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Income risk and income stabilization tool in Croatian horticulture

Rizik dohotka i osiguranje dohotka u hortikulturi Hrvatske

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ABSTRACT

Due to the lack of reliable longitudinal data, farm income and income trends haven't been much analysed in Croatia, specifically among horticultural producers. Based on Croatian Farm Accountancy Data Network (FADN), the goal of this paper is to research the income of all farms in comparison to horticultural farms. In addition, paper tests farm's eligibility for Income Stabilization Tool (IST) compensation. Objectives of the paper are: (1) analysis of farm income in the period 2014-2017 for all farms and specifically for horticultural farms, and (2) analyse how many horticultural farms have potential for IST compensation. For the second objective, we prepared scenarios of annual income drop of 10%, 20%, and 30% of the three-year average income. Scenarios are shown for groups - wine, orchard, and olive farms (calculated group index) and for individual farms (calculated farm index). Results show that horticultural farms' income is on the similar level to the data for all the farms in FADN. The group index calculation compared to farm index income calculation shows a higher number of farms eligible for IST. The paper might serve as a basis for the introduction of IST in Croatian agriculture.

Keywords: FADN, horticulture, income, income stabilization tool, risk

SAŽETAK

Zbog nedostatka pouzdanih longitudinalnih podataka, dohodak i trendovi dohotka poljoprivrednih gospodarstava nisu mnogo istraživani u Hrvatskoj, posebice među hortikulturnim proizvođačima. Na temelju Sustava knjigovodstvenih podataka poljoprivrednih gospodarstava u Hrvatskoj, cilj ovog rada je istražiti dohodak svih gospodarstava u usporedbi s hortikulturnim gospodarstvima. Osim toga, u radu se ispituje sposobnost poljoprivrednih gospodarstava za primjenom alata za stabilizaciju dohotka (IST). Ciljevi rada su: (1) analiza dohotka poljoprivrednih gospodarstava u razdoblju 2014.-2017. za sva gospodarstva, i posebno za hortikulturna gospodarstva, te (2) analiza koliko hortikulturnih gospodarstava ima potencijal za IST potporu. Za potrebe drugog cilja pripremili smo scenarije pada godišnjeg dohotka od 10%, 20% i 30% trogodišnjeg prosječnog dohotka. Prikazani su scenariji za skupine - vinogradarska, voćarska i maslinarska gospodarstva (izračunati grupni indeks) i za pojedinačna gospodarstva (izračunati indeks gospodarstva). Rezultati pokazuju da je dohodak hortikulturnih gospodarstava na sličnoj razini kao i podaci za sva gospodarstva u FADN-u. Grupni indeks u usporedbi s indeksom dohotka poljoprivrednog gospodarstva pokazuje veći broj gospodarstava koja ispunjavaju uvjete za IST. Rad bi mogao poslužiti kao osnova za uvođenje IST-a u hrvatsku poljoprivredu.

Ključne riječi: FADN, hortikultura, dohodak, osiguranje dohotka, rizik

INTRODUCTION

Various risks impact agricultural businesses. Besides climate change and extreme weather events that cause high economic losses, prices variability of input and output also impacts agricultural households. Meuwissen in 2011 emphasized the expected increment of income variability after 2013. The main reasons for volatile income are factors that impact agricultural production and price (Meuwissen et al., 2011). In various research primary indicator for income is farm net value added (FNVA) (Severini et al., 2018; Severini et al., 2019) available in the EU's Farm Accountancy Data Network (FADN).

EU Farm income began to grow in 2014. This positive trend on farms continued in 2015. EU-28 average farm net value added (FNVA) increased only marginally (0.5%) from 2014 to 2015. Average FNVA/AWU in 2015 remained stable at EUR 18,600, unchanged from its level in 2014. Agricultural holdings with the highest income per working unit were mainly located in Denmark, northern Italy (Lombardia), northern France (Champagne Ardenne), and north-west Germany. In these regions, there is a high percentage of highly intensive granivore production (i.e., pigs and poultry), horticulture, and dairy farms. The lowest average FNVA/AWU per farm was in the Adriatic Croatia (European Commission, 2018).

Majority of analyses conducted on the FADN database point to the great significance of the Common Agricultural Policy (CAP) support for farms in the EU. According to available information, farm revenues would be 27% lower without CAP support, while for some farm types the CAP payments make up to 50% of the total farm income. The FADN sample size in Croatia varies between 1,290 and 1,337 in the period 2014-2017. In the same period, the total farm output value varies between 405 and 486 thousand of HRK (around 54 thousand EUR).

Farm income and income trends among horticultural producers in Croatia have not been much researched. Because of the importance of horticulture in Croatia and exposure to climate change and income risk IST could be an attractive and effective tool in stabilizing farm income (Čop et al., 2020).

