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Projecting Circular Economy in rural areas and its impact on sustainable development principles, a case study from Kosovo

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1 INTRODUCTION

According to BIILGEN ET AL. (2007) the only natural, renewable carbon resource known that is large enough to be used as a substitute for fossil fuels is biomass. For biomass to be effective at reducing greenhouse gas emissions, it must be produced in a sustainable way (EUROPEAN COMMISSION, 2014). Pellet it considered as a source of renewable energy for heating and electricity, however as a result of frequent reports (FAZEKAS & TUERK, 2016; NRDC, 2020; WAL, 2021) that the production of pellets from wood is not sustainable and causes deforestation which is expressed mainly in developing countries, authors (FAZEKAS & TUERK, 2016; PERLACK, 2005) required to give importance to the use of agricultural residues (dry matter) as renewable energy for heating, in this case it would bring extra income to farmers and also reduce deforestation (European Commission, 2018). One of the most widespread crops in the world is wheat and its residues, which are the main contributors to biomass burning (YEVICH & LOGAN, 2003). A tool that help in this transition is Circular Economy. The Circular Economy concept is based on recovering onsite resources that are still circulating (overproduction, waste) instead of importing them from abroad (DONIA ET AL., 2018). According to ENEL (2008), circular economy is a strategic ally of sustainable development. Working on the circular economy means working on the majority of Sustainable Development Goals (KRUCHTEN & EIJK 2020). Using biomass residues for energy would be a nonfarm generating activity for farmers, and besides reducing poverty, it is also environmentally friendly (KUROWSKA ET AL., 2014; ROZBICKA & SZENT- IVÁNYI, 2020; YMERI ET AL., 2020). SCHOR, (2017) highlights that C.E. may increase inequalities due to disadvantages that low-income, less-educated people have regarding access. GRADZIUK ET AL. (2020) states that small farms reduce substantially the possibility of using high-performance, large-sized presses, which in turn determines the economic feasibility of biomass supply. In line with this statements are also authors who reported that extra income can increase inequality (IQBAL ET AL., 2018; KMOCH ET AL., 2018). Thus KIRCHHERR ET AL. (2017) suggest that those who propose C.E. may be well-advised to state social equity as one of its design variables. When it comes to environmental aspect and biomass capacity, there are different factors that impact the amount of straw including the type of crops, crop variety, crop rotation, agricultural management practices (e.g., tillage), climate, and physical characteristics of the soil, type of harvest, fertilizers (BATIDZIRAI ET AL., 2016; LARSEN ET AL., 2012; PELTONEN-SAINIO ET AL., 2008; SKØTT, 2011) thus, there are no criteria on straw removal except “loss of soil fertility if too much straw is removed” (ELBERSEN ET AL., 2010; GLITHERO, RAMSDEN, ET AL., 2013). Besides its importance there are authors (TOWNSEND

ET AL., 2017) that proclaimed that usually biomass residues are overestimated this is because in general, different studies discussed the amount of wheat residues that are available to use for energy purposes, without agronomic measurement, most of them found this amount based on coefficients suggested from literature review(CAI ET AL., 2008; KARAJ ET AL., 2010; KUMAR ET AL., 2015; LANFRANCHI, 2012; MARKS-BIELSKA ET AL., 2019; SAHITI ET AL., 2015; YANLI ET AL., 2010; ZHANG ET AL., 2019; EZEALIGU AT AL., 2021). While, according to GIANNOCCARO (2017) In the economics of biomass, it is possible to apply the method that considers the willingness of farmers to supply which is critical in the early stages of commercialization of new technologies and industry development (ALTMAN ET AL., 2015; GAUS ET AL., 2013; GLITHERO, RAMSDEN, ET AL., 2013; PANNELL ET AL., 2006; ZYADIN ET AL., 2019). A comparison between these approaches and the convention alone could lead to new interdisciplinary collaborations, and this type of data could be used as a basis for further studies. Thus the first aim of this study is to recognize the impact of non-farm income on farmer's wellbeing regarding poverty and inequality, to distinguish farmers' attitudes toward a new biomass market from wheat straw as a source of energy and the third one to measure the potential capacity of wheat residues based on agronomic assessment and willingness of farmers to sell straw, these are vital to design and present economic and policy incentives successfully.

1.1 Problem Statement and Justification

Typically, in developing countries, a large amount of agricultural waste suitable for energy use remains unexploited, remaining on the arable land or being burned in the field (MCNULTY & GRACE, 2009; NIKOLOV, 2011; Y. WANG ET AL., 2010). Complicating matters is the fact that some countries have significant fossil energy reserves. This is also the case in Kosovo, which has the largest coal (lignite) reserves in southeastern Europe (C.E.E.B.N. 2019). An important question is how polluting, and non-climate-friendly fossil fuels are to be replaced when they are available cheaply and in large quantities, and in the same time how can we reduce deforestation when 85-100% of households use wood for heating purposes while other sources of heating are electricity, natural gas, heavy oil and coal (KABASHI ET AL., 2016). Based on the data from Eurostat (EUROSTAT 2019; M.E.E. 2021) regarding Kosovo, electricity from coal is 94.86%, it is one of the highest shares of energy from coal compared to neighbouring countries see: (ITA, 2020; KISS & PETKOVIČ, 2015; NIKOLAKAKIS ET AL., 2019). The obligatory general target of partaking in energy from renewable energy in G.F.C.E. of energy in 2020 was 25%. Kosovo reached the target of 25.69%, and made a voluntary target of 29.47%, however from the achieved target from overall G.F.C.E, 23.89% is from biomass for heating purposes, and 1.8% from renewable electricity (EUROSTAT 2019; M.E.E. 2021).

When it comes to Circular Economy and renewable energy several authors claim that social equity is usually absent on the C.E. concept, including unequal distribution of wealth, income, and labour conditions. Selling straw is considered as an extra nonfarm income. However, there are reports where nonfarm incomes cause inequality between farmer's households (IQBAL ET AL., 2018; KMOCH ET AL., 2018; MAT ET AL., 2012; WOLDEHANNA & OSKAM, 2000). Thus in the first part of our study, we analyzed if nonfarm incomes create inequality in Kosovo's case. Our second purpose was to specify the amount of straw available for energy use; when it comes to this topic, two reasons require attention: The first reason is described by TOWNSEND ET AL. (2017), who states that biomass is overestimated because of the variation with cultivar and location-specific factors. The ratios must be calculated for individual cultivars and locations to predict straw yield from grain yield accurately. While the second reason is described by GLITHERO ET AL. (2013*a*), who stated that straw availability might also be overestimated as calculations often assume that all farmers who can sustainably supply straw will supply that straw, whereas, in reality, many farmers are unwilling to do so because of, for example, concerns about negative soil impacts and potential delays in planting subsequent crops. Studies in social science fields usually can overestimate the amount of straw caused by missing the part of agronomic measurement or the willingness of farmers to sell straw. Our study gives a clear picture regarding how nonfarm incomes will impact rural households' wellbeing and the biomass capacity of Kosovo for bioenergy based on farmers' willingness to sell straw and agronomic measurement.

2 OBJECTIVES TO ACHIEVE

The motive for this study is to reduce deforestation, straw burning in fields that are associated with forest burnings through the use of straw as renewable energy for heating purposes. The new energy biomass market would also bring extra income to the farmers and reduce air pollution. Additionally, our study aims to provide scientific information to local/national organizations as well as on governmental level, regarding the capacity of wheat residues from three most used cultivars in Kosovo, which would be the first step (regarding biomass sources-except wood) that would help in the transition from coal to sustainable biomass use. Regarding international literature, the study's objective is to give the exact values of straw measurement by combining agronomic measures with the willingness of farmers to sell straw, based on the sustainable removal rate of straw. The other objective of this study is to understand how non-farm income affects the welfare and inter household income inequality in Kosovo's case

Specific Objectives

1. Analyze the impact of off-farm income on poverty and inequality.

2. Analyze which socio-economic factors determine the willingness of farmers to sell straw on higher amounts.

3. Analyze practices, barriers and incentives toward a new market with straw biomass.

4. To find out correlation between wheat parameters in order to better predict the amount of straw, and assess the ratio between total dry biomass to seed, straw for energy purposes to total dry biomass and straw for energy purposes to collectable straw.

2.1.1.1 Scientific research model

Degradation of the natural environment and the energy crisis are two vital issues for sustainable development worldwide (NI ET AL., 2006). Sustainable development implies creating environmental quality, economic prosperity and social equity for current and future generations(KIRCHHERR ET AL., 2017). The implementation of the Sustainable Development Strategy through the Sustainable Development Goals 2015-2030 needs to take into consideration the EU' package from December 2015 concerning the achievement of the Circular Economy under the vision of the 3R - Recycle, Reuse, Reduce (CIANI ET AL., 2016). According to ENEL (2008), circular economy is a strategic ally of sustainable development. Working on the circular economy means working on the majority of SDGs, not as a cost item but as a business model (KRUCHTEN & EIJK, 2020). It is fundamental to highlight that the Circular Economy means changing people habits, mentalities (BELC ET AL., 2019). C.E. must promote loops when socially desirable and efficient(ANDERSEN, 2007). From all key components of sustainable development principles, less than 1% of literature on circular economy speak of equity or equality, human attitudes and only ca. 1% covers poverty (VELENTURF & PURNELL, 2021). Based on the study of SCHROEDER ET AL. (2019) circular economy can also contribute to poverty, reduced inequlities, renewable energy and climate action. Figure 1. Represents the relationship between sustainable development goals and circular economy, which both have common principles; Environmental Quality, Economic Prosperity and Social Equity.

