Appendix 1: Online questionnaire Survey

Agriculture Residues in Indonesia

Consent to Participate in a Research Study

The purpose of this page is to provide you with the information that you need to consider in deciding whether to participate in this research study. The study is being conducted as part of my MSc Agri-food Systems and Rural Development degree at Czech University of Life Sciences in Prague.

Project Description

This study seeks to understand and measure farmers' knowledge about the production and use of biomass to produce energy based on crop residues on local farms and their willingness to use such resource. This study will not cause any physical or mental harm; therefore, you will not experience any distress whilst participating in this study.

Confidentiality of the Data

There is complete anonymity and confidentiality of the data, which will be kept safely electronically. Your details such as email address will be personally unidentifiable and only seen by the researchers when collecting the data, but this information will not be in the report and only the results will be kept after the study is completed.

Disclaimer

You are not obliged to take part in this study and should not feel coerced. You are free to withdraw at any time. Should you choose to withdraw from the study you may do so without disadvantage to yourself and without any obligation to give a reason.

- I have the read the information sheet relating to the above research study and have been given a copy to keep. The nature and purposes of the research have been explained to me, and I have had the opportunity to discuss the details and ask questions about this information. I understand what is being proposed and the procedures in which I will be involved have been explained to me.

- I understand that my involvement in this study, and particular data from this research, will remain strictly confidential. Only the researchers involved in the study will have access to identifying data. It has been explained to me what will happen once the research study has been completed.

- I hereby freely and fully consent to participate in the study which has been fully explained to me. Having given this consent I understand that I have the right to

withdraw from the study at any time without disadvantage to myself and without being obliged to give any reason. I also understand that should I withdraw; the researcher reserves the right to use my anonymous data in the write-up of the study and in any further analysis that may be conducted by the researcher.

If you have any questions or concerns about how the study has been conducted, please contact Dr Tatiana Ivanova (ivanova@ftz.czu.cz). If you are happy to continue then please confirm that you consent to taking part in this study by ticking the box and click on "Next".

Thank you for taking part in this survey. Please complete the survey in one session.

This questionnaire is anonymous, and results will be used to Diploma Thesis data collection and writing at Czech University of Life Science, Faculty of Tropical AgriSciences, Kamýcká 129, 165 00 Prague, Czech Republic.

Agricultural background, perception, and application of biomass residues.

Q1. What type of agriculture products do you cultivate on your farm?

- Crops only
- Animals only
- Mixed crops and animals

Q2. How much kg of the crop production do you generate on average in a month?

Answer: _____

Q3. Please specify the total area (hectare) of the land used for your farming activities.

Answer: _____

Q4. Can you specify your current land tenure?

- Private
- Communal
- Open access
- State

Q5. Do you have paid helpers/workers working on the farm?

- Yes
- No

Q5a. If YES, how many do you currently employ?

Answer: _____

Q6. Please select the main purposes of the agriculture farming in your farm.

- Subsistence
- Trading
- Livestock Feeds
- Other

Q7. How much revenue (IDR) do you make on average in a month from the productions?

Answer: _____

Q8. What type of agriculture residues do you have/or you produce in your farm?

- Stalks
- Branches
- Leaves
- Straw
- Wastes from pruning
- Other

Q9. What do you normally do to with agriculture residues?

- Throwing out
- Livestock feeding
- Using as a fertilizer
- Sell to bioenergy plants
- Other

Q10. Are you aware of bioenergy and biofertilizer productions made from agricultural residues?

- Yes
- No

Q11. If there is a biomass heating plant buying agricultural residues from farms, will you consider selling the remaining residues?

- Yes
- No
- Maybe

Q11a. If YES, what will be the expectation of price per kilogram?

Answer: _____

Q12. Have you ever purchased organic (bio)fertilizer made from agricultural residues?

- Yes
- No
- Maybe

Q12a. If YES, please select the benefits of the biofertilizer made from agricultural residues based on your overall experiences.