According to our knowledge, there are no studies related to income volatility in Croatia and Croatian horticulture. Therefore, we fill this research gap by investigating the income volatility from 2014 to 2017 for all Croatian farms and for horticultural farms. Furthermore, according to the income volatility, we try to research how many farmers will be eligible for innovative insurance instruments, Income stabilization tool (IST) depending on scenarios that would be further discussed in the paper.

Based on Croatian FADN data, this paper aims to research farm income trends of all farms and specialized horticulture farms (wine, orchards, and olive farms) for 2014 to 2017 and determine how many farms had the potential for IST compensation.

Objectives of the paper are:

(1) farm income review through the years 2014-2017 for all farms from the FADN database in Croatia, specifically for horticultural farms, and simulation of income horticultural farms variability in Croatia, and

(2) scenario analyses of how many horticultural farms have the potential for IST compensation in scenarios of annual income drop of 10% (proposed threshold), 20% (sectoral IST threshold regarding EU Regulation 2017/2393), and 30% (IST threshold regarding EU Regulation 1305/2013) of three-year average income based on FADN data using group (sector) or farm index.

The paper estimates the effect of a reduced income threshold (10% and 20%) on the number of producers eligible for IST compensation.

The research will provide preliminary research on income risk in Croatian horticulture and examine whether the FADN is a good base for the application of IST. Paper will serve as a basis for the introduction (design and development) of IST in Croatian agriculture.

Study background

According to the Croatian Bureau of Statistics (2021), the total utilized agricultural area in Croatia increased in the period from 2010 to 2019 by around 13%, and decreased in the last five years, by slightly more than 2%. Of the total utilized agricultural area in 2019, the largest share is for arable land (around 53%), and permanent grassland (39.42%), while under permanent crops (vineyards, orchards, and olive groves) is only 4.79%.

The average total utilized agricultural area per farm is 37.8 ha (2017) (Juračak and Njavro, 2019). In the last ten years, utilized agricultural horticultural area decreased, around 12%. An increment of utilized agricultural area (UAA) is recorded for orchards and olive farms while on the other hand, a decline is visible among wine farms. According to UAA in 2019 47% of horticultural UAA refers to the orchards area, 25.50% to the olive grove, and 21% to vineyards. Production (in tonnes) of olive, wine, and fruits decrease from 2010 to 2019, with a decrement of 13%, 48%, and 20% respectively (Figure 1). Wine production in Croatia decreased from 842 thousand litters in 2014 to 704 thousand litters in 2019, and on the other hand production of olive oil increased from 10,640 hl in 2014 to 44,497 hl.

As an overview, we can say that Croatian horticultural production (fruits, vegetables, olives) has favourable agro-ecological conditions for growth and development, but it is below the level of self-sufficiency, low level of competitiveness, and, consequently, low added value. The common characteristic of Croatian horticulture is a low level of producers'/business linkages, and this leads to the difficult entry of small farmers into the market. Thus, small agricultural producers are unable to achieve economies of scale, access to capital is difficult, investment in processing and storage is insufficient, as joint branding of products. Climate risks are also important for this sector, and the application of insurance is low. There are problems on the demand side, but also on the supply side. Production characteristics make it difficult to develop insurance products, and high-risk exposure makes this sector unattractive to the insurance industry (Krišto et al., 2020). IST is imposed as a solution for farmers' income risk.

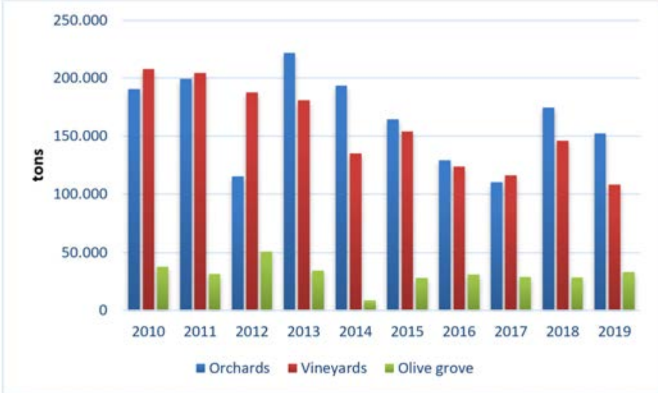

Figure 1. Horticultural production in Croatia, tons

Source: Croatian Bureau of Statistics, www.dzs.hr

Overview of Income Stabilization Tool as Risk Management tool

In agriculture, there are various sources of risks, production, market, institutional, financial, personal, and traditional (Hardaker et al., 2015). Globally known production risk is climate change that is presented in the change of yield, quality, and quantity and consequently impacts income volatility (Novickytė, 2018). Financial is linked with the ability to settle debts. Income risk can be explained twofold, production risk that depends on the decisions of the farmer, and as market risk, because the farmer operates their business under market conditions (Novickytė, 2018). Income risk is caused by the volatility of input and output prices that are needed for agricultural production. Novickytė (2018) and Trestini et al. (2017) stated that the volatility of farm income depends on prices, yields, and costs. In addition to the market fluctuations, environmental, technological, economic, and structural changes impact income risks (Novickytė, 2018). Research by Thorat and Sirohi (2018) shows that volatile income affects agricultural households' welfare. Various sources stated that income risk represents one of the most important risks at the farm level together with price and production risks (Meuwissen et al. 2008; European Commission, 2017). Variability of input and output prices due to climate change and changes in the business impacts the income entirely.