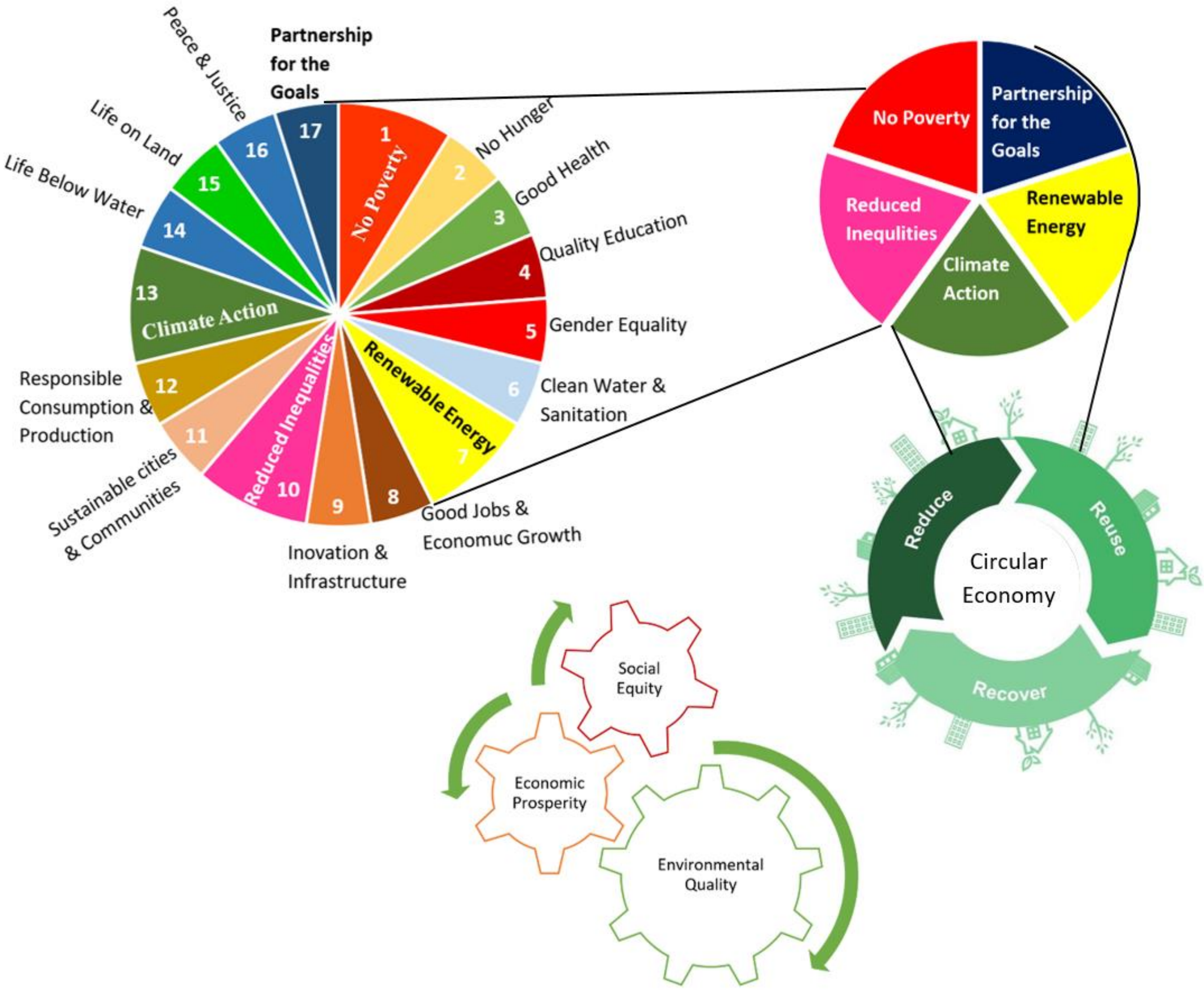
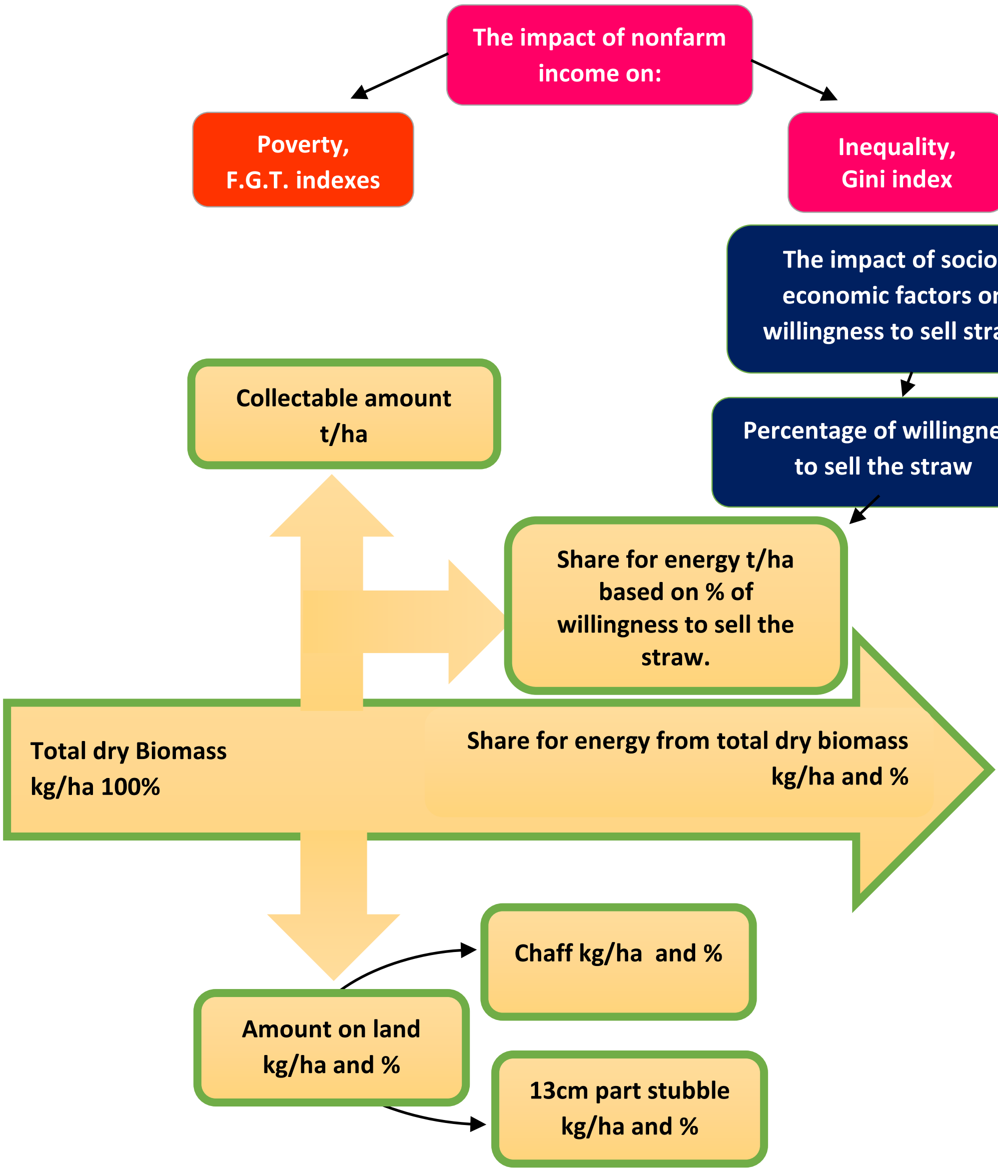


Figure 1. Conceptual framework model; Sustainable Development goals in terms of Circular Economy.

Source: Author's own construction based on UNITED NATION,(2015) assembly and EUROPEAN COMMISSION (2015)

From the total seventeen goals of sustainable development, the study analyzes these SDGs in Circular Economy perspective: SDG (1) No poverty, SDG (10) Reduced Inequalities, SDG (7) Renewable Energy, SDG (13) Climate action and SDG (17) Partnership for the Goals. The study aim to provide scientific information regarding to povery and inequality amog rural hoseholds in Kosovo, and the impact that extra incomes have on these (related to: SDG 1 and 10). According to KIRCHHERR ET AL. (2017) the dimension of social equity has to do with how the Circular Economy aims to protect, transform, strengthen and develop society, human wellbeing and job. Furthermore the study aims to measure the capacity of biomass residues from wheat as a source of renewable energy (SDG 7) based on circular pillar "Recover", regarding to climate action (SDG 13) the studys' aim is to reduce burnings of wheat residues into open fiels and reduce deforestation by using agriculture residues as renewable energy at the same time fulfilling the renewable energy targets, while our partnership for the goals (SDG 17) in the study will be farmers and their willingness to participate into a new market for renewable energy production. According KRUCHTEN AND EIJK (2020) the transition to the circular economy requires systemic change and asks for collaboration. Below is described the flow of the model with specific analysis. The figure 3 explains the research model of this study;



- Face to face interview, the year 2017, sample 203
- Face to face interview, the year 2019, sample 206,
- Two years experiment 2018-2019 and 2019-2020 in two regions of Kosovo, three winter wheat cultivars.

Figure 2. Research Model
Source: Author's own construction

Regarding experiment, different authors suggest a sustainable removal rate of straw residues from land between 33-60% (DAIOGLOU ET AL., 2016; SPÖTTLE ET AL., 2013) and available biomass for energy purposes 25-62% (ALAKANGAS, 2011; CAI ET AL., 2008; KARAJ ET AL., 2010; WEISER ET AL., 2014; YANLI ET AL., 2010). However, according to TOWNSEND ET AL. (2017), there is uncertainty regarding the amount of straw chopped, incorporated and used, and, taken together with the uncertainty regarding the amount of straw that can be sustainably harvested, it is unclear how much straw is available for bioenergy production. While, according to GAUS ET AL. (2013) and GLITHERO ET AL. (2013*a*), farmers' decision-making determines the amount of straw available on the market. Thus this study takes into account the amount of straw that can be produced in sustainable way and based on willingness of farmers to sell it.

2.2 Research Questions and Hypothesis Research Questions and Hypothesis

The main research questions of the paper are: what is the biomass capacity which can be used for energy purposes in Kosovo and what are farmers' attitudes regarding a new straw market? How will the extra incomes impact the wellbeing of rural households?

H1: There is a significant difference in nonfarm incomes based on household income

H2: There is a significant difference in nonfarm income between the engagement time of farmers in agriculture

H3: The presence of animals and the experience in selling straw has impact on farmers' willingness to sell straw

H4: Socio-economic factors have a significant effect on farmers' willingness to sell straw

H5: There is a significant difference regarding the amount of residues based on cultivars, regions, years.

3 METERIALS AND METHODS

3.1.1 Sampling Procedure/Techniques and Sample Size

Kosovo is divided into seven regions and 38 municipalities LATIFI-PUPOVCI ET AL. (2020). Our samples were chosen based on the willingness of farmers to cooperate. Due to the absence of knowledge in using the internet among farmers, the questionnaires were filled out through face-to-face interviews by making personal visits to rural areas, both at home and the workplace of respondents and in one of the mills. It is important to note that the study sample can be considered statistically representative at the national level because of the data collection methods used. The sample adequacy tests showed that the sample chosen for the study is adequate at a 95% confidence level with a margin of error of 6.8% and 6.7% for the first and second study.

