niger decided an environmental policy of management of the spaces during many decades in Tahoua region. The population grows at an exponential rhythm, the rate increases from 3.21% in 2010 to 4.6% in 2012 according to the results of the 4th general population and housing census of 2012. This rate is the highest one of the eight (8) Niger regions. If this tendency remains, the number of farms and the average areas per household will be more reduced.

The actors

The property commission

Related to 118 up to 121 articles *enactment N °93-015 fixing orientation principles of the rural code*, *"The property commission* was created in each department (local state) and city hall, and is under the authority of the Local Governor or the Mayor. It is composed of many persons among whom the Permanent Secretary of Rural Code, the responsible of the various civil servant services and the traditional chiefs concerned in the case, a representative per group of farmers, herd men, women, youth and any other person whose expertise can help. The commission has a consultative competence and a decision power. Related to its consultative competencies, the opinion of the commission is formally needed, by no means, for all cases related to determining the content of exploiting the land in the local state and city hall; and the procedure of elaborating rural concession able of leading to the acquisition of property right over the conceded lands. The commission has also a general control over the exploitation of lands in its zone of responsibility.

Despite its decisional power and consultative competencies, the commission fails in its mission. This weakness of the commission is the result of a poor vulgarization of the rural code, for instance, in 2010, only 3,000 commissions of the 15,000 villages and tribes were set, which represent a covering rate of only 20%. It is not surprising that the principles of the rural code are not well broadcasted in the direction of property and natural resources users (Jamart, 2010) result of the attitude of the major part of the population related to the acquaintance of the commissions and their missions and consequently their dependence on external financing.

The city halls (communities)

Indeed, they were created by *Law N°2002-014/ 11 June 2002 on creation of communal district and fixing their headquarters*, but decentralisation has been effective only from December 2004 as the results of local elections. The city halls play the role of the promotion of the development of the communities they are in charge of. For sure, the dynamics of administrative ruling make every community consider the recovered lands for other uses opposite to the regulations. The city halls are accomplice of appropriation of lands. The migrants buy lands in order to make private housing development or to keep them for speculative aims. This amplifies the property pressure in rural area.

The traditional chiefs

Before the years 60s, the Niger customary authorities were owners of the lands; thus they perceive "*dime*" and "*Achoura*" kinds of tax. They are types of taxes recovered under pressure allowing customary, religious, and administrative authorities to benefit of a "*dime*", or a percentage of an amount taken from the harvest, the agricultural products or handicrafts in nature and species, given by the farmer or his offspring.

The *dime* is considered to be locative rights upon the use of the land, legitimately required by the owner of the property in relation to the cultivated land over the lender or the precarious exploiter. And *Achoura* is a kind of withdrawal of any

nature except the successive and eventual rights to the benefit of the public treasure, carried out of successions and inheritance by customary, administrative or religious authorities and particularly traditional dues or fees called "*Achoura*". In fact, the "*Law N°60-029 prohibiting of the dime and Achoura*" in its articles 1 and 2 brought a change and a relief to rural producers. Those ones suffered of the implementation of *dimes* and *Achoura* from Niger customary authorities during the years 1960. The reclaimed land perimeters are free of all customary rights (article 66 of the order 93-015 of the rural code) at the opposite of the protected forestry domain.

The peasants' organizations

The rural populations are governed by public decentralized and deconcentrated authorities. They can constitute organizations and gather in societies or associations of private right (article 110 of the order 93-015 of the rural code). The Peasants' Organizations (PO) are the driving force of rural development. They motivate people through sensitizations to participate in actions of development. They also play the role of visual witnesses in the rural area management. They are informed by the traditional chiefs, city halls, and civil service office and development projects about any issue of common interest in the area. But, within these POs, there are some kinds of misunderstandings between men and women, between traditional chiefs and PO leaders and between the chief and the inhabitants he rules over.

State Government's Representatives

The Civil servants' Services and the projects are State Government's Representatives. They act in the local development of communal, departmental and regional administrative entities. The offices of rural development have their representatives in the property commission. They control and supervise the actions of development in the region. Misgoverning and corruption disconcert them from their proper mission.

CONCLUSION

There is a challenge to tackle in search of better governance to avoid conflicts between actors of the property system. The issues are important and persistent in that complex region where two types of dwellers of different interests live together. The galloping demography and the division into small pieces of the inherited lands still make fragile the property system. At last, referring to equality of chances and equity in the access of natural resources between men and women is a necessity to promote a sustainable development.

