

MILK PRODUCTION AND CHALLENGES IN TRANSITION FROM CONVENTIONAL TO ROBOTIC MILKING IN CROATIA

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ABSTRACT

Milk production in the Republic of Croatia is facing a great challenge. Over the years, there has been a decline in the number of farms, cattle and the amount of milk production. Data for 2019 show a decrease in the number of cows for milk production of 4.4% compared to the previous year, or 14.4% over the last 5 years. Consequently, during the mentioned period, there was a drop in milk production by 15.5%. There are several reasons for this situation: high fragmentation of parcelled land, rural population moving to cities and other richer EU countries, negative population demographics, strong pressure of cheap milk imported by retail chains from western and northern EU member states, insufficiently modernized farms. All this makes it difficult for the survival of the Croatian farmer. Self-sufficiency in milk production in 2019 in Croatia was only 48.4%. In order to somewhat stop these negative trends, the Government of the Republic of Croatia is trying to encourage farmers to modernize dairy farms. One way of modernization is the introduction of milking robots. Farmers increasingly accept the proposed idea. Currently, 40 robots were installed in Croatia, distributed on 27 farms. Preliminary production results show that on robotic farms there has been an increase in milk production at the lactation level of about 528 kg. In addition to the production effect, the robotization of farms also leads to a financial effect on the entire Croatian economy.

Key words: milk production, conventional milking, robotic milking, cows, Croatia

INTRODUCTION

Milk production, on a global scale, refers mainly to the milk of ruminants and herbivores, cattle, sheep, goats, camels, buffaloes and horses and is the most important technological direction in livestock production [FAO 2021]. Looking at the total production related to the dairy sector, it can be said that the European Union is an important producer of milk and dairy products in the world. Total milk production in the EU is estimated at around 155 million tonnes per year. The largest producers are Germany, France, Poland, the Netherlands, Italy and Spain, which together account for almost 70% of the total Union production [CLAL 2021]. Milk as a food market item generally refers to cow's milk. Cattle production in Croatia is the strongest branch of animal husbandry with a very long tradition. Organized selection work and keeping records of cattle began 100 years ago [Mijić 2013].

In order to facilitate the hard and daily work of the population engaged in agricultural production, technological modernization is being introduced more and more. Many technological processes and operations are now performed by robots. One of the most complex is the process of milking cows. However, robots in agriculture also need to have human interaction in order to better solve problems related to the complexity of programming a particular task. A robotic arm that must satisfy certain movements, but also economic efficiency [Butler et al. 2012], most often performs work tasks. Agricultural robots use a combination of advanced sensors, cameras, software and technology. The need to use robots in developed livestock countries, or automated milking in cattle production, emerged in the 1980s [Meijering et al. 2004]. The main feature of automatic milking was higher labour efficiency, lower labour costs, and labour shortages. This system is especially suitable for farms with a free way of

keeping cows, for stables with beds, but also for cows on pastures [Winnicki et al. 2019]. The use of milking robots with accompanying computer and software programs enables complete automation of the milking process [De Koning 2011]. It is important to emphasize that milking cows represents 25–35% of the annual work spent on the farm [Havranek and Rupić 2003]. Therefore, the introduction of milking robots reduces the share of human labour in milking, and increases the share of labour in the management and control of milking.

The aim of this paper is to present the trends of milk production in the Republic of Croatia, and some guidelines that can lead to the revitalization of the dairy sector and milk production. Modernization of farms led by automated milking systems is currently one of the most significant investments for Croatian farmers. The assumption is that such modernization of farms will partially stop the negative trends of milk production and increase the interest of the younger rural population in this production.

Situation in the dairy sector and reasons for modernization of dairy farms in Croatia

Milk production in the Republic of Croatia mostly takes place in the northern part, where dominate a plains and hilly landscapes. The agro-climatic conditions for cattle production are favourable in this area; the soil is fertile and arable and the breeds for milk production have high genetic predispositions. However, today's amount of milk production in Croatia is not at a satisfactory level. The average milk production per cow in the Republic of Croatia places us at the very bottom of the scale of European countries.

One of the reasons is the large share of family farms with a small number of cows. According to official data [CAAF 2021], the purchase of milk by dairies in Croatia was recorded on approximately 5,000 farms. Of this number, as many as 71.6% of farms keep less than 6 cows (Fig. 1) and a total number of cows of 19.9%. Nevertheless, the largest number of cows in milk production (79.1% of cows) is located on farms that own more than 6 cows.