- The first study was conducted during spring of 2017. Our sample area consisted of five regions. The sample sizes of the five regions were: 31; 38; 57; 51, and 26 (number of questionnaires distributed). In total, the survey covered 203 heads of farm households. Our research highlights the effect of non-farm income on poverty and inequality of household income.
- Collection of data for the second study was done during the period May–October 2019. The sample consists of six regions. The sample sizes of the six regions were: 58; 56; 50; 20; 11; and 11 (number of questionnaires distributed, 206). Municipalities were selected throughout Kosovo at a distance of up to 70 km from an energy plant site, a similar distance we can find in the study of GIANNOCCARO (2017).
- Third study is done through experiment; After discussing with different agricultural pharmacies in two main regions in Kosovo, we selected three most used wheat cultivars. A similar selection based on their wide use was chosen in the study of DUBS ET AL. (2018). The three winter wheat cultivars: *Euclid* from France, *Vulcan* from Croatia and *Exotic* from Romania. The experiment with three cultivars of wheat was conducted during the years 2018/2019 for the first experiment, and it was repeated during 2019/2020 as the second experiment in two main reagions of Kosovo; Dukagjini Plain and Kosovo Plain.

3.1.2 Data analysis

In order to analyse inequalities or differences within our sample, between the poorest and the richest, the total sample was separated into three income classes (tertile) based on respondents' incomes. To determine the significance level, these three variables (tertile) are compared with each other in terms of socio-economic factors, using one-way ANOVA (Tukey method) in Minitab 17. A similar methodology for analysing the significant differences between three variables are used in different studies elsewhere (MÖLLERS & BUCHENRIEDER, 2011; YMERI ET AL., 2017). Furthermore, farms were divided based on farm type to understand better the link between the level of farmers' engagement in agriculture and their income. According to MÖLLERS & BUCHENRIEDER (2011), full-time farms are characterised by only 10% income coming from non-farm sources, the second type of farms (complemented part-time farming) have a share of non-farm incomes between 10%-50%, and the third type of farms with more than 50% of income from non-farm sources are considered as subsidiary part-time farming. These three types of farms are considered as independent variables.

For the second study, data was examined with a statistical package for social sciences (SPSS). Binary logistic regression was used to check significant factors influencing the percentage of straw that farmers are willing to sell to a power plant, similar method with the willingness was used in the study of MURIQI ET AL. (2019).

While for the third study, One-way ANOVA was used to test differences between cultivars within the region, t-test was used to analyze differences of wheat cultivars between regions and years, while Correlation was used to see the link between wheat parameters; Total dry biomass, chaff and seed (in gram), height of pant, height of spike and height if straw.

3.1.3 Measurement of Poverty and Inequality

To examine the impact of non-farm income on poverty, we used poverty decomposition techniques- Foster, Greer, and Thorbecke (FGT) , as has been done by MÖLLERS & BUCHENRIEDER (2011). The modified version of the index created by Foster-Greer-Thorbecke (FOSTER ET AL., 1984) can be used to observe the effects of nonagricultural income on poverty. The study considers three versions of the income poverty index to shed more light on different aspects of income poverty (1) the headcount index, (2) the poverty deficit index, and (3) the poverty severity index. According to FOSTER ET AL., (1984), the three poverty measures are explained by (2).

$$P(\alpha) = \frac{1}{n}\sum_{i=1}^{m}\left[max\left(\frac{z-ci}{z}\right), 0\right]^{\alpha} \qquad (2)$$

where z is the poverty line, ci is the income of the individual i, n is the total number of individuals, and m represents the number of poor individuals. In terms of poverty measures, the parameter α can change. P(0) displays the headcount index, which signifies the share of poor individuals below the poverty line, where parameter α is determined to be equal to 0, we obtain P (0). When parameter α is determined to be 1, we obtain P (1) that is the poverty deficit; this measure considers how far the poor, on average, fall below the poverty line. Lastly, poverty severity measures; if α is equal to 2, we obtain P (2), which takes into account the difference in the severity of poverty by giving more weight to the poorest or taking into account the inequality among the poor.

The international poverty line, which the World Bank recommended, was used as a measure of absolute poverty. We also present a relative poverty line that corresponds to 60% of the sample's median equivalised per capita income (OECD, 2017). According to ATKINSON ET AL. (1995), equivalence scales can help determine a value for each household type, which is in proportion to its needs. To estimate equivalence scales, we can find three methods: Here, we use a class of equivalence scales which can be described by the following formula: (3)

$$Equivalent\ size = (Adults + Children)^{\theta} \qquad (3)$$

where θ is a parameter between 0 and 1 to be chosen or estimated. We set the equivalence scale θ to 0.53. The following equivalence number for normal household sizes is too close to what is called the OECD-II equivalence scale[1]. According to SHKOLNIKOV ET AL. (2003), the widely known and used measure of inequality is the Gini coefficient, which relies on the Lorenz curve; this curve represents a cumulative frequency curve. It compares the share of a specific variable (for example, income) over the population to show inequality. Another Gini is calculated based on how a source of income decreases/increases the overall Gini coefficient. The Gini coefficient lies between 0 and 1, with 0 signifying absolute equality and 1 meaning absolute inequality (MÖLLERS & BUCHENRIEDER, 2011; WORLD BANK, 2000).

3.1.4 Binary Logistic Regression

In regard to the analysis with the willingness of farmers to sell straw, binary logistic regression is applied. Using this model, factors (X–independent variables) affecting the percentage of straw willingness to sell, and results (Y–dependent variables) could be measured. The formula used for this analysis is as follows:

Y= B_0 + B_1 *Already sell straw* + B_2*Soil Concerns* + B_3*Presence of animals* + B_4*Engagement in Agriculture* + B_5 *Age* + B_6 *Farm size with wheat* + B_7*Farm type* + B_8*Employment* + B_9*Education* + B_{10}*Percentage of willing to sell corn* + B_{11}*Farm size with corn* + B_{12}*Family size* + *ui.*

In regard to the percentage of selling straw, almost all farmers had a refereeing point of 50% (less or more than 50%). Thus the model is described as follows: The percentage of willingness to sell was involved as the binary dependent variable [(0) less than 50%; (1) more than 50%], with twelve variables located in table 7.

[1] "OECD-modified scale." After having used the "old OECD scale" in the 1980s and the earlier 1990s, the Statistical Office of the European Union (EUROSTAT) adopted in the late 1990s the so-called "OECD-modified equivalence scale." This scale, first proposed by (Haagenars et al. 1994), assigns a value of 1 to the household head, of 0.5 to each additional adult member and of 0.3 to each child (OECD, 2015)

3.1.5 Field Experiment

After discussing with different agricultural pharmacies in two regions, we selected farmers' that most used wheat cultivars. A similar selection based on their wide use was chosen in the study of DUBS ET AL. (2018). There were three winter cultivars: *Euclid* from France, *Vulcan* from Croatia and *Exotic* from Romania. Plots were sown and harvested on the following dates (table 1). A similar methodology was repeated for the second year.

Table 1. Sown and Harvested Date of Wheat Plants.

Region	**Dukagjini Plain**		**Kosovo Plain**	
Years	2018/2019	2019/2020	2018/2019	2019/2020
Sown date	19.10.2018	21.10.2019	26.10.2018	23.10.2019
Harvest date	12.07.2019	10.07.2020	16.07.2019	15.07.2020

Source: authors' own calculation

The research was conducted in two different agro-climatic and terrestrial regions of the Republic of Kosovo (in the Dukagjini Plain and the Kosovo Plain). Test fields were planted on the experimental farms of the Kosovo Agricultural Institute, in the Dukagjini plain (Vitomirica/Peja), in the Kosovo plain (test fields were planted in Lipjan).

Kosovo Plain is influenced by continental air mass with an average temperature of -10 ^{0}C during winter, whereas summers are very hot with an average temperature of 20^{0}C. The annual precipitation in the Kosovo Plain is estimated to be 600mm. Dukagjin Plain is highly influenced by hot air masses that go through the Adriatic Sea. The average temperature during the wintertime is 0.5^{0}C to 22.8^{0}C. The average annual precipitation of this climatic area is 700mm (RKS-GOV, 2021). This research project has been implemented and monitored by the Crop Production Sector in cooperation with the laboratories mentioned above, which operate within the Agricultural Institute of Kosovo in two regions (Dukagjini Plain and Kosovo Plain).

Harvest index and **the ratio of straw to grain** are calculated based on formulas below:

1) $HI = \frac{Grain\ Yield}{Biological\ Yield} x\ 100 = \frac{Grain\ Yield}{(Grain\ Yeild + Straw\ Yield*)} x\ 100$

2) $Ratio = \frac{Total\ dry\ biomass}{Grain\ Yield}$

3) $Ratio.C = \frac{Collectable\ Straw\ Yield}{Grain\ Yield}$

4 $Ratio.C.W = \frac{Collectable\ Straw\ Yield}{Grain\ Yield} x\ willingness\ to\ sell\ the\ straw(\%)$

Ratio C= collectable amount of straw to grain ratio
Ratio C. W=collectable amount of straw to grain (based on willingness to sell the straw in percentage) ratio

4 RESULTS AND DISCUSSION

4.1 Incomes of Farm Households

With per capita GDP estimates of close to €3,000, Kosovo is one of the poorest countries in Europe. Average per capita income is about one-tenth of E.U. levels, and poverty remains high. No significant differences exist between urban and rural poverty, but there are some notable regional differences (WORLD BANK, 2016).

4.1.1 Distribution of Non-Farm Incomes Based on Income Level of Rural Households

The study has analyzed the relationship between income level and distribution of off-farm income sources in total households' income. Contrary to the expected decreasing or u-shaped curves, the higher level of non-farm incomes in the middle-income class leads to an inversely shaped u-curve. The poorest group, with around 22%, belongs to a moderately low degree of non-farm income (described in figure 2). Generally, poorer households have high motivation but low ability to be involved in other sources of income; BARRETT ET AL. (2001) has discussed this case. We can also see the percentage of migration, which is the lowest in the poorer households and is in line with different studies (MCKENZIE, 2017; MENDOLA, 2008). Again if we analyze middle-income class, we see that non-farm income sources increases total income, therefore, it might be a distress-push situation as the reason for the inverse u-shaped relationship. In this situation, access to non-farm employment is easier or more difficult for certain parts of the population. Simultaneously, farming is seen as the most profitable solution for rural households compared to all other sources of income. Middle-income households appear to be defined by their potential and skills to find other options in the non-farm activities, enabling them to increase their total income and compensate for low farming income.