Aware of the importance of income risk Common Agricultural Policy (CAP) introduced a few measures in the second Pillar of the Rural Development Program (RDP) (European Commission, 2017) that directly (like measure 17 Risk management from Rural Development program), or indirectly contribute to the risk management. Three risk management tools are subsided insurance schemes, mutual funds (MF), and income stabilization tool (IST). IST help to stabilize the variability of income.

IST or precisely, income insurance or income programs is widely developed and applicable in US and Canada (Diaz-Caneja et al., 2009). Income insurance schemes are available in the USA, while in Canada income insurance is known as Income stabilisation programme. IST is a form of revenue insurance. IST is activated when the farm considers income drop more than 30% of the average annual farmer's income in the preceding three-year period or a three-year average based on the preceding five-year period, excluding the highest and lowest entry. IST was introduced through EU Regulations 1305/2013, with a 30% income threshold, and later modified through Council Directive 2017/2393/EC, named "Omnibus". The IST was additionally introduced for farmers of a specific sector, in the situation where the drop of income exceeds the threshold of at least 20% of the average annual income. Farmers stated that the income threshold of 30% is too high and there is a need for considering and suggesting a lower threshold, farmers suggested 10% as an income threshold (Čop et al., 2020).

El Benni et al. (2016) stated that there are different tools for coping with income risks while Cafiero et al. (2007) differs private and public tools for income risk management. Private tools encompass crop diversification, crop insurance, contract farming, hedging, income-generating portfolio management, while on the side of public policies are subsidies to crop insurance, public crop insurance, solidarity fund, price support, income transfers, etc. For example, whole-farm income insurance served as a base for designing IST (El Benni et al., 2016). Some of the advantages of IST are that it insures income risks, can be said it insure whole-farm, and insure risks caused by extreme weather events. IST is a voluntary tool, managed and financed by European Commission.

Different research shows the advantages of income stabilization tool. First, Finger and El Benni (2014a) stated that IST stabilizes farm incomes and affects the income inequality within the farm population. Another reason is that the benefits from such a tool might be highly heterogeneous across farm types (El Benni et al., 2016). When indemnification payments are discussed, research show highly volatile levels of indemnification payments, that require large buffers (Pigeon et al., 2014) and that indemnification depends on the calculation of the reference income (Finger and El Benni, 2014b). Last is that IST might cause large transaction costs (Liesivaara et al., 2012) and may occur moral hazard problems (Liesivaara and Myyrä, 2016) (from Biagini, 2020). Secondary sources show that the IST covers losses from price volatility and production risk (Finger and El Benni, 2014). Fabian et al. (2016) show that the IST protects farmers from changes in income that emerged from production and other risks. Finger and El Benni (2014) concluded that an IST reduces income inequalities between farmers in Switzerland. Severini et al. (2018) confirm that the IST stabilizes income among Italian farmers. In conclusion, the use of IST among farmers enables the reduction of income variability and stabilizes income.

IST is not implemented in Croatia, while only implemented is subsidized crop and livestock insurance. Only Hungary, Italy, and Castile-León (Spanish region) planned the introduction of IST. For now, IST is only implemented in Italy in one region (the Autonomous Province of Trento) and there is two sector-specific IST: in the apple sector and in the dairy sector (Rippo and Cerroni, 2021).

Other risk management measures in the frame of CAP are subsidized insurance and mutual funds. Mutual funds are designed as a joint action of farmers in which farmers pay some amount of money for the occurrence of future risks in business (Krišto et al., 2020). Subsidized crop and livestock insurance represent already known agricultural insurance that represents financial contributions to premiums for crop, animal, and plant insurance. Mutual funds and subsidized insurance cover risks caused by climate events, animal or plant disease, pest infestation, and environmental incidents which destroy more than 30% of the average annual production of the farmer in the preceding three-year period or a three-year average based on the preceding five-year period, excluding the highest and lowest entry (Council Directive 2017/2393/EC).

MATERIALS AND METHODS

Farm net value added (FNVA) from FADN was used as an income indicator (Severini et al., 2018; Severini et al., 2019). The FNVA formula is gross farm income (GFI) minus depreciation costs (DC) (1) that measures the amount available for remuneration of the fixed production factors (work, land, and capital) (European Commission, 2018).

$$FNVA = GFI - DC \tag{1}$$

As above mentioned, the farm net value added (FNVA) represents the remuneration of the factors of production, irrespective of their ownership. After the deduction of the costs of paid labour, interest, and rent, the family farm income represents the return to the farmer for the use of his own production factors.