We see the base for modernization and robotization of farms in producers who have 31 to 250 cows on the farm. There are about 3.4% of such farms in Croatia and they own 26% of cows for milk production. Such farms usually decide to robotize farms, usually buying one to three robots for milking cows.

In the European Union, annual milk production has a growing trend. In 2019, about 158.2 million tons of milk were produced (Fig. 2). Of this amount, 438,000 tons of milk were produced in Croatia, which is a modest 0.3% of European Union milk production (Fig. 3). Although there are almost all prerequisites for successful milk pro-

duction, the Republic of Croatia is at the very bottom of the scale for milk production in the EU [CLAL 2021].

The negative trend in milk production in Croatia has been going on for many years. Figure 4 shows the ratio of production in 2019 versus 2018. The decline in production in 2019 compared to the previous year was 3.9%, which is also the largest decline in one EU member state.

The number of dairy cows, i.e. the number of cows of dairy and combined breeds has a very similar descending order as the number of all cows in the Republic of Croatia. According to data published on Milk Market Observatory [2021], the number of dairy cows at the end of 2019 was 130,000, which is 4.4% less than on the same date last year.

In the period from 2015 to 2019, milk production in Croatia decreased by 77.8 million kilograms or 15.15% less. In the same period, the number of milk producers decreased by 3763 producers, or 43%. The positive trend is an increase in the quantity delivered per producer by 49% (Fig. 5).

Based on the presented data, the Republic of Croatia is currently self-sufficient in milk production only 48.4% and is in the penultimate bottom of all EU members (Fig. 6). Insufficient own milk production is met by milk from other EU countries (Hungary, Slovakia, Austria, Slovenia).

According to TISUP [2021], the purchase price of raw milk in Croatia for the July of 2021 was 32.49 EUR per 100 kg of milk. This price was 9.14% lower than the average purchase price of milk in the EU-27 [TISUP 2021]. In addition to such a low price of milk, a big problem for the correct price of milk is the large supply of milk through foreign retail chains. Some retail chains in stores sell milk in a tetra pack almost at the level of the purchase price of raw milk in Croatia. Unfortunately, the Ministry of Agriculture of the Republic of Croatia cannot do much in regulating the market and prices. Foreign companies own almost all large retail chains.

Current situation of installed milking robots, experience and opinions of farmers about incorporation of robotic milking in the Republic of Croatia

In the Republic of Croatia, the robotization of milking cows began in 2008 when the company Belje d.d. for the needs of its dairy farm Topolik procured six robots. At the time, it was the only farm in this part of Europe. The number of farmers who have acquired milking robots will gradually increase from year to year. Today in the Croatia, according to the Croatian Agency for Agriculture and Food, there are 40 robots distributed on 27 farms (Table 1). Although there is a growth trend, it is not enough intense. These numbers show that in Croatia only 0.6% of farmers own milking robots, which

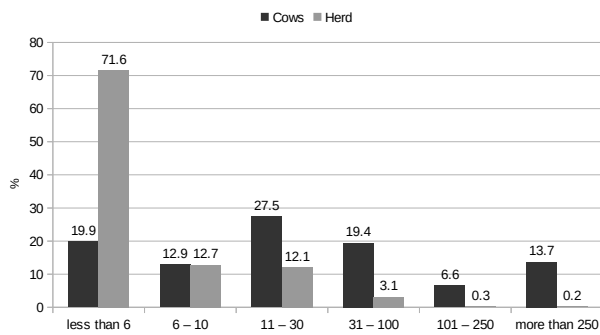


Fig. 1. The structure of the number of cows and herds for milk production in Croatia for 2020 [CAAF 2021]

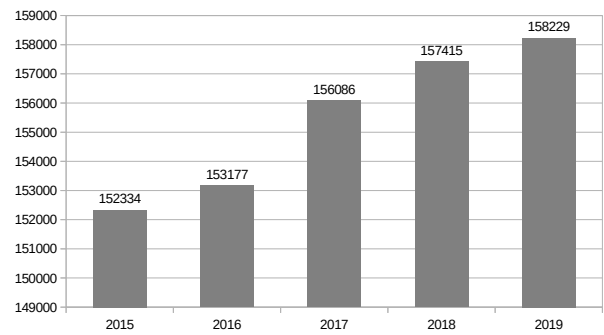


Fig. 2. Movement of milk production in the EU ('000 tons) [CLAL 2021]