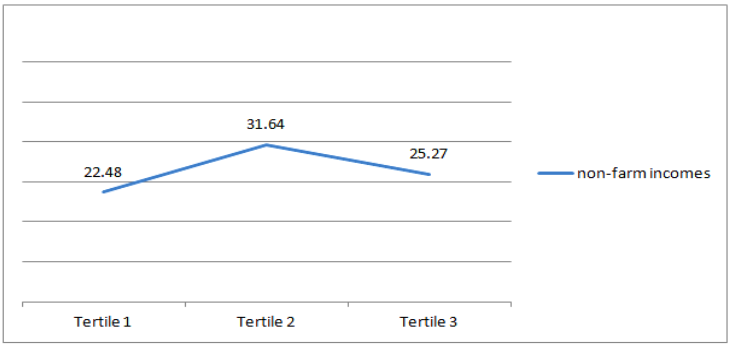


Figure 3. Income Groups and Share of Non-farm Incomes (%)
Source: authors' own calculation

4.1.2 Level of Farmers' Engagement on Agriculture

Farmers are engaged in agriculture on different levels; based on these levels, farm type is created. According to MÖLLERS & BUCHENRIEDER (2011), from the total income of full time farms, only 10% are from non-farm sources, while the second type of farms (complemented part-time farming) have a share of non-farm income between 10%-50% and the last one subsidiary part-time farming is as a typical subsidiary farm where the head of household gives priority working outside the farm sector and as a result, non-farm income is higher than farm income (part-time farms, subsidiary). The study analyzes farmers' incomes based on farm types (table 3). The results show that complemented part-time farming (type 2) fares better compared to per capita incomes $p>0.05$. This difference may be explained because farm income per hectare of land on type 2 is the highest. Nonetheless, this farm income per land on type 2 farms is not significant, another explanation may be due to high share of non-farming income compared to full-time farms $p<0.05$. According to per capita income, full-time farms are the poorest, even though they have higher income per ha than subsidiary farm types. Full-time farms disadvantage remains on the lowest share of non-farm income $p<0.05$, thus non-farm income sources are essential, and it seems that alternative employment can increase income.

Table 3. Incomes According to Farm Type Classes in Kosovo, 2017

Farm type (N)	Per capita income, equivalent scale (€)	Farm income per ha of land (€/ha)	Nonfarm income per capita eq. scale (€)	Farm share In total income (%)
Full-time farms (99)	3997[a]	2601.71[a]	29.7[c]	99.2
Complemented part-time farming (63)	5165[a]	3001.98[a]	1923[b]	62.32
Subsidiary part-time farming (40)	4223[a]	2055.17[a]	2909[a]	31.59
p-value	0.182	0.167	0.000	0.456

Means that do not share a letter are significantly different; Source: authors' own calculation

Based on the finding of MÖLLERS & BUCHENRIEDER (2011), full-time farms had a share in the total income of around 68.1%, and per capita incomes of full-time farms fared the best compare with the other two types of farms. The same author MÖLLERS & BUCHENRIEDER, (2011) stated that this could be due to a higher share of farming income and higher productivity. In our case, usually, farmers had more than 10% share from non-farm incomes or not a share at all. As a result, full-time farms were fully engaged or had a farm share in the total income of 99.2%, with significantly low non-farm income, these type of farms also had lowest income per capita and lower income per ha compared to complemented part-time farming.

4.1.3 Poverty incidence and income distribution

Table 4 shows the poverty incidence of rural households. The headcount index calculated based on a USD 4.30 poverty line (JIMENO ET AL., 2000) results in that 20% of the farm households in the sample face absolute poverty. Based on the results, almost one quarter (24%) of the households' sample falls below relative poverty line. Poverty severity, this indicator shows relatively low figures for the sample households, meaning that there is no considerable inequality in income distribution amongst the poor. The poverty gap index measures the total difference between the actual incomes of poor households and the poverty line. This index shows how much money should be transferred to the poor to lift them out of poverty (REINERT, 2017). The poverty deficit, defined as the average distance of the poor to the relative poverty line, is relatively low at 9%. In our sample, a household can be lifted above the relative poverty line with an additional 489.79 € per year and above the absolute poverty line with 316.42€. According to the impact that non-farm income and unearned income have, non-farm income lifts 16% of households out of poverty. The effect of unearned income is lower by about 2.7%-3.45%

Table 4. Poverty Incidence and Income Distribution

	Household Yearly income (€)	Headcount -index	Poverty Severity	Poverty Deficit (Gap)	**The share of households shifted above poverty line due to**	
					Non-farm Income	**Unearned Income**
Absolute poverty line $4.30 USD-line (1USD=0.94€)	3255.59	0.20	0.03	0.07	16%	0.03%
Relative poverty line 60% of median	3886.41	0.24	0.04	0.09	16%	3.45%

Source: authors' own calculation

Table 5 shows the distribution of total household income in the sample based on the Gini coefficient. The income distribution was calculated, excluding non-farm incomes too. The Gini coefficient of 0.488 for the farm households in the sample indicates that income distribution is unequal. At the Gini coefficient, which was calculated without considering non-farm incomes, we find a notable increase in the Gini coefficient, namely 0.699; this implies that non-farm income contributes to equal income distribution in rural areas. The examination of partial coefficients calculated based on decomposed Gini coefficients confirms that all household sources reduce inequality, especially the farm income. To calculate Gini coefficients, all households in the sample were considered, including those with no share in the respective income source (MÖLLERS & BUCHENRIEDER, 2011).

Table 5. Income distribution and non-farm incomes

Gini coefficient		
based on adjusted per capita incomes (equivalent scale)	0.488	
non-farm incomes excluded	0.699	
Decomposed Gini coefficients		
based on farm incomes	0.496	(-0.252)
based on non-farm incomes	0.754	(-0.0451)
based on unearned incomes	0.94	(-0.0024)
Gini Total	0.452	

Source: authors' own calculation

4.2 Farmer's Attitude on Using Wheat Straw

According to literature, sale of biomass for briquettes or pellets could be a future option. The price of the new product will primarily determine opportunities.

4.2.1 Contract Volumes and Price Preferences

Farmers' preferences regarding quantity (Figure 2a) and price (Figure 2b) of straw sold via contracts with a power plant are as follows: The highest frequency was for supplying a fixed area of straw, for a spot market price, while the second-highest was for supplying an amount dependent on farm surplus. As for price, the second most popular response was a fixed price.

Figure 2a. Quantity supply contract preferences; Figure 2b. Price supply contract option preferences

Source: authors' own calculation

Almost half of the farmers are willing to supply a fixed area of straw (44.2%) with a spot market price (68%). Similar results can be found in GLITHERO ET AL. (2013*A*) study, where 42% of farmers chose to supply a fixed area of straw, while the most popular response was fixed price (34% of farmers); this means that farmers do not want the risk of losing potential gains when market prices rise in Kosovo. The potential market of straw for bioenergy purposes is new to most farmers, so it is possible that they can expect the price to rise if this industry starts to take off. According to KUROWSKA ET AL. (2014), an unstable biomass market and its price fluctuations are seen as a weakness and threat, whereby the poor state of infrastructure and an unfavourable fuel situation can harm the market (BRODZIŃSKI ET AL., 2014).

4.2.2 Reasons for not Baling Straw and Incentives to Encourage Baling

In the study done by GLITHERO ET AL. (2013*A*), the lack of a market and machinery were excuses given by less than 10% of the farmers.

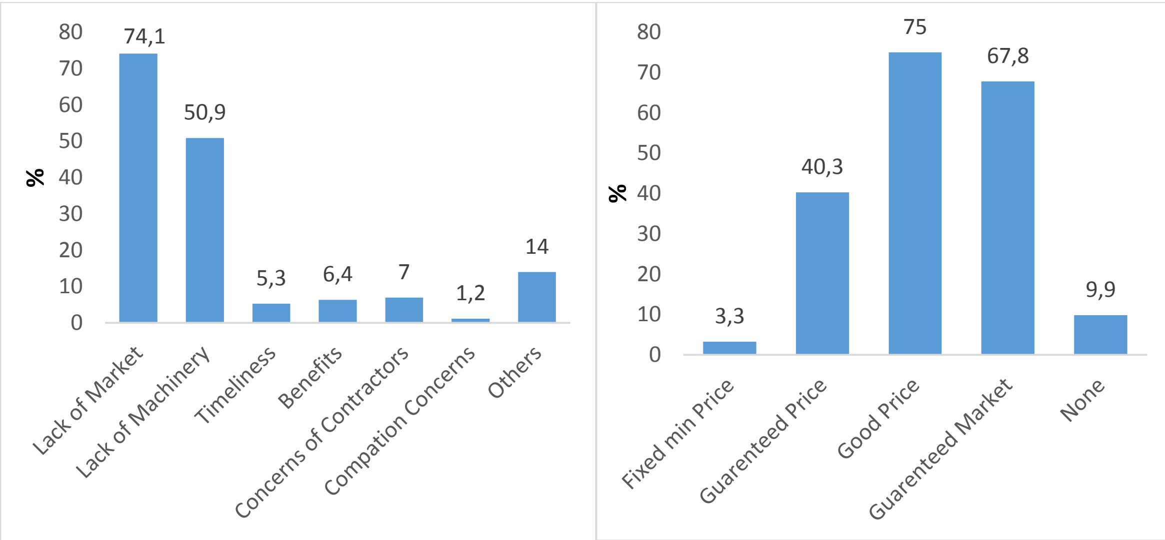


Figure 3a. Reasons for not baling/selling straw; Figure 3b. Incentives to encourage straw baling
Source: authors' own calculation

When farmers were asked about their reasons for not baling/selling (including selling in swath) some or all of their straw (figure 3a), the most popular response was a lack of market interest (74.1%) and the second reason was a lack of machinery (54.9%). When farmers were asked about factors that would motivate them to bale and sell their straw (figure 3b), the most popular response was a good price (75%), followed by a guaranteed market (67.8%) and guaranteed price (40.3%). Farmers were generally less interested in a fixed price, and some of them will not be encouraged by any of these reasons.