- Help to make plant's nutrients more available
- More effectiveness compared to traditional fertilizers
- Reduce the need for traditional fertilizers
- Reduce the overall cost of the crop
- Environmentally friendly
- Other

Q12b. If YES, please select the disadvantages of the biofertilizer made from agricultural residues based on your overall experiences.

- Expensive
- Inefficient
- Complicated storage facility
- Short shelf-life
- Other

Q13. In general, do you agree with the positive impacts agricultural residues have on the farmers?

- Yes
- No
- Maybe

Personal Background

Q14. Are you...?

- Male
- Female

Q15. How old are you?

- 18 – 24
- 25 – 34
- 35 – 44
- 45 – 54
- 55 – 69
- 70+

Q16. What is the highest degree or level of school you have completed?

- Sekolah Dasa
- Sekolah Menengah Pertama (SMP)
- Sekolah Menengah Atas (SMA)
- Diploma Akademi (DIII)
- Sarjana (Universitas)
- None of these

Q17. Where are you from? Please write name of the city and provinces.

Answer: _____

Q18. How many members make up your home?

Answer: _____

Q19. Do you contribute at least half of the household income for your home?

- Yes
- No

Appendix 2: Raw material samples

Appendix 3: Calculations of total energy yield

Type of residual biomass	Crop to Residue ratio (k)	Production 2020 (t/year)	Net Calorific Value (TJt^{-1}_{ar})	Annual Energy Potential (TJ_{ar})	Annual Energy Potential (TWh_{ar})	Net Calorific Value (TJt^{-1}_{d})	Annual Energy Potential (TJ_{d})	Annual Energy Potential (TWh_{d})
Palm kernel shells (PKS)	0.06	256,528,600	0.0171	263,423	73.17	0.0182	280,277	77.85
Empty fruit bunches (EFB)	0.22	256,528,600	0.0153	865,462	240.41	0.0167	942,608	261.84
Sugarcane bagasse	0.33	28,913,829	0.0066	63,186	17.55	0.0102	96,945	26.93
Sugarcane trash (leaves)	0.23	28,913,829	0.0149	99,227	27.56	0.0164	108,778	30.22
Paddy rice husks	0.21	54,649,202	0.0128	146,767	40.77	0.0144	165,275	45.91
Paddy rice straw	2.32	54,649,202	0.0121	1,534,713	426.31	0.0134	1,703,235	473.12
Coconut shell	0.34	16,824,848	0.0171	97,901	27.19	0.0192	109,832	30.51
Maize stover (leaves)	0.20	23,143,728	0.0155	71,578	19.88	0.0171	78,981	21.94
Maize stover (stalks)	1.58	23,143,728	0.0151	552,617	153.50	0.0162	592,558	164.60
Maize stover (cobs)	0.27	23,143,728	0.0153	95,525	26.53	0.0170	105,919	29.42

1) The total production of five tested crops was extracted from (FAOSTAT, 2022) with the recent data available online.
2) Crop to residue ratio (k) of the tested materials was extracted from the previous publications and the values are calculated as an average value of the biomass residues (if applicable) where:
   - k for palm kernel shells (PKS) is **0.06**, the value was obtained from the previous study (Moni, et al., 2018)
   - k for empty fruit bunches (EFB) is **0.22**, the value was obtained from the previous study (Moni, et al., 2018)
   - k for sugarcane bagasse is **0.33**, the value was obtained from the previous studies (Asakereh, et al., 2014); (Benová, et al., 2021)
   - k for sugarcane trash (leaves) is **0.23**, the value was obtained from the previous studies (Asakereh, et al., 2014); (Kumar & Verma, 2021); (Benová, et al., 2021)
   - k for paddy rice husks is **0.21**, the value was obtained from the previous studies (Asakereh, et al., 2014); (Osei, et al., 2021); (Benová, et al., 2021)
   - k for paddy rice straw is **2.32**, the value was obtained from the previous studies (Asakereh, et al., 2014); (Osei, et al., 2021); (Benová, et al., 2021)
   - k for coconut shell is **0.34**, the value was obtained from the previous studies (Elauria, et al., 2005); (de Gouvello, et al., 2008)
   - k for maize stover (leaves) is 0.20, the value was obtained from the previous studies (Seglah, et al., 2019)
   - k for maize stover (stalks) is 1.50, the value was obtained from the previous studies (Osei, et al., 2021); (Seglah, et al., 2019); (Alhassan, et al., 2019)
   - k for maize stover (cobs) is 0.27, the value was obtained from the previous studies (Osei, et al., 2021); (Seglah, et al., 2019); (Alhassan, et al., 2019)