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CONSERVATION AGRICULTURE BETWEEN CONCEPT AND APPLICATION

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ABSTRACT

The challenges of agricultural sustainability have become more intense in recent years with the sharp rise in the cost of food, energy and production inputs, climate change and water scarcity. The question is how to meet such challenges? How should be agriculture in the 21st century? The worldwide scientific and empirical evidences highlighted the important role could be achieved through rapid adoption and spread of conservation agriculture (CA). Experience worldwide over the past four decades has demonstrated how CA through the simultaneous application of a set of practices of minimal mechanical soil disturbance, organic soil cover and diversified cropping can lead to greater and stable yields, better use of production costs, enhanced crops, soil and ecosystem health, and improved climate change adaptability and mitigation. However, despite of the beneficial effects of the CA on the environment sustainability and in improving productivity and economics, yet the question arise: why CA is not spreading faster and why then do the majority of farmers are still using other tillage implements? This could be mainly attributed to the fact that much of the current production system science and education as well as the policy and institutional support systems for the modern tillage-based agricultural practices are not suitable to transformation towards enhance conservation agriculture. Furthermore for a greater number of countries there is lack of knowledge about CA systems and their management and absence of funded research and extension services. The needed enabling policies, and practical actions to promote the transformation of current production systems towards CA ones will be fully discussed in this paper.

Keywords: *conservation agriculture, soil management, environmental sustainability, Mediterranean.*

INTRODUCTION

The expected increase in population and the associated demands for food will bring additional pressures on the natural resources land and water. Consequently, the development community strongly highlighted the need for the development of sustainable agriculture production systems that are compatible with the management of all ecosystem services and also permit the restoration of degraded

agricultural lands. Indeed, nowadays, business –as-usual with regards to agriculture development is increasingly considered inadequate to deliver sustainable production intensification to meet future needs in terms of food security, poverty alleviation and economic growth and ecosystem services (Friedrich et al., 2009a, Kassam et al., 2009). Modern agriculture paradigm based on genetics, agrochemicals and intensive tillage, is beginning to run out of steam and is being increasingly challenged.

Indeed under the conventional tillage agriculture, globally we currently have most of our agricultural lands performing under sub optional and degrading conditions (Huggins and Reynolds, 2008). The sever degradation of the resource base on one hand and the environment deterioration on the other one beside other negative extremities are the major driving forces to shift from the tillage system (TA) to the conservation agriculture one (CA) which offers optional resource use with high productivity and enhanced ecosystem services. CA now spearheads an alternative biological and ecosystem paradigm that can make a significant contribution to sustainable production intensification and in meeting agricultural and food needs of future human population (Uphoff et al., 2006; FAO, 2008 Pretty 2008; Friedrich et al., 2009, Kassam et al., 2009, and FAO, 2010).

Empirical and scientific evidence from different parts of the world have shown that CA concepts and principles are of universal validity and their practices locally can successfully provide a range of productivity, socio economic and environmental benefits to the producers and the socity at large (Goddard et al., 2008; Reicosky, 2008; Pepresch and Friedrich, 2009a, 2009b).

This paper will cover some issues related to CA including (A) concepts and principals of CA; (B) world wide experience of benefits that can and are being harnessed through CA systems; (C) current status of adaption and spread of CA globally and its relevance to farming in the Mediterranean semi-arid environment.

Why CA?

Now a days many countries around the world are facing several difficult issues among them the number of unnourished and hungry people are increasing, the land available per person is decreasing and demand for food is increasing. The big question is how to produce the additional food to meet the increasing demand? And in the main time maintain a small farm profit? In spite of difficulty in answering the raised question yet, the solution could be found in CA systems as it a seems to be an appropriate solution tackling the several problems mentioned above.

There are several reasons which are strongly pushing towards the transformation of the agricultural systems from the tillage practices to the conventional ones, some of these crucial reasons could be outlined in:

- Global agricultural production will need to increase by 70 percent (and by practically 100 percent in developing countries) to meet needs of an estimated world population of approximately 9.2 billion in (2050) FAO, 2006.