4.2.3 Length of Supply and Contract

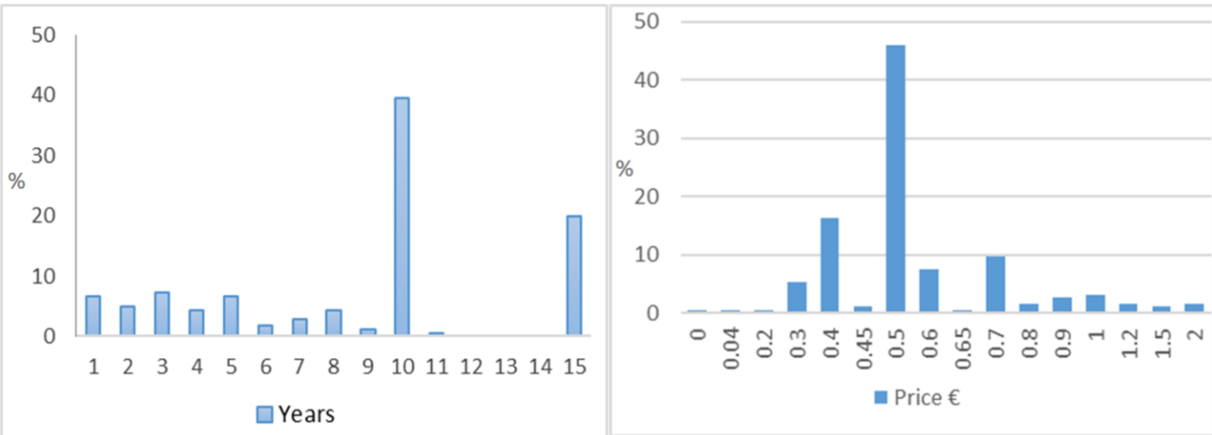


Figure 4a. Maximum Contract Length Supplying; Figure 4b. The Preferred Price of Straw
Source: authors' own calculation

Farmers were asked about the length of time (in years) (Figure 22) they would prefer to consecutively supply straw to a bioenergy plant and the maximum contract length that would be acceptable to them. Almost all farmers gave the same response for both, so we combined them into one question. The most popular contract lengths were 10 years (39.4%), 15 years (20%), and three years (7.2%). Note that while contract lengths of 15 years or less were most popular, none of the farmers rated 12, 13, or 14 years, while 6.7% of farmers preferred a five-year contract. The minimum price for which farmers were willing to sell straw was €0.50/bale (Figure 23); this was selected by 45.9% of all respondents, with 0.5% of farmers able to give it for free at a farm gate (if harvested by the one who receives it). The highest price was €2/bale; 28% of all respondents already sold straw, and of these 52% sold it for a price of €0.5/bale, which is the market price, while the highest price was €1 (16% of farmers). The other 71.6% did not sell at all. Additionally, one bale was equal to 15 kg straw, and 90.7% of farmers from the sample would be willing to sell their wheat straw to a bioenergy plant, while 9.3% did not agree to sell it; thus, in general, from price per ton would be 38 euros, different studies use different prices per ton, like 56.48 euros/ton, 32 euros/ton, or 50 euros/ton (ELBERSEN ET AL., 2010; GLITHERO, RAMSDEN, ET AL., 2013; MARKS-BIELSKA ET AL., 2019). Similar results can be seen in Poland, where biomass production primarily depends on raw material prices and a guaranteed market (BRODZIŃSKI ET AL., 2014).

4.2.4 Actual Use of Wheat and Corn Straw

From table 6, we can see that most of straw is used for bedding (37.60%) and feeding animals (19.39%); there is a very low amount of straw that is incorporated back into the soil (9.73%) the other 33.38% is sold, given for free, or burned, while willingness to sell it for energy purposes is around 65%. From the results, we can conclude that, in general, farmers are willing to supply more than half of their straw (64.73%); similar results were found in the study by GLITHERO ET AL. (2013*A*). The details of our study are as follows: few farmers incorporate wheat straw into soil, 20 (9.8%) respondents incorporate between 20-50% of straw, while ten farmers or 4.9% of the sample incorporate straw 100% into soil. The other part, 173 (84.8%), do not incorporate straw at all. Only two farmers declared that they burn 100% of straw into the field; the others 99% do not burn it at all. However, this issue needs particular attention because the number of farmers who burn straw is very low in our sample, while in reality, the Ministry of Environment and Spatial Planning calls for farmers not to burn straw as there is a risk of burning buildings or forests. Bedding straw practice was applied by 48.5% of farmers. Furthermore, 56 (27.5%) farmers use around 50-100% of their straw for animal feed, while most of them 133 (65.2%) do not use it at all. Some farmers were able to find a market for selling straw; 36 (17.6%) of farmers sell their straw 100%, 15 (7.4%)

sell around 50% of their straw, while the other part 146 (71.6%) do not sell it at all. There are 20 farmers who give straw for free in exchange for wheat harvest; 18 (8.7%) of them give 100% of their straw.

Table 6. Straw use practices in a sample size of 206 farmers.

Percentage	Incorporated into soil	Burn into field	Bedding	Feeding	Sell it	Give it for free	Willingness to sell
0	173(84%)	204(99%)	106 (51.5%)	133 (64.6%)	148 (71.8%)	186 (90.3%)	18 (8.7%)
10	1 (0.5)			1 (0.5%)			3 (1.5%)
15					1 (0.5%)		1 (0.5)
20	3 (1.5%)		1 (0.5)	2 (1%)			9 (4.4%)
25	1(0.5%)			1 (0.5%)			
30	1 (0.5)			12 (5.8%)	1 (0.5%)		11(5.3%)
35	1 (0.5)		1 (0.5%)				
40				1 (0.5%)	1 (0.5%)		3(1.5%)
45	1 (0.5)						
50	13 (6.3%)		35 (17%)	39 (18.9%)	15 (7.3%)	1 (0.5%)	48 (23.3%)
55			1 (0.5%)				
60				1 (0.5%)	1 (0.5%)		11 (5.3%)
65			1 (0.5%)				
70	1(0.5%)		9 (4.4%)	1 (0.5%)	1 (0.5%)		5 (2.4%)
75	1 (0.5%)			1 (0.5%)			4 (1.9%)
80				1 (0.5%)	2 (1%)	1 (0.5%)	14 (6.8%)
85				1 (0.5%)			
90			1 (0.5%)				7 (3.4%)
95							
100	10 (4.9%)	2(1%)	51 (24.8%)	12 (5.8%)	36 (17.5%)	18 (8.7)	72 (35%)
Mean(%)	9.73	0.97	37.60	19.39	22.94	9.37	64.73

Source: authors' own calculation

4.2.5 Descriptive Data of Farmers

Concerning the socioeconomic factors of willingness to sell straw, the results (table 16) showed that most of the farms cultivated mixed cultures of wheat and corn; their average land size for wheat was 6.41 ha and for corn it was 4.49 ha, with the average number of animals being 7.81; on the other hand, a low number of farmers cultivated only wheat with an average land size of 4.40 ha and an average number of animals of 2.07. From the total sample, more than a quarter of farmers worked outside agriculture (including those employed in the public sector or private sector, self-employed in the nonagricultural sector, and other), while the others did not have any other work except agriculture. More than three-quarters of farmers had finished secondary school, and the rest had finished university. As for the land area devoted to wheat, most wheat farmers (89.3%) had large-scale farms of 0.01–9.99 ha, while a minority had >10 ha. Almost the same true for corn: the majority of farmers (92.7%) had 0.01–9.99 ha and only a few had >10 ha. When farmers were asked if they incorporate straw into the soil, most (84%) declared that they do not incorporate straw, while the others said the opposite. From the total sample, more than half of farmers (68%)

have animals, while the others have none. More than half (69.4%) of the farmers were engaged in agriculture as a full-time occupation, while the others were part-time farmers. As for age, 34% of the farmers were 20–40 years old, while the others were over 40. When asked if they were willing to sell corn straw for energy purposes, 11.6% of the farmers declared that they are not planning to plant corn at all; 36.9% were willing to sell <50% to power plants, and the other parts (51.5%) were willing to sell more than 50%. Around one-quarter of the farmers had more than nine family members, while the rest had households of 1–9 members (the average). Only 45.1% of farmers wanted to sell less than half of their straw, while the rest were willing to sell more than 50% of straw. The average price for farmers who are willing to sell less than 50% was 0.59 (€/15-kg bale), and for those who wanted to sell more than 50% of straw the price was 0.56; however, this is not a significant difference ($p < 0.05$). The average price is 0.57 euro per bale.

Table 7. Farmers' basic characteristics.

Factor	Code and Sort	Frequency	%	Mean and St. dev
I. Farm type	[0]. Wheat	32	15.5%	0.656 ± 483
	[1]. Wheat and Corn	174	84.5%	0.523 ± 500
II. Employment	[0]. Outside of Agriculture	68	33%	0.5882 ± 0.496
	[1]. Agriculture	138	67%	0.5217 ± 501
III. Education	[0]. Elementary/higher school	166	80%	0.5361 ± 500
	[1]. University	40	19%	0.575 ± 500
IV. Soil Concerns	[0]. Not Incorporated	173	84%	0.503 ± 501
	[1]. Incorporated into the soil	33	16%	0.758 ± 0.435
V. Animals	[0]. Do not have animals	66	32%	0.879 ± 0.323
	[1]. Have animals	140	68%	0.386 ± 0.489
VI. Engagement in agriculture	[0]. Part-time farmer	63	30.6%	0.556 ± 0.500
	[1]. Full-time farmer	143	69.4%	0.539 ± 0.500
VII. Currently sell the straw	[0]. Do not sell the straw	148	71.8%	0.487 ± 0.501
	[1]. Sell the straw	58	28.2%	0.690 ± 0.467
VIII. Age	[0]. 20–40 years old	70	34%	0.571 ± 0.498
	[1]. ≥41 years old	136	66%	0.529 ± 0.501
IX. Percentage of corn	[0]. Not planning to plant corn	24	11.7%	0.67 ± 0.482
	[1]. ≤50%	76	36.9%	0.08 ± 0.360
	[2]. ≥51%	106	51.5%	0.86 ± 0.350
X Land area of wheat	[0]. 0.01–9.99	184	89.3%	0.544 ± 0.500
	[1]. ≥10	22	10.7%	0.546 ± 0.510
XI. Land area of corn	[0]. 0–9.99 ha	191	92.7%	0.55 ± 498
	[1]. ≥10 ha	15	7.3%	0.47 ± 516
XII. Household size	[0]. (1–9)	154	74.8%	0.533 ± 0.500
	[1]. (≥10)	52	25.2%	0.577 ± 0.499
Dependent variable	[0] (≤50%)	93	45.1%	33.07% ± 20.01
(Willingness to sell wheat straw)	[1] (≥51%]	113	54.9%	89.73% ± 16.58

Source: authors' own calculation

4.2.6 Binary Logistic Regression

Binary logistic regression was used to check significant factors influencing the willingness of farmers to sell their straws. The logistic regression model gave a statistically significant result of $\chi2(9) = 131.095$, $p < 0.001$. This model explained between 47.1% (Cox and Snell R^2) and 63% (Nagelkerke R^2) of the variance in the percentage of willingness to sell straw and correctly classified 85.9% of the cases. Additionally, we obtained an insignificant value for the goodnessof-fit test (Hosmer and Lemeshow) $\chi2$ (8) = 9.146, $p > 0.330$. Table 17 presents the logistic regression output of the factors determining farmers' willingness to sell straw in Kosovo.