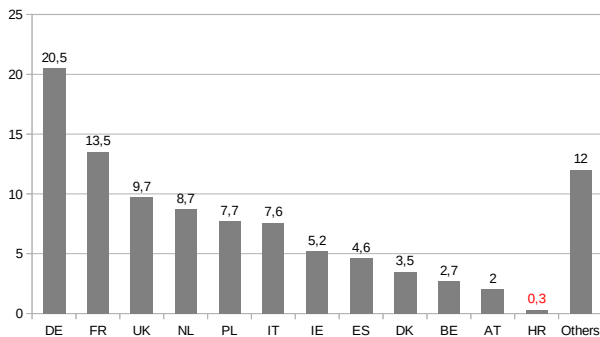


Fig. 3. Milk production by EU countries (%) [CLAL 2021]

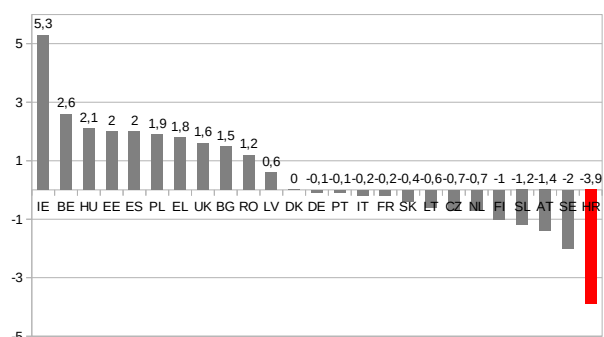


Fig. 4. Ratio of milk production trends 2019: 2018 (%) by EU members [Milk Market Observatory 2021]

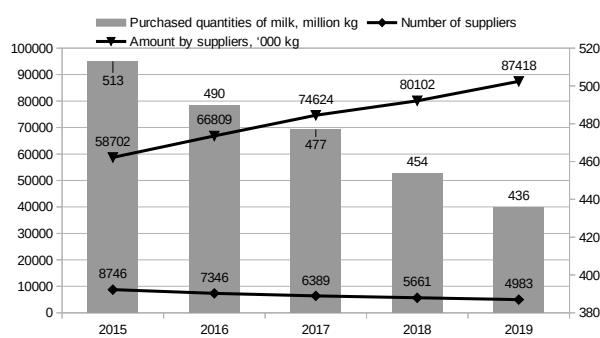


Fig. 5. Movement of the number of suppliers and purchased quantities of milk [CAAF 2021]

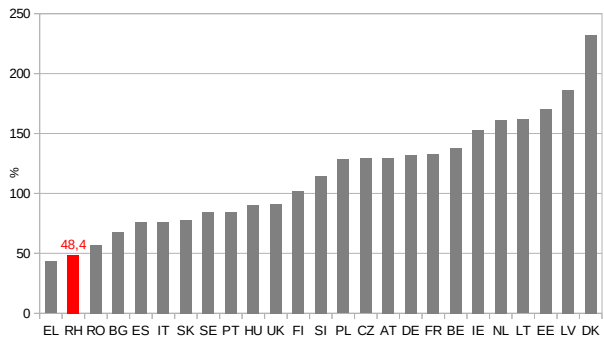


Fig. 6. Self-sufficiency in milk production by EU countries [CLAL 2021]

is still far below the average of Western European countries, where about 20% of farmers own milking robots. For a faster growth of farmers who would like to procure milking robots, it is necessary to invest much more effort in both the profession and the Ministry of Agriculture of the Republic of Croatia.