- Crisis and emerging situations, which seem to be more frequent under climate change scenarios, and the political pressure for more sustainable use of natural resources and protection of environment on the one hand, and for improving and eventually reaching food security on the other provide opportunities to harness these pressure for supporting the adoption and spread of CA and for helping to overcome the existing hardness to adoption.
- With tillage agriculture and soil degradation, it is not possible to adequately harness the necessary ecosystem services for the society such as clean water, erosion control, carbon sequestration, nutrient cycling, etc.
- CA is an approach to managing agro-ecosystems for improved and sustained productivity while preserving and enhancing the resource base and the environment.
- As stated by FAO (2007) CA is a concept for resources saving agricultural crop production that strives to achieve acceptable profits together with high and sustained production level while concurrently conserving the environment.
- CA can be described as one of the best options available to farmers that improves food security, farm profitability, and farmer livelihoods.
- Furthermore through the adaption of CA practices, large productivity, economic, social and environmental benefits can be harnessed. (Lahmar and Triomphe, 2007).
- Widespread adaptation of CA has been demonstrated to be capable of producing large and demonstrable savings in machinery and energy use, and carbon emissions, arise in soil organic matter content and biotic activity, less erosion, increases crop water availability and thus resilience to drought, improve recharge of aquifers and reduced impact of the apparently increased volatility in weather associated with climate change. It will cut production costs, lead to more reliable harvests and reduce risks especially for small land holders (FAO, 2008).
- CA systems have a higher adaptability to climate change as well as a high potentiality to slow/reserve the rate of emission of CO2 and other greenhouses gases (GHG). (Baig and Gamache, 2009, CTIC/FAO, 2008).
- Society gains from CA on both large and small farms is quite felt by the increase stability of food supplies due to greater resilience of crops in the face of climate drought, and male nutrition, and health of rural population, with less call on curative health services (World Bank, 2000).

- Uncertainty about the price and availability of energy in the future suggests the need for measures to reduce overall requirements for farm power and energy while maximizing energy use efficiency. This can be achieved through CA practices hence energy requirement can be lowered by up to 60 percent or more compared to conventional farming.

CA Principles:

Conservation agriculture (CA) involves the simultaneous application of three interlinked principals (Figure 1) based on locally formulated practiced mainly: (Friedrich et al., 2009; Kassam et al., 2009, 2011a)

The first: is practicing minimum mechanical soil disturbance which is essential to maintaining minerals within soil, stopping erosion, and preventing water loss from occurring within the soil.

The second: Permanente organic cover which is much like the first in dealing with protecting the soil. The principle of managing the top soil to create a permanent organic soil cover can allow for growth of organisms with the soil structure, which will break down the mulch left on the soil surface and thereby produces a high organic matter level which will act as a fertilizer for soil surface.

The third: diversification of crop species grown in sequences and/or associations. Rotation/associations should involve 3 different crops. It aims at enhancing natural biological processes above and below the ground. Crop rotation can be used best as disease control against other preferred crops (Hobbs et al., 2007). Indeed, rotational crops will act as a natural insecticide and herbicide against specific crops. Establishing crops in rotation allows for an extensive build up of rooting zones which will allow for better water infiltration (Hobb et al., 2007).

The principles of CA and the locally formulated adaptation practices have the capacity to slow and reserve productivity losses and environmental damage, thus offering an innovative sustainable approach to farming in all agro ecologies.

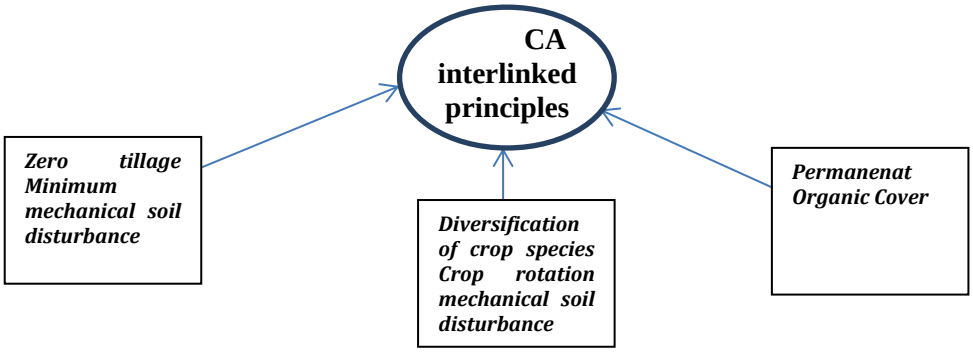

Figure 1: CA Principles

CA Restrictions:

The primary restriction to CA adoption is the assumption that soil tillage is essential for agricultural production. Other restrictions include those of intellectual, social, technical, environmental and political characteristics. Key restrictions with mainstreaming CA systems relate to problems with up scaling which is largely due to the lack of knowledge, expertise, inputs especially equipment and machinery, adequate financial resources and infrastructure, and poor policy support (Friedrich and Kassam 2009; Friedrich et al., (2009b). Other restrictions in the weakness in generating the knowledge needed for the transformation of farming sector towards (CA). This is the case in many countries including those of the Mediterranean region.