The results showed that the predicted logit of (PERCENTAGE OF WILLINGNESS TO SELL) = 1.827 + (–1.034) * SELL IT + (0.620) *SOIL CONCERNS + (–3.535) * ANIMALS + (–0.992) *TIME SPENT ON FARM + (–0.463) *AGE OF FARMER + (0.162) * WHEAT AREA + (–3.316) * FARM TYPE + (0.239) * EMPLOYMENT + (0.024) * LEVEL OF EDUCATION + (3.393) * P. CORN STRAW + (–0.165) * CORN AREA + (0.326) * FAMILY.

Binary logistic regression (Table 8) showed that farmers who already sell straw and have animals, farmers who have corn, and the percentage of willingness to sell the corn straw were significant predictors of willingness to sell the wheat straw ($p < 0.05$), while engagement in agriculture can be potentially significant ($p < 0.1$). Soil concerns, corn area, wheat area, farm type, employment, education, and the number of family members were marginally nonsignificant ($p >$ 0.05).

4.2.7 The Impact of Socio-Economic Factors on The Willingness to Sell the Straw

After loading a binary logistic regression in this chapter (Table 8), we found out which variables have a significant impact on willingness to sell the straw more than 50%; the description is as follows: farmers who are already selling the straw in the market they are also willing to sell it more than 50% for energy purposes while farmers who are willing to sell less than 50% for energy purposes they currently do not sell the straw at any market and this had a significant impact on willingness to sell more than 50% as the number of farmers who wants to sell "lower than 50%" on the market is very high. Farmers who have animals tend to sell less than 50% of their straw, while farmers who do not have animals were 34.48 times more likely to sell more than 50% of their straw and had a significant impact. Farmers who have only wheat tend to sell the straw more than 50% (this could also be linked with the presence of animals); they tend to sell 27.7 times more than farmers who have both cultures corn and wheat. Selling the corn straw is also linked with wheat straw; farmers who would sell the corn straw more than 50% are also willing to sell the wheat straw more than 50%, they are more likely to sell it for 29.75 times compared to those who sell the corn less than 50% this also has a significant impact. Engagement in agriculture tend to have a significant impact as the level of part-time farmers is 2.69 times higher in agreeing to sell the straw, more than 50% compared to full-time farmers. Factors that are not significant and shaped into the willingness to sell the straw more than 50% are; soil concerns, as farmers who incorporate the straw into the soil are willing to sell it more than 50%. Then there are other factors such as land size with wheat, employment, land size with corn, education and family size. Further details are described as follows: It can be statistically justified ($p < 0.05$) that only three variables included in the model have an impact on the willingness to sell straw. Papers on methodology recommend the use of the so-called R value to express the role and power of specific independent variables in a model. The size of the value denotes the order of “importance” of independent variables. This index is not a part of the model's output; it needs to be calculated using the following equation: $R = \sqrt{\frac{Wald-2df}{Do}}$. Willingness to sell straw is mostly (0.383) shaped by the willingness to sell the corn straw, followed by the presence of animals on the farm (0.306), farm type (0.231), and the partial impact (0.059) of engagement in agriculture and of having a market (0.083).

Table 8. Binary Logistic Regression; Factors Affecting the Percentage of Willingness to Sell the Straw.

FACTORS	B	S.E.	Wald	Df	Sig.	Exp(B)	R
Sell the straw	-1.034	.521	3.940	1	.047	.356	0.083
Incorporated into soil	.620	.599	1.072	1	.300	1.859	-
Have cows	-3.535	.662	28.479	1	.000	.029	0.306
Fulltime/part-time	-.992	.573	2.999	1	.083	.371	0.059
Age	-.463	.444	1.088	1	.297	.629	-
Wheat size	.162	.830	.038	1	.846	1.175	-
Corn size	-.165	1.048	.025	1	.875	.848	-
Farm Type	-3.316	.801	17.120	1	.000	.036	0.231
Family	.326	.495	.433	1	.511	1.385	-
Employment	.239	.543	.193	1	.660	1.270	-
Education	.024	.592	.002	1	.968	1.024	-
% Willing to sell corn	3.393	.513	43.671	1	.000	29.748	0.383
Constant	1.827	.778	5.522	1	.019	6.217	0.111

-2log likelihood 152.537; Hosmer and Lemeshow (χ 2 = 9.146, df=8, p =0.330); Pseudo R squares (Cox & Snell R Square R2= 47.1%; and Nagelkerke R2= 63%); Overall percentage of correctly predicted= 85.9%; B: unstandardized regression weight; S.E.: standard error; Sig.: significance; Exp(B): exponentiation of the B coefficient; Wald.: Wald chi-square value; Df.: the degrees of freedom ("-") Factors that were not shaped in the percentage of willingness to sell; Soil concerns, age, wheat size, corn size, family, employment, education)

Source: authors’ own calculation

4.3 Biomass Assessments

4.3.1 Differences Between Cultivars and Regions for 2019 and 2020 (g, cm/ wheat plant)

Different studies reported differences in wheat due to location, cultivar and year, for example TOWNSEND ET AL. (2017) found small differences on total straw yield between cultivars, and high variability across years, the author suggests that being able to provide accurate straw yield data for cultivars might prove to be difficult. LARSEN ET AL. (2012) also found differences between cultivars ranged 2.7-4.6 tons/ha in two different field experiment similar results we can find also in different studies (DAI ET AL., 2016; R. E. ENGEL ET AL., 2003; GRADZIUK ET AL., 2020).

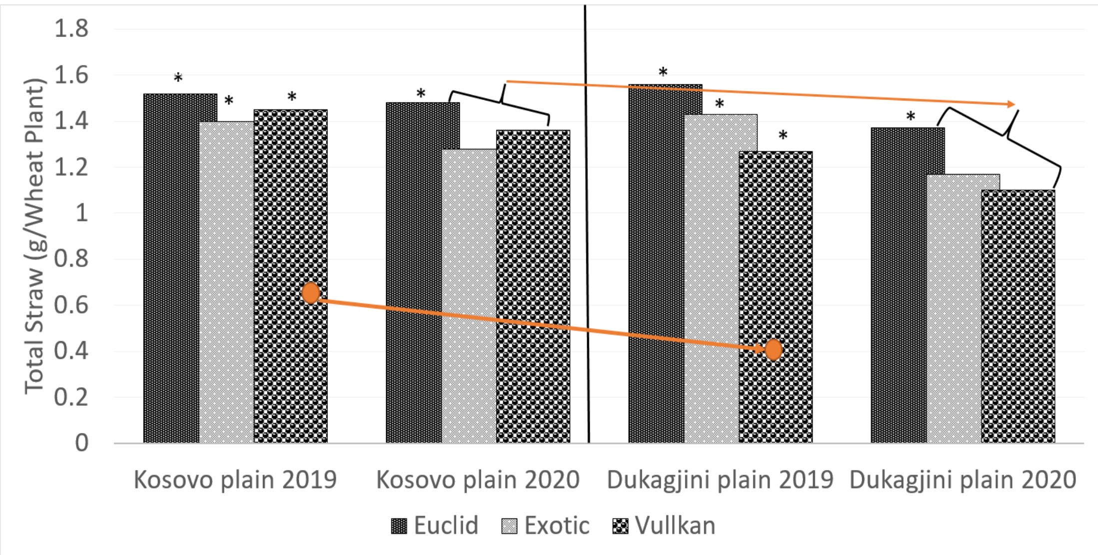


Figure 5. Total Straw Based on Cultivar, Region and Year (g/plant)
Source: Author's own calculation

Figure 5. Represents the results of each experiment in two regions regarding total straw. Three cultivars are measured in gram/plant. **Total straw and leaves (g/plant) on 2019-** the highest weight of straw and leaves had Kosovo plain 1.46±0.29 compared to Dukagjini Plain 1.42±0.32. There are significant differences between the three cultivars within the region, while there are no significant differences of these cultivars between regions, except the cultivar Vulcan. However, the highest weight in both regions had Euclid. **Total straw and leaves(g/plant) on 2020-** Similar to the previous year**,** the highest weight of straw and leaves had Kosovo plain 1.37±0.30(g) compared to Dukagjini Plain 1.21±0.25(g). In both regions, cultivar Euclid had the highest amount compared to Vulcan and Exotic $p<0.05$. There are significant differences between the three cultivars in both regions. According to different authors (BASTOS ET AL., 2020; FANG ET AL., 2020), a high number of wheat plants (plant density) is a critical component in increasing the amount of yield. Thus, the number of plants per m^2 can significantly change the straw and grain yield of the current cultivars; details are given in the table below, where we converted grams to kg per ha. In the study of CAO ET AL. (2019), this amount varies between 3.67 to 8.33x 10^6/ha wheat plant.