During the year 2020, a survey was conducted among Croatian dairy farmers which had transferred from conventional to robotic milking [Mijić and Bobić 2020]. The survey form consisted of 21 questions aimed at obtaining as clear a picture as possible of the experiences of farmers who switched from conventional to robotic milking of

Table 1. Distribution of milking robots on the dairy farms in the Republic of Croatia [CAAF 2021]

Robot manufacturer	Lely	DeLaval	GEA	BauMatic	Ukupno
2019					
Number of robots	17	10	2	1	30
Number of dairy farms	12	5	2	1	20
2020					
Number of robots	22	14	3	1	40
Number of dairy farms	16	7	3	1	27

Table 2. Part of the research results from Mijić et al. [2021] revised and adapted by the author of this article

Trait	Conventional Milking	Robotic Milking	Differences*	Significances
Lactation	2.51 ^a	1.77 ^c	-0.74	p < 0.0001
Milk (kg)	7828.5 ^a	8357.6 ^c	+529.1	p < 0.0001
Fat (%)	4.06 ^a	3.85 ^c	-0.21	p < 0.0001
Protein (%)	3.48 ^a	3.47 ^a	-0.01	NS
Somatic Cell Count (1.000 · mL ⁻¹)	266 ^a	283 ^a	+17	NS
Urea (mg · dL ⁻¹)	25.34 ^a	23.86 ^c	-1.48	p < 0.0001

*Differences in production traits after transition from conventional to robotic milking; NS – not significant.

cows. All the respondents had bought robots in 2019, and they were mostly young farmers (84%), less than 30 or up to 50 years of age. The surveyed farmers stated that the most common reason for switching from conventional to robotic milking was to reduce the human labour (47%), and to improve their own quality of life (26%) (Fig. 7). Most of these answers were given by the owners of family farms, while the owners of larger farms wanted to manage the farm more efficiently or increase production results.

According to most farmers (about 53%), an investment in the purchase of robots is too high, while about 47% think that the price of robots is realistic (Fig. 8).

More farmers (79%) managed to secure funds from multiple sources (EU funds, banks, etc.). Those who used EU funds were able to get support of 50% of the value of the equipment. However, others farmers failed to do so and had to invest their own money. About 68% of farmers managed to adapt most of their cows on the farm within three months, as well as their new commitments to robotic milking. About 84% of farmers reported that using milking robots in their cows led to an increase in milk production. For 53% of farmers, this increase was at least 10%, while 5% of farmers had an increase in production of over 30% (Fig. 9). Although the majority of

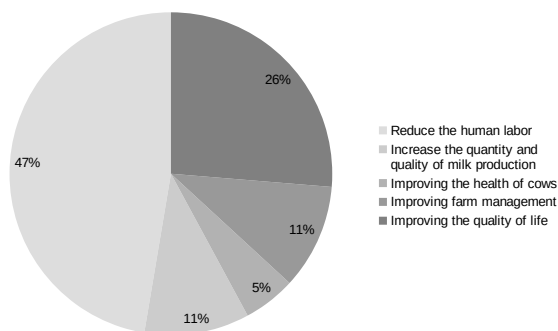


Fig. 7. Reason for transition from conventional to robotic milking of cows [Mijić and Bobić 2020]

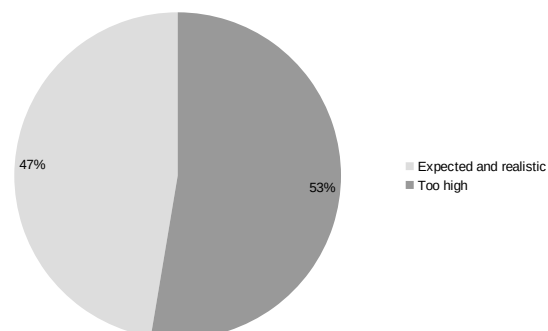


Fig. 8. Opinion of farmers on the amount of money invested for the purchase of milking robots [Mijić and Bobić 2020]

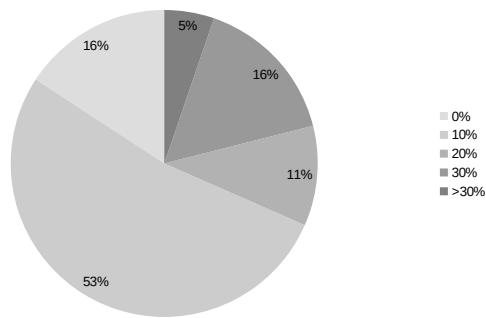


Fig. 9. Increase in milk production after the introduction of milking robots (%) [Mijić and Bobić 2020]