The analysis was used to research how many farms can be eligible for IST compensation if income drop in the observed year (2017) is more than 10%, 20%, and 30% of the three-year average income (2014-2016). Measures of central tendency, variability, asymmetry, and decision tree in some situations were used to describe the data.

Analysis covers:

(1) measures of central tendency (mean, median, standard deviation (SD), and coefficient of variation (CV)) for all farms in the FADN sample, for all horticultural farms and horticultural groups (wine, orchards, and olive farms) with income data in all four observed years (2014-2017). Income variability through the years is compared. The cumulative distribution function (CDF) was used to represent the average income distribution of horticultural farms.

The equations for mean, median, SD, and CV are available below:

$$Mean = \frac{Sum\ of\ all\ observations}{Total\ number\ of\ observations} \tag{2}$$

$$Median = \frac{(n+1)}{2} \tag{3}$$

$$SD = \sqrt{\frac{\sum(x_i-\bar{x})^2}{n-1}} \tag{4}$$

$$CV = \frac{SD}{mean} * 100 \tag{5}$$

(2) farm index calculation and group index calculation (for wine, orchards, and olive farms) were used to analyse how many farms are eligible for IST according to income threshold 10%, 20, 30%, on-farm level, and group level, respectively

The farm index (6) is calculated according to farm data for the period from 2014 to 2017. FNVA data from 2017 at the farm level was divided with the three-year (2014-2016) average annual farmer's FNVA, expressed in percentage.

$$Farm\ index = \frac{FNVA\ per\ farm}{average\ FNVA\ per\ farm} * 100 \tag{6}$$

The group index (7) was calculated according to FNVA per farm (from 2017) divided with the average FNVA group (wine, orchard, and olive farms) index (2014 – 2016), expressed in percentage.

$$Group\ index = \frac{FNVA\ per\ farm}{average\ group\ FNVA} * 100 \tag{7}$$

(3) use of stochastic simulation to simulate horticultural income variability.

Additional analyses were conducted using the variable region (Adriatic or Continental region). Correlation analysis will be used to measure the relationship between income and horticultural size farms in the last available year (2017).

In the analysis, farms with negative income in 2017 (observed year) were removed from the calculation (Severini et al., 2019).

Table 1. Sample of horticultural farms in Croatia, 2014-2017

Year	Wine farms	Orchards	Olive farms	Total horticultural farms
2014	47	53	30	130
2015	52	54	42	148
2016	58	57	49	164
2017	60	53	53	166
Number of farms with data in all four observed years	31	32	21	84

Source: Authors according to FADN database

FADN data for the period of 2014 to 2017 will be used for the analysis. FADN code was SE415 that represents Farm net value added (FNVA) expressed in absolute numbers in HRK per farm.

Sample of all farms in 2014 was 1,290, in 2015 – 1,337, in 2016 – 1,328 and in 2017 – 1,295 farms.

The sample of total wine farms, orchards, and olive farms are summarized in table 1. The number of wine farms that are in FADN for all four observed years is 31 farms, for orchards 32 and olive farms 21. In total there were 84 horticultural farms with data in every observed year (2014-2017). Another share of farms had the FADN dataset for only one or two years.

The used variable for income is farm net value added (FNVA).

Figure 2. FNVA mean, median, and SD for all farms in Croatia in the period 2014 to 2017

Source: Authors according to FADN database

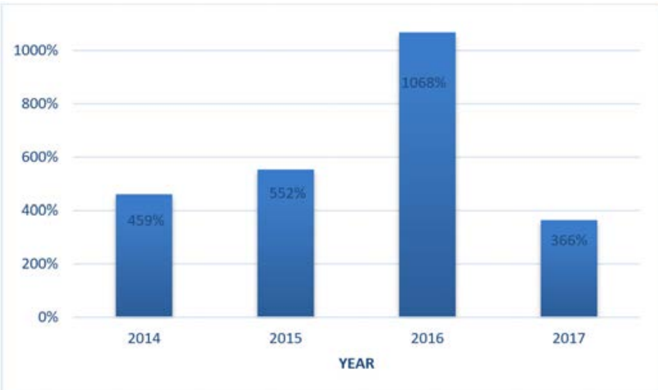

Figure 3. Coefficient of variation for all farms in Croatia

Source: Authors according to FADN database

RESULTS AND DISCUSSION

In total in Croatia in 2017 were 164,458 agricultural holdings. According to all farms in Croatia, available within the FADN from 2014 to 2017, it can be seen an increment of mean FNVA from 171,522 HRK (22,830 EUR) to 187,618 HRK (24,972 EUR) with a decrement of FNVA in 2015 (Figure 2). The average median for observed years is 57,012 HRK (7,588 EUR) with the highest in 2017 at around 73,136 HRK (9,735 EUR). Income data in 2017 range from -2.468.640 HRK (326.258 EUR) to 19.931.835 HRK (2.634.210 EUR). The average SD for observed years is 1,075,379 and the average CV is 6.11 or 611%. The coefficient of variation is lowest in 2017 with 366% and the highest in 2016 with 1,068% (Figure 3).