Table 9. Winter Wheat Parameters (Gram/plant and Kilogram/ha)

Region	Type of cultivar	Seeds (gram)	Chaff (gram)	Collectable straw	Stubble (part 13 cm)	Wheat plant m^2	Wheat plant (ha)	Seeds kg/ha	Chaff kg/ha	Collectable strawkg/ha	Stubble (13cm kg/ha
Kosovo Plain 2019	Euclid	2.01	0.68	1.2	0.32	393.09	3930900	7961.18	2693.24	4711.27	1285.09
	Vulcan	2.01	0.59	1.13	0.32	334.33	3343300	6724.17	1957.63	3750.77	1083.43
	Exotic	1.91	0.64	1.06	0.34	361	3610000	6887.77	2318.77	3818.17	1225.73
Kosovo Plain 2020	Euclid	1.93	0.43	1.21	0.27	540	5400000	10396.8	2326.4	6537.03	1446.3
	Vulcan	1.35	0.32	1.07	0.29	713	7130000	9598.6	2314.4	7599.3	2084.6
	Exotic	1.8	0.47	1.01	0.27	557.15	5571500	10053.3	2632.5	5625.63	1503.7
Dukagjini Plain 2019	Euclid	2.4	0.56	1.26	0.3	567	5670000	13616.15	3194	7091.38	1721.17
	Vulcan	1.85	0.45	1	0.27	621	6210000	11506.94	2729.79	6235.43	1671.5
	Exotic	2.65	0.58	1.09	0.34	517.65	5176500	13748.03	3098.02	5625.93	1777.51
Dukagjini Plain 2020	Euclid	1.71	0.42	1.1	0.27	559.89	5598900	9557.9	2340.84	6160.11	1495.15
	Vulcan	1.38	0.34	0.85	0.25	706.43	7064300	9767.8	2407.7	6021.87	1727.94
	Exotic	1.92	0.44	0.89	0.28	496.33	4963300	9506.84	2194.4	4399.01	1403.98

4.3.2 Correlation Between Wheat Parameters

Residue-to-grain ratios are often used to predict straw yield from grain yields for trials where straw yield has not been measured, usually assuming a direct or linear relationship between grain and straw yields(ENGEL ET AL., 2003). In the study of GLITHERO ET AL. (2013b), there was no clear relationship between harvested grain to straw yields for wheat because the correlation was weak and not significant. Many farmers use shorter cultivars and choose management practices to escape the straw lodging from the weather; however, BRAGG ET AL. (1984) found that although reduced plant height, it did not significantly influence straw or grain yields.

Table 10. Correlations Between Wheat Parameters

Variables	1	2	3	4	5	6	7
1) Total Straw (cm)	1						
2) Spike (cm)	-.270**	1					
3) Seed (g)	.030	.367**	1				
4) Chaff (g)	-.182**	.575**	.578**	1			
5) Total Straw (g)	.205**	.543**	.620**	.616**	1		
6) Height of Plant (cm)	.988**	-.121**	-.089**	-.097**	.297**	1	
7) Total Dry Biomass(g)	066*	.607**	654**	.825**	.947**	.164**	1

**. Correlation is significant at the 0.01 level (2-tailed).

Source: authors' own calculation

From the table 10 with the total number of samples for two years and two regions, seeds have a significant positive correlation with straw(g) (R^2=0.620), chaff (R^2=0.578) and spike (cm) (R^2=0.367) $p<0.05$ and total dry biomass ((R^2=0.654), from the above parameters seeds, have the strongest correlation with total dry biomass and total straw and the lowest no significant correlation with the height of straw and plant.

4.3.3 The Share of Total Dry Biomass for The Two Regions

It is suggested that under standard conditions, only about 50% of the non-grain biomass can be baled even when the height of the combine cut is low(AHDB, 2017). This can be because some residues are unable to collect, like chaff, leaves and stubble.

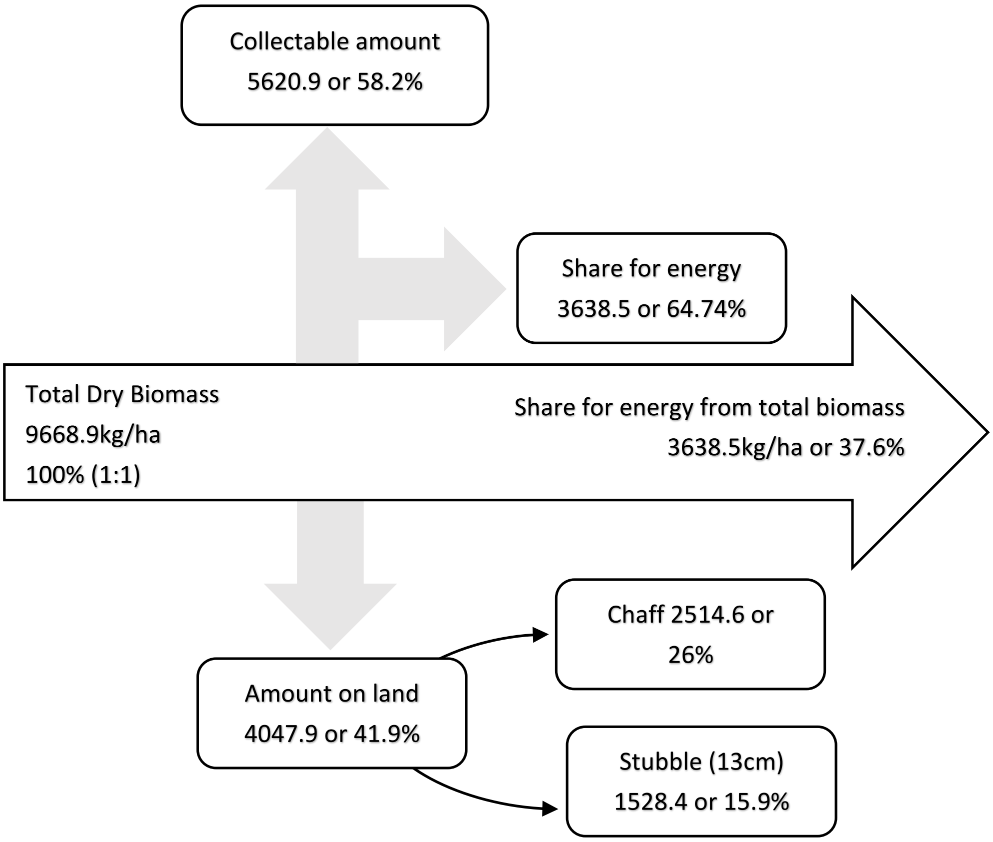


Figure 6. The Share of Total Dry Biomass (on Land, Collectable, Energy Purposes) in Kosovo Plain and Dukagjini Plain; kg/ha

Source: authors' own calculation

From the figure 6, we can see that the collectable amount of straw is around 58%, our result match with different studies. The available straw for energy purposes from the collectable amount of straw, based on the willingness of farmers to sell the straw, is 64.74% similar result we can find in the study of GLITHERO ET AL. (2013*A*). Based on our results in figure 29 from the total amount of dry biomass, we can say that around 38% can be used for energy purposes, while in other studies, we can see the different percentage for available straw for energy 25%-27% from the total dry-biomass, without specifying much for other purposes (ALAKANGAS, 2011; WEISER ET AL., 2014). The Collectable amount in our study is around 58% which came by harvesting straw at a cutting point of 15cm (which is also similar to daily practices by farmers); our finding is also in line with sustainable removal rate as it is quite similar to different papers.

Our study's percentage of straw left on land is 42%; this percentage is in line with the sustainable removal rate discussed above. Chaff in our study represent around 26% of total dry biomass, the uncut residues (stubble 13cm part) in our study represents 16% similar results we can find in the study of SUARDI ET AL. (2020).

4.3.4 Differences Between Cultivars and Regions (kg/ha), for 2019 and 2020

LARSEN ET AL. (2012), in attempting to identify the cultivars with high straw yields for use as feedstock for biofuel production, found yields ranged from 2.7 t ha^{-1} to 4.2 t ha^{-1} in one field experiment and 3.4 t ha^{-1} to 4.6 t ha^{-1} in another (baled straw). According to ASSENG ET AL. (2020), annual wheat yields range from <1 t/ha/y when water or nutrients are limiting to >10 t/ha/y in cooler, well-watered (via high rainfall or irrigation).

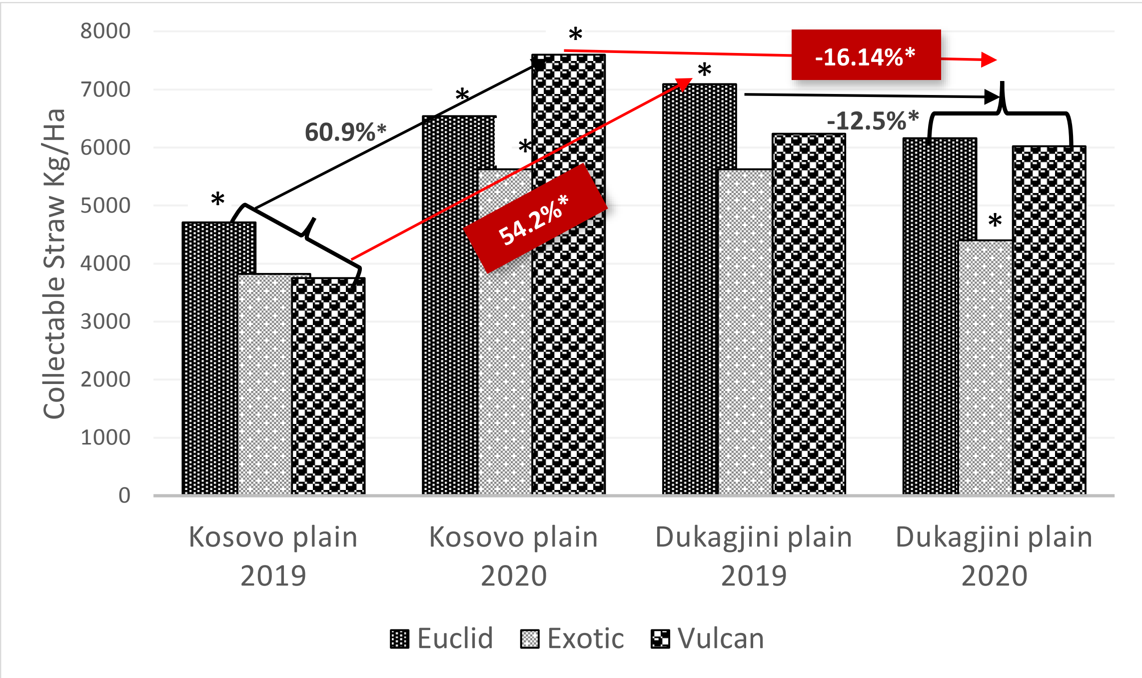


Figure 7. Collectable straw Based on Cultivar, Region and Year (kg/ha)

The figure 7 shows that the best cultivar during 2019 in the Kosovo plain was Euclid, which was significantly higher than Exotic and Vulcan. Again, in the same region but different year 2020, the best cultivar was Vulcan, significantly higher than Euclid and Exotic. In the Dukagjini plain during 2019, the best cultivar was Euclid which was significantly higher than Vulcan and Exotic, and again in 2020 in the Dukagjini plain, the best cultivar was Euclid; however, it was not significant with other cultivars Exotic nor Vulcan. From both figures, we can see that cultivar Euclid was shown higher in straw and seeds; even though Vulcan and Exotic had higher seed in the Dukagjini plain 2019 and 2020, they were not significant to Euclid.