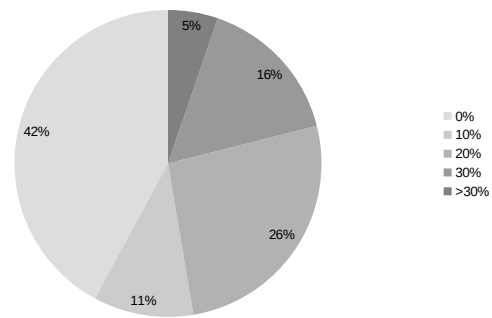


Fig. 10. Increase in microbiological and health quality of milk after introduction of milking robot (%) [Mijić and Bobić 2020]

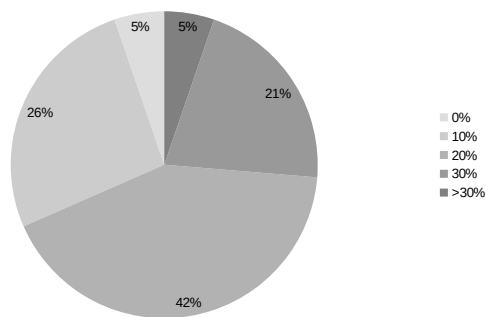


Fig. 11. Increasing the health of cows (reproduction, mastitis, hooves, etc.) after the introduction of milking robots [Mijić and Bobić 2020]

respondents (about 58%) also had an increase in the microbiological and health quality of milk, a considerable number (about 42%) did not notice this (Fig. 10).

In 95% of farmers there was an improvement in the health of cows, whether it was reproductive problems, mastitis, hooves, etc. (Fig. 11). About 74% of farmers stated that their quality of life, free time and opportunity to engage in other work increased by 30% or more.

Robotic milking of cows, according to farmers, for the most part (about 89%) did not have any negative impact on cows. However, 11% of farmers report noticing certain behavioural changes or poorer cow health. At the end of the survey, farmers stated the need for various educations, most often citing issues related to genetics and selection of cattle suitable for robotic milking.

Aiming to investigate production results of dairy farms that have undergone a transition from conventional to robotic milking cows, Mijić et al. [2021] analysed a two such dairy farms. Their results showed a significant ($p < 0.0001$) decrease in the number of older cows seen through the number of lactations after the transition from conventional to robotic milking from 2.51 to

1.77 lactation (Table 2). According to Mijić et al. [2021] the average production per cow increased significantly ($p < 0.0001$) by about 500 kg milk in the second year after the introduction of robotic milking, while the percentage of milk fat (-0.21) and urea (-1.48) in milk decreased significantly ($p < 0.0001$; from 3.48 and 25.34 to 3.47 and 23.86, respectively). The number of somatic cells increased, but not significantly. Mijić et al. [2021] emphasize that the first (transitional) year (the year of transition to robotic milking) poses the biggest challenges for farmers in production: adaptation of the facility and installation of robots, habituation of cows to robotic milking, increased herd culling, mastering technical features of robotic milking systems and information, etc.

CONCLUSIONS

In conclusion, it can be said that the pioneering work of switching from conventional to robotic milking of cows with Croatian farmers was successful. Along the way, there were various challenges and ambiguities, most often of a financial or bureaucratic nature. However, the first

production results encouraged all farmers. Most of the surveyed farmers have experienced positive trends on the farm, whether it is increasing milk production, improving the quality of life of farmers or reducing the share of human labour on the farm. In the initial phase of the introduction of robots, additional effort is needed by farmers in the selection of cows suitable for robotic milking, and the creation of the habit of cows to go to milking more often. In order to maximize the efficiency and utilization of robots, a number of different trainings need to be conducted with farmers.