Appendix 4: Calculations of sieve analysis test

Sieve opening size	Repetition 1 [g]	Repetition 2 [g]	Repetition 3 [g]	Average of repetitions [g]	Standard deviation [g]
Paddy rice husks					
4.50 mm	0.57	0.15	0	0.24	0.30
3.15 mm	0.66	0.09	0.03	0.26	0.35
2.50 mm	20.57	0.55	0.54	7.22	11.56
1.50 mm	26.22	45.56	44.17	38.65	10.79
1.00 mm	1.55	2.33	3.01	2.30	0.73
0.50 mm	1.02	1.49	1.96	1.49	0.47
0.25 mm	0.17	0.3	0.42	0.30	0.13
Collecting pan	0.12	0.32	0.46	0.30	0.17
Total mass of all fractions	50.88	50.79	50.59	50.75	
Palm kernel shells					
10.00 mm	20.66	15.1	18.62	18.13	2.81
8.00 mm	13.21	16.11	11.73	13.68	2.23
6.70 mm	10.44	13.12	13.46	12.34	1.65
5.60 mm	4.4	5.13	4.59	4.71	0.38
4.50 mm	2.61	1.51	2.78	2.30	0.69
3.15 mm	0.49	0.22	0.95	0.55	0.37
1.50 mm	0	0.11	0.23	0.11	0.12
Collecting pan	0	0.01	0.06	0.02	0.03
Total mass of all fractions	51.81	51.31	52.42	51.85	
Maize stover (cobs)					
10.00 mm	42.06	42.49	48.75	44.43	3.74
8.00 mm	8.84	9.21	2.72	6.92	3.64
6.70 mm	0.32	0.33	0.41	0.35	0.05
5.60 mm	0	0.01	0.02	0.01	0.01
4.50 mm	0	0	0	0.00	0.00

3.15 mm	0	0	0	0.00	0.00
1.50 mm	0	0	0	0.00	0.00
Collecting pan	0	0	0	0.00	0.00
Total mass of all fractions	51.22	52.04	51.9	51.72	

Appendix 5: Calculations of moisture content

Tested sample	Mass of an empty dish and lid [g]	Mass of a dish and lid with a sample before drying [g]	Mass of a dish and lid with a sample before drying [g]	Moisture content as received, wet basis [%]	Average moisture content [%]	Standard deviation of moisture content [%]
Paddy rice straw						
Repetition 1	27.7455	28.7616	28.6954	6.5151	6.53	0.04
Repetition 2	25.0864	26.1623	26.0916	6.5712		
Repetition 3	26.1033	27.4233	27.3376	6.4924		
Sugarcane trash (leaves)						
Repetition 1	24.7734	25.8824	25.7762	9.5762	9.57	0.03
Repetition 2	26.2629	27.2762	27.1789	9.6023		
Repetition 3	25.8074	26.82	26.7234	9.5398		
Maize stover (stalks)						
Repetition 1	27.7455	28.8274	28.7376	8.3002	8.28	0.02
Repetition 2	25.0872	26.4168	26.3067	8.2807		
Repetition 3	26.1035	27.5149	27.3982	8.2684		
Maize stover (leaves)						
Repetition 1	26.2083	27.8068	27.6683	8.6644	8.69	0.03
Repetition 2	26.4201	27.9299	27.799	8.6700		
Repetition 3	26.4125	27.9482	27.8142	8.7257		
Empty fruit bunches (EFB)						
Repetition 1	24.7735	25.7988	25.7087	8.7877	8.74	0.06
Repetition 2	26.2629	27.3113	27.2194	8.7657		
Repetition 3	25.8075	26.8144	26.7271	8.6702		
Maize stover (cobs)						
Repetition 1	27.7454	28.9876	28.8803	8.6379	8.67	0.04