To fulfill this gap those countries should rely on: (a) the evidence and successful experiences already exist in several countries around the world; (b) establish a network of publically funded on farm operational research in which farmers can be provided with an opportunity and financial support to experiment with CA practices and adopt them to suit their socio-economic and agro-ecological conditions; (c) the management of the machinery sector to develop a new set of mechanical technologies for CA farming and (d) governments must make a firm and sustained commitments to encourage and support CA and above all providing the farmers with the needed financing and logistic support to adopt CA practices (Friedrich and Kassam 2009; Freidrich et al., 2009).

CA Challenges

- Like with any farming system, adoption of CA has constraints, CA is more technologies normally have to be tailored to specific production environment. Establishing CA can be difficult in the initial years, particularly in some semiarid areas, more clayey soils, compact soils, and on poorly drained soils, under those conditions special innovation are often required.
- Other challenge under CA practicing is pest and disease control where specific residue attract specific pests and this will require the use of pesticides and herbicides at least in the initial years.
- Under the CA systems one of the main principles is maintenance of soil cover with crop residues and this to some extent eliminates an important source of animal fodder particularly in the areas where livestock are important in farm economies.
- However, the globally experiences gained and learned lessons on the adoption and spread of CA show that the above mentioned challenges can be and are being overcome through locally-formulated solutions involving a range of public and private sector stakeholders working together with

farmers along different pathways of adoption and transformation tillage agriculture system to the conservation one.

- Under CA systems weed controls often highlighted as special challenge. To face this challenge still more research is needed to provide local solutions on integrated weed management in CA systems that can keep the use of herbicides to a minimum or avoided where necessary possible.

Potential benefits from Conservation Agriculture.

In the field of CA there are many benefits that both the producer and conservationist can obtain: on the side of conservationist CA can change the way humans produce food and energy. With conservation come environmental benefits of CA. These benefits include less erosion possibilities, better water conservation, improvement in air quality due to lower emissions being produced and a chance for larger biodiversity in a given area.

On the side of producers and/or farmers: CA gives farmers a means of conserving, improving, and making more efficient use of their natural resources FAO (2006). CA is shown to have even higher yields and higher outputs than conventional agriculture once it has been established over long periods.

The FAO believes that there are three major benefits from CA:

- Within fields that are controlled by CA the producer will see an increase in organic matter.
- Increase in water conservation due to the layer of organic matter and ground cover to help eliminate transportation and access runoff.
- Improvement of soil structure and rooting zoon.

However, as much as conservation agriculture can benefit the world, there are some problems that come with it. There are many reasons why conservation agriculture cannot always be a win-win situation:

- There are not enough people who can financially turn from conventional farming to conservation,
- The process of CA takes time, when the producers starts the CA process, the results can be of financial loss to them.
- Another financial undertaking in purchasing of new equipment in order to produce effectively.

Box 1:. Conservation farming offers many benefits to TOP and agriculture including:

- *Reduced erosion and improved soil structure.*
- *Improve infiltration and moisture efficiency.*
- *Improved soil health and nutrient retention.*
- *Lower soil temperature and better establishment.*
- *Increased planting opportunities and flexibility.*
- *Lower machinery labour and maintenance cost, and*
- *More reliable yields. (reference ?)*

Spread of conservation agriculture

CA comprising minimum mechanical soil disturbance and direct seeding, organic mulch cover from residues and cover crops, and crop species diversification through rotations and associations, is now practiced globally on about 117 million ha in all continents and all agricultural ecologies**. (Table 1)**

Table 1. Extent of Adoption of Conservation Agriculture Worldwide (countries with > 100,000 ha)

Country	Area under No-tillage (ha) (2008/2009)
USA	26,500,000
Argentina	25,785,000
Brazil	25,502,000
Australia	17,000,000
Canada	13,481,000
Paraguay	2,400,000
China	1,330,000
Kazakhstan	1,300,000
Bolivia	706,000
Uruguay	655,000
Spain	650,000
South Africa	368,000
Venezuela	300,000
France	200,000
Finland	200,000
Chile	180,000
New Zealand	162,000
Colombia	102,000
Ukraine	100,000
Total	116,921,000

**Source: Derpsch and Friedrich., 2010*

During the last decade, CA has been increasing at the rate of 6 million hectares per annum mainly in north and South America and Australia, and more recently in Asia, Africa, and Europe, where large increase in the adoption of CA are expected.