Concerning horticultural farms in FADN, the number of horticultural farms increased from 130 to 166 (Table 2). Average FNVA increased through the years in horticultural farms, as the FNVA median. Average FNVA through years is around 175 thousand HRK (23 thousand EUR), the average median is 57 thousand, average SD for observed years is 1,074,029 and the average CV is 613%. Observed FNVA data for horticultural farms is like the data for all farms.

Further analysis shows us that according to groups (wine, orchard, and olive farms) the highest average income had wine farms (195.828 HRK – 26, 066 EUR), with the highest SD (1,281,880) and CV (655%). The lowest income average had olive farms with 130.800 HRK (17,410 EUR) but compared to another group's highest average median around 70,500 HRK (9,384 EUR), and lowest SD and CV, 342,177, and 262% respectively.

Analysis has found that wine and orchard farms have a slightly higher average income compared to all analysed horticultural farms (Figure 4). Only olive farms have around 34% lower income than the average of horticultural farms. In table 3 is it seen that the lowest SD is in olive farms, and consequently income variability.

The simulation included Monte Carlo sampling with 1,000 iterations. Based on the income data for all horticultural farms (84) stochastic simulation model was calculated. Simulation data resulted that there is a 5% chance of negative income, around, -221 thousand HRK (-29,416 EUR), there is a chance of 50% of around 79 thousand HRK (10,515 EUR) income or higher, and

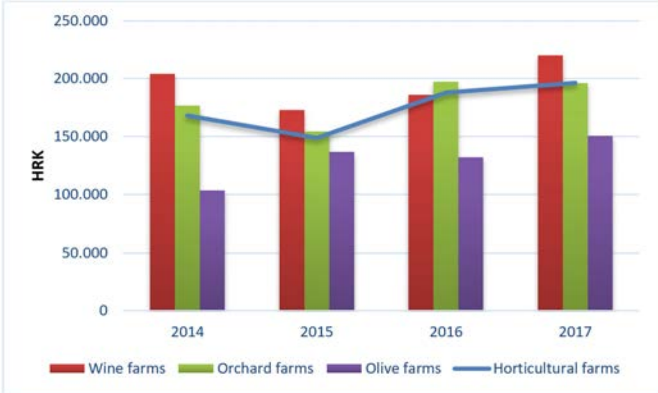

Figure 4. FNVA trend of wine, orchard, and olive farms from 2014 to 2017

Source: Authors according to FADN database

there is a 90% chance of income between a 359,364 HRK (47,832 EUR) and -199,930 HRK (26,611 EUR).

Furthermore, skewness is present in average income (2014-2017) for all horticultural farms, and separately for wine, orchard, and olive farms. Figure 5 of the cumulative distribution function (CDF) was used to present average income distribution (2014-2017), and it is seen that around 20% of orchard farms had negative income, around 14% olive farms, and all horticultural farms around 12%. On the other hand, only 5% of wine farms have negative income.

Table 2. Income mean, median, SD, and CV for horticultural farms in Croatia

	Mean	Median	SD	CV
Horticultural farms (2014), N=130	168,343 HRK	63,099 HRK	778,078 HRK	462%
	22,407 EUR	8,399 EUR	103,566 EUR	
Horticultural farms (2015), N=148	148,574 HRK	44,390 HRK	832,926 HRK	561%
	19,776 EUR	5,908 EUR	110,867 EUR	
Horticultural farms (2016), N=164	188,157 HRK	47,422 HRK	1,965,535 HRK	1,045%
	25,044 EUR	6,312 EUR	261,623 EUR	
Horticultural farms (2017), N=166	196,285 HRK	73,136 HRK	719,576 HRK	367%
	26,126 EUR	9,735 EUR	95,779 EUR	
Average	175,340 HRK	57,012 HRK	1,074,029 HRK	613%
	23,338 EUR	7,588 EUR	142,959 EUR	

Source: Authors according to FADN database

Table 3. Income mean, median, SD, CV, and skew for wine, orchard, and olive farms in Croatia