Repetition 2	25.0866	26.2552	26.1533	8.7198		
Repetition 3	26.1034	27.4427	27.3268	8.6538		
Sugarcane bagasse (as received)						
Repetition 1	146.07	207.15	182.7	40.0294	40.22	1.14
Repetition 2	238.2	325.85	291.5	39.1899		
Repetition 3	166.93	222.63	199.55	41.4363		
Palm kernel shells (PKS)						
Repetition 1	27.7448	29.056	28.9433	8.5952	8.52	0.06
Repetition 2	25.0862	26.3827	26.2728	8.4767		
Repetition 3	26.1028	27.4954	27.377	8.5021		
Coconut shells						
Repetition 1	26.2075	27.2245	27.1314	9.1544	9.12	0.05
Repetition 2	26.4195	27.4699	27.3738	9.1489		
Repetition 3	26.4115	27.4547	27.3601	9.0683		
Paddy rice husks						
Repetition 1	24.7725	26.3235	26.18406	8.990329	8.94	0.04
Repetition 2	26.2621	27.7663	27.6323	8.908390		
Repetition 3	25.8064	27.0871	26.9727	8.932615		
Sugarcane bagasse (grinded and dried)						
Repetition 1	25.0861	26.7551	26.5889	9.958059	9.86	0.69
Repetition 2	26.103	27.7539	27.6032	9.128354		
Repetition 3	26.4113	27.7898	27.6451	10.49692		

Appendix 6: Calculations of ash content

Tested sample	Repetition	Mass of empty dish [g]	Mass of dish with a sample [g]	Mass of dish with ash [g]	Ash content on a dry basis [%]	Average ash content [%]	Standard deviation of ash content [%]
Paddy rice husks	1	26.0829	27.4493	26.3726	21.2017	21.28	0.07
	2	17.7069	19.2257	18.0304	21.2997		
	3	18.0697	19.4723	18.3688	21.3247		
Palm kernel shells (PKS)	1	15.6349	16.704	15.7292	8.8205	8.73	0.09
	2	16.7525	17.7839	16.8425	8.7260		
	3	22.3539	23.6775	22.4684	8.6507		
Empty fruit bunches (EFB)	1	21.8871	22.9259	21.972	8.1729	8.29	0.17
	2	18.2389	19.3523	18.3303	8.2091		
	3	17.1092	18.2824	17.2087	8.4811		
Sugarcane bagasse	1	26.8714	27.9703	27.4667	54.1724	50.00	4.08
	2	24.6008	25.7691	25.1825	49.7903		
	3	18.6627	19.8492	19.2088	46.0261		
Sugarcane trash (leaves)	1	16.7141	17.8193	16.7797	5.9356	5.96	0.03
	2	26.4815	27.4889	26.5414	5.9460		
	3	20.8125	21.944	20.8803	5.9920		
Maize stover stalks	1	20.3095	21.4409	20.3448	3.1200	3.12	0.011
	2	21.5177	22.8264	21.5584	3.1100		
	3	18.4752	19.7575	18.5152	3.1194		
Maize stover leaves	1	25.7968	26.826	25.911	11.0960	11.09	0.04
	2	20.3532	21.402	20.4699	11.1270		
	3	21.6774	22.8702	21.8092	11.0496		

Maize stover cobs	1	16.1491	17.4716	16.197	3.6219	3.59	0.11
	2	25.3812	26.5445	25.424	3.6792		
	3	18.0822	19.3586	18.1265	3.4707		
Coconut shells	1	24.1792	25.4302	24.1938	1.1671	1.18	0.01
	2	20.223	21.3564	20.2364	1.1823		
	3	25.3685	26.7458	25.3851	1.2053		
Paddy rice straw	1	18.4889	19.6045	18.6803	17.15669	18.00	0.91
	2	24.8646	25.9795	25.0640	17.8850		
	3	25.0623	26.2585	25.2892	18.9684		