Nowadays CA is actually applied on about 10 percent of the world's crop land and adoption is growing fast. However, it is not growing fast enough to face the challenges ahead, such as the need to eradicate hunger and food insecurity for a growing population and address the threats of climate change, land and environmental degradation, resource scarcity and increasing cost of food productions inputs and energy.

However, for the rapid adoption and spread of CA we are in need to:

- A change in commitment and behavior of all concerned stakeholders.
- For farmers, it is needed a mechanism to experiment, learn and adopt
- For the policy makers and institutional leaders, transformation of tillage system to CA requires that they fully understand the large and long term economic, social and environmental benefits
- Sustained policy and institutional support role that can provide incentives and required services to farmers to adopt CA practices and improve them over time.

CA in the Mediterranean

Several researchers Lahmar and Triomphe (2007), and Plata et al., 2007, in their work concerning CA and its implementation in the Mediterranean region, all endorsed the benefits that can be harnessed by farmers in the semiarid Mediterranean environment, in the Mediterranean countries and particularly the developing one. However, they reported that CA is perceived as a powerful tool as it allows farmers to improve their productivity and profitability as well as conserving and even improving the natural resources base and environment. It should be understood that without farmer engagement and appropriate enabling policy and institutional support, rapid uptake of CA is not likely to occur.

Unfortunately deep analysis of CA practices and its adaptation, indicate that national administration in many developed and developing countries of the Mediterranean are still not full convinced that the concept of conservation agriculture is the most promising one to meet the requirements of an environmentally friendly farming, capable to meet the needs of the farmers to lower production costs and increase farm income due to increases and greater stability in yield production, soil protection against wind and water erosion, greater nutrient efficiency and better water economy in dry land areas.

CA practices in dry Mediterranean areas: challenges and constraints

CA adoption in dry lands faces critical challenges linked to water scarcity and drought hazard, low biomass production and acute competition between conflicting uses including soil cover, animal fodder, cooking, heating fuel, raw material for habitat etc. Other key factor is attributed to poverty and vulnerability of many small holders those relying more on livestock than on grain production. However, in dry climate areas it has been shown that biophysical, economic and knowledge constraints.

Can be surmounted if the stakeholders are working together and if policy and institutional support and relevant knowledge can be provided to farmers. Equally, for small holder farming there is critical need for a comprehensive assessment of the ecological and socio-economic conditions under which CA would be practiced.

Enhancement of CA practices: supporting measures. (Box 2)

- Formation of producers associations. This is one of the measures of vital importance particularly in developing countries where small farms are dominant. Such associations can provide the farmers with the required machinery tools needed for CA practices. In addition, it facilitates the exchange of experience, the dissemination of information on the CA practices amongst smaller farmers.
- Support of agricultural service providers. This measure plays an important role in facilitating the wide spread adoption of CA practices as it disposes of direct drills beside providing the seeds that can grow successfully under the prevailing local conditions and thereby easing the constraints related to adoption of CA practices.
- Support of adaptive research on CA systems lags behind what farmers are discovering and adapting own initiatives. Indeed, the many synergistic interactions between components of CA practices are not fully understood. There are still some research is needed concerning crop rotation, weed control, increase crop water productivity and on farm water use efficiency. In order to find sustainable solutions to the most urgent questions behind the low application rate of CA, the national research institutions should install multi-stations trials accompanied by on farm trials.
- Facilitation of exchange of information and experiences among farmers. This is the primary task of the extension surface officers. This implies that extension service stuff should be under continuous training to update their know how and knowledge of CA systems. Strengthening the extension service body is a win-win game not only in facilitating exchange amongst farmers but also providing research institutions with the actual problems the farmers are facing to decide on the actions to be implemented.
- Education. Students at agricultural schools and universities have to become acquainted with CA during their studies. Furthermore students should be provided with well-organized training programmes in CA during their studies. The production of training manuals beside scientific videos and technical information handbooks are the most appropriate tools for this task.