N = 31	Mean	Median	SD	CV	Skew
Wine Farms (2014)	203,987 HRK	77,700 HRK	985,600 HRK	483%	2.18
	27,151 EUR	10,342 EUR	131,188 EUR		
Wine Farms (2015)	172,931 HRK	42,413 HRK	1,018,283 HRK	589%	1.23
	23,018 EUR	5,645 EUR	135,539 EUR		
Wine Farms (2016)	186,137 HRK	47,629 HRK	2,435,522 HRK	1308%	1.03
	24,776 EUR	6,340 EUR	324,180 EUR		
Wine Farms (2017)	220,256 HRK	82,592 HRK	688,114 HRK	312%	0.14
	29,317 EUR	10,993 EUR	91,591 EUR		
Average Wine Farms	195,828 HRK	62,584 HRK	1,281,880 HRK	655%	2.17
	26,066 EUR	8,330 EUR	170,624 EUR		
N = 32	Mean	Median	SD	CV	Skew
Orchards (2014)	176,770 HRK	66,448 HRK	846,695 HRK	479%	-2.32
	23,529 EUR	8,845 EUR	112,699 EUR		
Orchards (2015)	154,326 HRK	40,162 HRK	927,808 HRK	601%	-0.77
	20,542 EUR	5,346 EUR	123,496 EUR		
Orchards (2016)	197,617 HRK	38,609 HRK	2,212,360 HRK	1120%	-0.15
	26,304 EUR	5,139 EUR	294,476 EUR		
Orchards (2017)	196,293 HRK	68,223 HRK	753,352 HRK	384%	3.58
	26,128 EUR	9,081 EUR	100,275 EUR		
Average Orchards	181,251 HRK	53,361 HRK	1,185,054 HRK	654%	0.44
	24,125 EUR	7,103 EUR	157,737 EUR		
N = 21	Mean	Median	SD	CV	Skew
Olive Farms (2014)	103,533 HRK	35,968 HRK	386,404 HRK	373%	-3.82
	13,781 EUR	4,788 EUR	51,432 EUR		
Olive Farms (2015)	136,764 HRK	78,814 HRK	331,165 HRK	242%	-2.41
	18,204 EUR	10,491 EUR	44,080 EUR		
Olive Farms (2016)	132,163 HRK	80,753 HRK	280,640 HRK	212%	1.16
	17,592 EUR	10,749 EUR	37,354 EUR		
Olive Farms (2017)	150,741 HRK	86,601 HRK	370,498 HRK	246%	-1.80
	20,064 EUR	11,527 EUR	49,315 EUR		
Average Olive Farms	130,800 HRK	70,534 HRK	342,177 HRK	262%	-3.07
	17,410 EUR	9,388 EUR	45,545 EUR		

Source: Authors according to FADN database

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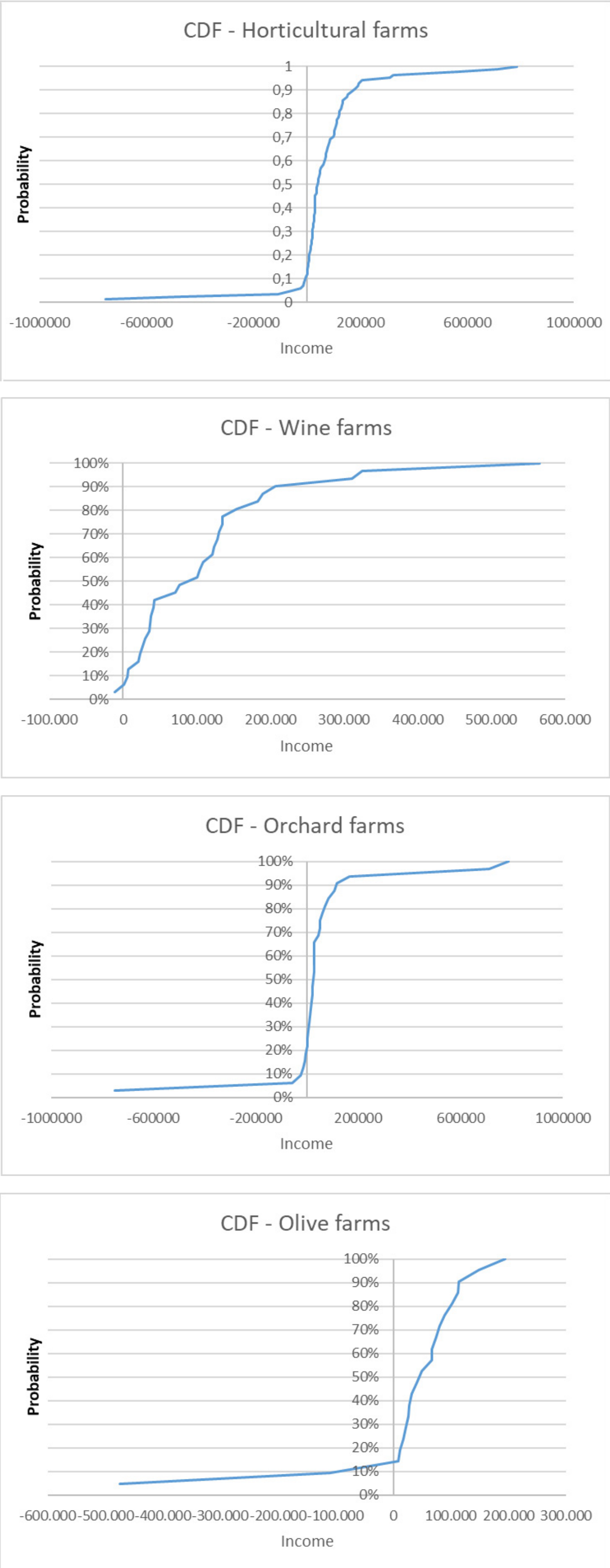