4.3.5 Harvest index and ratio straw to grain, based on the cultivar, region and year

Table 11. Harvest Index and Straw to Residue Ratio Based on Cultivar, Region and Year

Parameters	Year	Euclid	Vulcan	Exotic	Average	Total Average
Harvest Index-Kosovo Plain	2019	0.478	0.498	0.483	0.486	0.50
	2020	0.502	0.444	0.507	0.485	
Harvest Index-Dukagjini Plain	2019	0.531	0.520	0.567	0.539	
	2020	0.489	0.490	0.545	0.508	
Collectable Straw to Grain, Kosovo Plain	2019	0.592	0.558	0.554	0.568	0.57
	2020	0.629	0.792	0.560	0.660	
Collectable Straw to Grain, Dukagjini Plain	2019	0.521	0.542	0.409	0.491	
	2020	0.645	0.616	0.463	0.575	
Total dry biomass to Grain, Kosovo Plain	2019	1.091	1.010	1.069	1.057	0.99
	2020	0.992	1.250	0.971	1.071	
Total dry biomass to Grain, Dukagjini Plain	2019	0.882	0.924	0.764	0.857	
	2020	1.046	1.040	0.836	0.974	
Total straw to Grain, Kosovo Plain	2019	0.753	0.719	0.732	0.735	0.73
	2020	0.768	1.009	0.709	0.829	
Total straw to Grain, Dukagjini Plain	2019	0.647	0.687	0.539	0.624	
	2020	0.801	0.793	0.610	0.735	
Willing to sell x Collec. Straw, Kosovo Plain	2019	0.383	0.361	0.359	0.368	0.371
	2020	0.407	0.512	0.362	0.427	
Willing to sell x Collec. Straw, Dukagjini Plain	2019	0.337	0.351	0.265	0.318	
	2020	0.417	0.399	0.300	0.372	

Source: authors' own calculation

Table 11 shows the Harvest Index (seeds/ seeds+ total dry biomass) can differ from cultivars, years and regions with a scope from 0.48 to 0.54. After harvest index, the ratio straw to grain was calculated, the amount of straw in this index represents straw which is able to be collected by machinery, when machinery cuts it 15cm above the ground together with chaff, this type of index varies from 0.55 to 0.79, which an average of 0.57, which means from one kg of seed, 0.57kg of straw is able to be collected. When it comes to "Total dry biomass" or the ratio between total dry biomass and seed, the index is 1:1, which means for every kg of seed, around 1 kg of dry biomass is produced. The "total straw" in on average of 0.73, which means if the machinery cuts straw 2cm above ground without chaff, for every kg of seeds, we will have around 0.73kg straw, however cutting straw in this way is not sustainable. The last parameter which we calculated is collectable straw and the willingness of farmers to sell it; this parameter is based on the willingness of farmers to sell straw from straw which is able to collect. From collectable straw, farmers are willing to sell around 64.73% of it. This ratio number is found as collectable straw * willingness of farmers to sell straw divided by kg of seeds. This ratio has an average of 0.37, which means based on farmers' willingness to sell straw, per every 1 kg of seed, only 0.37kg of straw can be used for energy purposes.

Table 1. Potential of wheat biomass in Kosovo

Amount of dry biomass	Kosovo Plain (2019-2020) kg/ha	Dukagjini Plain (2019-2020) kg/ha	Average kg/ha	Land with wheat (80,273 ha) ton
Total Dry Biomass	9133.3	10204.53	9668.9	776,151.6
Total Straw	6760.3	7548.3	7154.3	574,297.1
Collectable Straw	5325.36	5916.5	5620.93	451,208.9
Willing. to sell **x** collec. straw	3447.1	3829.75	3638.43	292,067.7
Seeds	8584.61	11262.17	9900.74	794,762.5

Source: authors' own calculation

In Kosovo, around 80,273 ha are planted with wheat. Based on collectable amount and willingness to sell the straw, we calculate 292,067.7 tons, and the average price is €0.57/15-kg bale. The price for a ton would be 38 euros, and in total, farmers would generate 11 million euros.

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

1. The poorest farmers, had the lowest share of non-farm income, $p<0.0$ while extra income slightly reduce inequality and contribute to softening the poverty between farmers.

2. Circular economy regarding R.E is socially desirable as around 91.3% of farmers are willing to sell the straw, the average amount of selling the straw based on farmers' willingness, was 64.74%.

3. Factors that impact the amount of straw willing to sell are: having animals, farm type, willingness to sell the corn and engagement in agriculture. (Farmers who have no experience on selling straw, they don't want to sell the straw more than 50%)

4. The main reason for not selling the straw was lack of market and machinery, while the main incentives were having a good price and guaranteed market.

6. From the total biomass, around 58% of it is able to collect while the other part of 41.7% would stay on land, this rate also supports sustainable removal rate suggested from different authors.

7. In our study, the best predictor for the amount of straw are grain. The average report of total dry biomass to grain is found to be 1:1; from this report, based on collectable straw and willingness of farmers to sell the straw 1:0.37kg. There is significant difference of straw between cultivars, years and regions. The available biomass for energy purposes in Kosovo is 292,067.7 tons

5.2 Recommendations

1. As non-farm income contributes to a more equal income distribution in rural areas, the study recommends that public institutions need to support farmers through the provision of extension services and government subsidies to improve farm production and income of farmers.

2. The environmentally friendly treatment of surplus straw (avoiding burning in the field by all means) should be directed to attractive market conditions. In addition to wheat straw, corn straw has a significant impact on the market for bioenergy derived from biomass.

3. In the case of Kosovo, our study recommends using the ratio between straw to seeds of 0.37, which means for every kg of seeds, around 0.37kg of straw is available for energy purposes

4. Straw need to measure the by precision technologies and based on willingness of farmers to sell the straw. A list with wheat cultivars with yield and straw reports is needs as database.

5.3 Limitations

Regarding the analysis with non-farm income, the research is limited due to its sample size. Data collection focused on farmers with different cultures (vegetables, small fruits), which led to heterogeneous overall results. We found that part-time farmers had a significantly higher income per hectare than full-time farmers; thus, analyzing this difference in incomes per hectare based on farm type needs further research and analysis. While limitations on the analysis with farmers' attitude, our study does not cover all possible topics within the biomass utilization but is limited to what we consider important in farmers' attitude. The research does not represent farmers' attitudes to biomass energy market, but the results identify the dominant tendencies of the market community. The amount of wheat biomass is based on the experiment monitored by experts; the results of ton/ha are based on a 1-m2 edge-protected experimental area and not from farm fields, which can be lower. A greater range of cultivars needs to be assessed in the future, with a more extended period.

6 NEW SCIENTIFIC RESULTS

Our study is the first one in the international literature review, which assess wheat biomass-based of agronomic measurements and willingness of farmers to sell straw, taking into consideration sustainability of straw removal rate. The study also considers the inequality between rural households and the impact of non-farm income on inequality and poverty.

In connection with the results of this study which had been presented, the novel scientific outcomes drawn from this research are as follows:

1. Based on my analysis, which is done by using Poverty (FGT) and Gini Indexes, extra income does not increase inequality; on the contrary, they slightly reduce inequality and contribute to softening poverty between farmers, which could help reduce migration from rural to urban areas. By using One-Way ANOVA to compare three groups of farmers based on their income, the results showed that the poorest rural households had the highest share of farm income (77.52%) since they were less able to respond to attractive emerging non-farm income, and hence had less diversified incomes opportunities, $p<0.05$. Non-farm incomes have a positive impact on poverty alleviation, thus, the study suggests adopting suitable rural policies to enhance nonfarm employment. Thus, extra income from renewable energy would positively affect poverty, which would lead to a sustainable poverty reduction. By using descriptive statistics which are taken from the face to face questionnaires, I conclude that farmers have positive attitudes regarding selling straw for energy purposes; the main reason for not selling straw was lack of market and machinery, while the main incentives were having a good price and guaranteed market.

2. By using Binary Logistic Regression, I conclude that factors which are significant and shaped in the percentage of willingness to sell straw are experience with selling straw, (was positively correlated with willingness to sell straw), having animals has negative correlation on willingness to sell straw, farm type: farmers who planted wheat and corn are less willing to sell straw compared to farmers who cultivate only wheat. Engagement in agriculture also significantly impacts willingness; part-time farmers are more willing to sell straw than full-time farmers. While soil concerns, age, land size with wheat, land size with corn, education and family size have no significant impact on the willingness of farmers to sell straw.

3. From the results of experiment which was carried out for two years consecutively in two regions with three most used winter wheat cultivars, I conclude that from the total biomass, if it is cut 15cm above the ground, around 58% of it is able to collect while the other part of 41.7% would stay on land (without counting 2cm above the ground together with roots), this rate also supports sustainable removal rate suggested from different authors. The amount of dry biomass which stays on land contains 26% chaff and 16% stubble. From the collectable amount of straw, based on the willingness of farmers to sell straw, only 64.7% is available for energy purposes, converting in kg per ha this amount in the Kosovo plain is 3447.1kg/ha while in the Dukagjini plain, this amount is 3829.8.

4. From experimental fields, based on statistical analysis such as; One-Way ANOVA and T-test, there is significant difference of straw between cultivars, years and regions. Difference on the amount of collectable straw between two years within a region was from 12 to 37.9%, difference between regions for the first and second year of experiment was from - 16.14% to 35.14%. While

in total territory, the difference on the amount of collectable straw for two years is 14%. The results of Pearson Correlation shows the strongest correlation with seeds had wheat straw (g) and total dry biomass (g) which was positive 0.627 and 0.654, significant at value $p<0.01$, while a lower correlation was found with plant height (cm) $p<0.01$ and straw(cm) $p>0.05$. In our study, the best predictors for the amount of straw are yields. The average harvest index is 0.50, and the average report of total dry biomass to grain is found to be 1:1; from this report, based on collectable straw and willingness of farmers to sell straw, we can say that for every kg of wheat, around 0.37 kg of straw can be used for energy purposes.

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