- National and regional networking. Experiences with national and regional networks showed to be very efficient in enhancing the disseminative of CA practices. The running networking activities exchange is easing of information and experiences between practitioners and researchers and other experts, enhancing institutional support and improving cross sectorial co-ordination in terms of making the best use of existing but dispersed experience and information. According to Hamdy (2010), to gain major benefits from networking and networks it is needed to dedicate capable key members acting as focal points, consistent flow of adequate trusted information, a shared scene of professional development, political and decision making and above all a good and reliable communication system.

Box 2:. CA Practices supporting measures*::*

- *Formation of procedures associations*
- *Support agricultural services providers*
- *Support of adaptive research on CA*
- *Facilitation of exchange of information and experiences among farmers*
- *Education*
- *National and regional networks (reference ?) retention.*
- *Lower soil temperature and better establishment.*
- *Increased planting opportunities and flexibility.*
- *Lower machinery labour and maintenance cost, and*
- *More reliable yields*

Spreading CA systems: major governmental tasks

Globally, courtiers involved in introducing and implementation CA systems to replace the conventional TA in order to tackle the notable deterioration in soil health and its productivity, environment degradation and shortage in food production, governments are requested to do the followings:

- Harmonize their policies to support the adoption of CA
- Introduce mechanisms which provide incentives for farmers to CA
- Pursue the case of conservation agriculture as a central mechanism for agriculture sector climate change mitigation in the international negotiations for a post Kyoto climate change agreement
- Include conservation agriculture as base concept for the adaptation of agriculture to the challenges of climate change in the national action plans for adaptation
- Support the UN food and agriculture organization in the endeavor to establish a special programme on conservation agriculture to facilitate this process in its member countries.

CONCLUDING REMARKS AND RECOMMENDATIONS

- CA is knowledge intensive and a complex system to learn and implement, it cannot be reduced to a simple standard technology. It is now considered to be a practical agro-ecological approach achieving sustainable agriculture intensification. It offers environmental. Economic and social advantages that are not fully possible with tillage-based production systems, as well as improved productivity and resilience and improved ecosystem service while minimizing the excessive use of agrochemicals, energy and heavy machinery. (FAO, 2011)in addition in order to put chandler practicing.
- The scaling up of CA practices to achieve national impact requires a dynamic complement of enabling policies and institutional support to producers and supply chain service providers only then it will become possible for CA practices.
- Conservation agriculture, like many agricultural methodology, must be adapted to local environmental and socio economic conditions. It is not a silver bullet solution to the problems facing modern agriculture, but it is one of the better alternatives available.
- Every country in the world must begin to set target for change towards CA, and use all available means and processes to set the transformation in motion thereby securing significant economic, socioeconomic and environmental benefits for the farmers and for the population at large in the world.
- If CA practices are to take off in many countries particularly those suffering serious food shortage a behavioral change in all stakeholders must be encouraged and facilitated. This includes the role and competences of the key national extension, research and education institutions, the government departments, development agencies and donors that support them as well as the private sectors that has an important role to play in innovation processes and in input supply including equipments and machinery
- A full benefits of CA take several years to fully manifest themselves, fostering dynamic CA sector requires an array of enabling policy and institutional support over a long-term time horizon. This will allow farmers to take advantage of the future carbon and water markets and support for environmental services currently under discussion internationally.

- Yield is the primary output commodity from CA systems. However we need to consider the long-term positive economic, environment, social, cultural and policy dimensions of CA systems as opposed to the corresponding negative attributes of conventional tillage agriculture. Thus it becomes quite important that we understand all of the benefits of CA, not just the yield impacts.
- In addition, now it is being increasingly recognized as important for longer-term sustainability and resilience of food production and agriculture systems, in the face of increased climatic variability and climate change.
- A more structural response to the opportunities presented by CA calls for a realignment of agricultural institutions, including research, extension and education, as well as agriculture development policies to enable CA to choice around which to strengthen national and international food and agriculture system.

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The 1st issue of the AGROFOR International Journal has been published with the assistence of the Regional Rural Development Standing Working Group (SWG) in South-Eastern Europe within the SWG GIZ project: "*Strenghtening regional capacities for rural development through integrated forest and water resources management in southeast Europe*".


Agrofor