Figure 5. Cumulative distribution function (CDF) of income for all horticultural farms, and specifically wine, orchard and olive farms

Number of farms eligible for Income stabilization tool

According to the Council Directive 2017/2393/EC indexes may be used to calculate the annual loss of farmers' income. Three-year average (2014-2016) income (farm index) was compared to observed (2017) income including only wine farms, orchard, and olive farms. Through further analysis of data, there is a low number of farms with data in all observed years. The wine sample had only 31 wine farms, two of them had negative average income value in 2017, the orchard sample had 32 with 9 negative incomes in 2017, and 21 olive farms with 3 farms - negative income in 2017. According to Severini et al. (2019) farms with negative observed income were excluded from the calculation. The final wine sample is 29 wine farms, 23 orchard farms, and 18 olive farms.

Through FNVA as an indicator of farm income, it is seen that if the income threshold is 30%, 14% of wine farms are eligible for IST compensation and if the threshold is lowered to 10% or 20% the percent of wine farms for compensation increases on 20%. In comparison to wine farms, the share of orchard farms with an income threshold higher than 30% increased on 22%, and with lowering income threshold to 10% or 20%, in total 26% of farms are eligible for IST compensation. In the end, the share of olive farms eligible for IST compensation is 22% if the income threshold is 10% or 20%, and olive farms decreased on 17% if the income threshold is 30% (Figure 6).

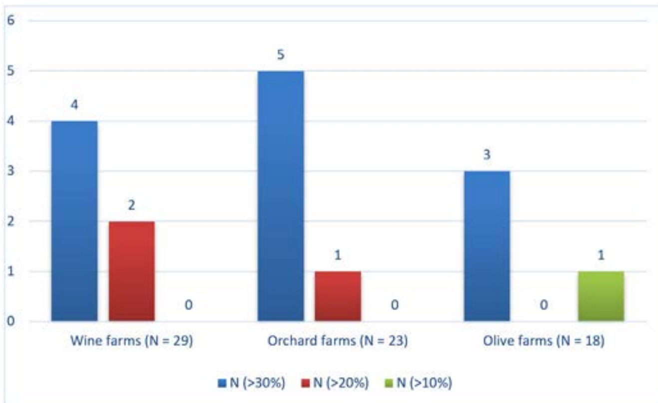

Figure 6. Number of wine, orchard and olive farms with income drop higher than 10%, 20%, and 30%

Source: Authors according to FADN database

According to historical data, the presented percent of farms are eligible for IST and it can be expected that with an adverse event occurring or price/income volatility the share of farmers with income decrement will increase.

Using the group index method, we calculated the average income for three farm groups (three base indexes) and compared observed farm income in 2017 with a base index group (Figure 7).

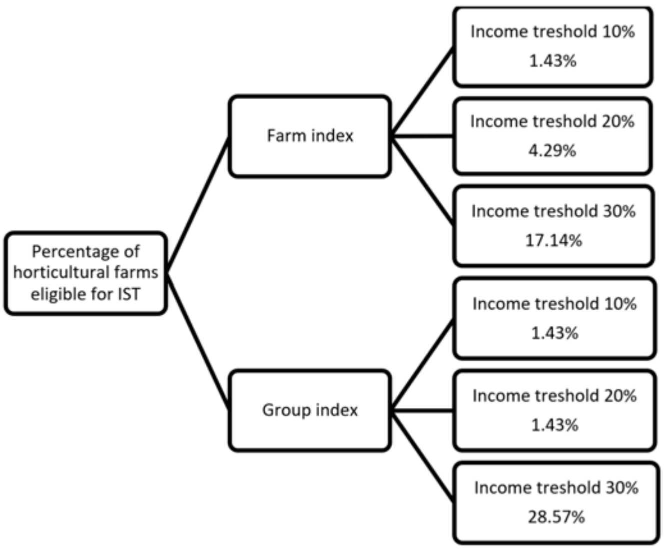

Figure 7. Schema (decision tree) of horticultural farms (%) eligible for IST according to farm and group index

Results show that using the index method, the average income (index) of wine farms is 107,603 HRK (14,322 EUR), orchard farms are 29,301 HRK (3,900 EUR) and in olive farms, the average income (index) was 22,200 HRK (2,955 EUR). The analysis shows that the share of farms with income drop higher of 10 to 30% increases, so there is 41% of wine farms (12 of 29 farms), 35% of orchard farms (8 of 23 farms), and 11% of olive farms (2 of 18 farms).

In terms of the farms' region, 51 horticultural farms belong to the Adriatic Croatia, and 33 to Continental Croatia. In Adriatic Croatia are 9 farms with income drop higher than 10%, and 7 farms in the Continental region with an income threshold of around 20%. Correlation analysis between income and horticultural farm size in the last available year (2017) shows a significant positive relationship between the farm size and income, $r(82)=0.259$, $P<0.05$ ($P=0.017$). Further analysis shows that there is only a significant positive relationship between the orchard farm size and orchard income, $r(30)=0.51$, $P<0.05$ ($P=0.0029$).