REFERENCES

- Butler, D., Holloway, L., Bear, C. (2012). The impact of technological change in dairy farming: robotic milking systems and the changing role of the stockperson. *J. R. Agric. Soc. Engl.*, 173, 1–6.
- CAAF (2021). Cattle Breeding – Annual Report for 2020. Croatian Agency for Agriculture and Food, Osijek [in Croatian].
- CLAL (2021). EU-27: milk production and population. Italian Dairy Economic Consulting, www.clal.it.
- De Koning, K. (2011). Automatic milking: Common practice on over 10,000 dairy farms Worldwide. Dairy Research Foundation 2011 Symposium. Ed. Pietro Celi. Current topics in Dairy Production, University Printing Service Sydney. 16, 14–31.
- FAO (2021). Milk production. Food and Agriculture Organization of the United Nations, www.fao.org.
- Havranek, J., Rupić, V. (2003). Milk from the farm to the dairy. Croatian Dairy Association, Zagreb, Croatia. [in Croatian]
- Meijering, A., Hogeveen, H., de Koning, C.J.A.M. (2004). Automatic milking: a better understanding. Wageningen Academic Publishers, Wageningen, the Netherlands. DOI: 10.3920/978-90-8686-525-3.
- Mijić, P. (2013). Dairy properties of Simmental. International Forum on Simmental Breeding on the occasion of the 100th anniversary of organized breeding and selection work in animal husbandry of the Republic of Croatia and the establishment of the first Association of Cattle Breeders' Associations in Sveti Ivan Žabno. Days of Croatian Simmental. Ed. Bulić, V., Sv. Ivan Žabno 15. 06. 2013. Proceedings, 39–44. [in Croatian]
- Mijić, P., Bobić, T. (2020). Evaluation of the success of the transition from conventional to robotic milking of cows on the example of Croatian farms. XIV Counseling of Cattle Breeders in the Republic of Croatia, Terme Tuhelj, 29–30.01.2020, Osijek, Croatia, 99–111 [in Croatian].
- Mijić, P., Ivkić, Z., Bobić, T. (2021). Research of production results in the transition from conventional to robotic milking of cows. 13th International Symposium “Modern Trends in Livestock Production”, 06–08.10.2021, Belgrade, Serbia [in press].
- Milk Market Observatory (2021). EU Cow's Milk collected. <https://ec.europa.eu/>.
- TISUP (2021). Raw milk and milk products 7/2021. Market price information system in agriculture of the Republic Croatia, www.tisup.mps.hr.
- Winnicki, S., Romaniuk, W., Mielcarek-Bocheńska, P., Borusiewicz, A., Barwicki, J. (2019). Efficiency of Milking Cows Using Robot in a Large Herd. *Agric. Eng.* 23(4), 87–101. DOI: 10.1515/agriceng-2019-0040.

PRODUKCIJA MLEKA I WYZWANIA ZWIĄZANE Z PRZEJŚCIEM Z DOJU KONWENCJONALNEGO NA ZROBOTYZOWANY W CHORWACJI

STRESZCZENIE

Produkcja mleka w Republice Chorwacji stoi przed wielkim wyzwaniem. Na przestrzeni lat nastąpił spadek liczby gospodarstw, pogłowia bydła i wielkości produkcji mleka. Dane za 2019 rok pokazują spadek pogłowia krów mlecznych o 4,4% w stosunku do roku poprzedniego, czyli 14,4% w ciągu ostatnich 5 lat. W konsekwencji, we wspomnianym okresie nastąpił spadek produkcji mleka o 15,5%. Przyczyn takiej sytuacji jest kilka: duże rozdrobnienie parcelowanych gruntów, przenoszenie się ludności wiejskiej do miast i innych bogatszych krajów UE, negatywna demografia populacji, silna presja taniego mleka sprowadzanego przez sieci handlowe z zachodnich i północnych krajów UE, niedostatecznie zmodernizowane gospodarstwa. Wszystko to utrudnia przetrwanie chorwackiego rolnika. Samowystarczalność w produkcji mleka w 2019 roku w Chorwacji wyniosła tylko 48,4%. Aby nieco powstrzymać te negatywne tendencje, rząd Republiki Chorwacji stara się zachęcić rolników do modernizacji gospodarstw mlecznych. Jednym ze sposobów modernizacji jest wprowadzenie robotów udojowych. Rolnicy coraz częściej akceptują tę propozycję. Obecnie w Chorwacji zainstalowanych jest 40 robotów, rozmieszczonych w 27 gospodarstwach. Wstępne wyniki produkcyjne wskazują, że w gospodarstwach zrobotyzowanych nastąpił wzrost produkcji mleka o około 528 kg z laktacji. Oprócz efektu produkcyjnego, robotyzacja gospodarstw prowadzi również do zwiększenia efektu finansowego w odniesieniu do całej chorwackiej gospodarki.

Słowa kluczowe: produkcja mleka, dój konwencjonalny, dój zrobotyzowany, krowy, Chorwacja