This is one of the first studies that research the income risk among farms, specifically horticultural farms in Croatia, and the eligibility of farms for new risk management measure. Our goal in the study was not to determine the share of agricultural subsidies in farm income but to examine income changes (FNVA) from 2014 to 2017 and research how many farmers will be suitable for IST and which income threshold consider and determine for IST design. According to previous research, income risk can be defined as the risk that results in yields variability influenced by climate change and price changes (Reidsma et al., 2009) and results from different factors that impact agricultural production (Meuwissen et al., 2011).

Our analysis shows a small sample of farmers in Croatia and horticulture. On average (2014-2017), 1313 farms represented only 0,8% of the total agricultural holdings in 2017 in Croatia, and 152 farms (2014-2017) in horticulture.

The income increment for 2014 – 2017 was recorded, and the average income of all farms in Croatia was 174 thousand HRK (12 thousand EUR). The income of horticultural farms was similar to all farms (175 thousand HRK or 23 thousand EUR). In all analyses, high-income variability was recorded for both samples, around 6,11 (611%). Compared to Croatia in Hungary and Slovenia in nine years has been recorded variability in farm income but lower than for an Italian farm. The lower CV of farm income was 0.37 for Slovenia, 0.41 for Hungary, and 0.64 for Italy (Bojnec and Ferto, 2019a; Severini et al. 2016) compared to Croatian 6,11 CV.

Further research shows a positive income trend in EU-15 from 1990 to 2003 in Greece, Portugal, Italy, Ireland, and some regions in Spain, and a negative income trend in Nordic regions (Reidsma et al., 2009), as well as a negative correlation between income and increment in farm size, was recorded. On the other side, Reidsma et al. (2009) researched that using an irrigation system impact higher income while applying more fertilizer, low precipitation, and fewer subsidies decrease income. Research at the farm level shows that income variability is higher for arable farms and lower for pig farms, horticulture, and permanent crops (Reidsma et al., 2009). Compared to the mentioned research, we concluded that among horticultural farms, wine and orchard farms have the highest income, and the highest CV (income variability), even higher than the average income for all analyzed farms. Our higher income variability in horticulture (for wine and orchards) is the opposite of the Reidsma et al. (2009) research, but olive farms have income variability lower than all Croatian farms.

Various research emphasizes that subsidies directly impact income (Reidsma et al., 2009). For example, in Slovenia and Hungary large share of income represents subsidies, and Bojnec and Ferto (2019b) highlight the importance of agricultural subsidies in farm incomes.

The solution for income risk could be IST from CAP. Previous research was the only ex-ante evaluation of IST (IST profitability) and research about income variability among horticultural farmers and the number of farmers eligible for IST is lacking. Our study shows that a higher percentage of farms can be eligible for IST using group index calculation than farm index calculation. Furthermore, a more significant number of farmers with an income drop of more than 30% were noted in the research. According to our knowledge, this research is the first attempt at analyzing income risk among horticultural farmers and the possibility for IST using group (sector) or farm index.

Nevertheless, this research shows that with the insufficient number of farms, income differences and income variability can be observed among farms in the FADN sample, but additional considerations on expanding the FADN sample are needed to draw better conclusions.

CONCLUSION

To sum up, the income trend in Croatian horticultural farms is like the data for all farms in the FADN database, and with high variability. Horticultural income increased in the period from 2014 to 2017. In all four observed years, wine farms record higher income than average horticultural farms income and the lower percent of farms with negative income.

The Monte Carlo simulation is based on the income data for all horticultural farms (84). Simulation data resulted that there is a 5% chance of negative income, there is a chance of 50% of around 79 thousand HRK (10,515 EUR) income or higher, and there is a 90% chance of income between a 359,364 HRK (47,832 EUR) and -199,930 HRK (- 26,611 EUR).

Analysing how many horticultural farms have the potential for IST compensation in scenarios of annual income drop of 10%, 20%, and 30% of three-year average income were calculated using farm and group index. Data shows that using group index, there is a higher percentage of farms that can be eligible for IST than farm index in case of income drop by more than 30%.

Taking everything into consideration, we can conclude that the research limitation is the FADN sample that is too small for greater conclusions. To make a three-year average calculation of farms according to five years excluding lowest and highest income, and to analyse and compare how many agricultural holdings can contract IST with an income drop higher of 10%, 20% or 30% the bigger sample of farms with continuous data is needed.

Conducted research might have implications for the design and development of IST research and might recommend using IST among farmers against risks in agriculture, such as production and market risk (income risk). As well as further research can investigate in depth the development of Income stabilization tool and give an example of a design of the IST in Croatia and research the applicability among Croatian farmers.

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