

Landscape management by choosing the optimal land slots for SRC plantations – a fuzzy AHP approach

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IEA Bioenergy Task 43

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and governance aspects workshop**

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Introduction

- o Decentralisation of energy systems calls for a different approach in energy planning (Georgopoulou et al., 1998; Polatidis et al. 2006)
- o If bioenergy share is to be increased in energy balances, preferences of farmers and forest owners must be met.
- o **Local project implementation depends** not only on the technical performance but also on the **perceived socio-economic-environmental aspects** that project will bring to the community.

Bioenergy planning depends on decision-makers at both ends

- o Bioenergy is too complex to be grasped at a glance by an „outsider” (decision-maker, NGO, a citizen...)
- o 3D of sustainability:
 1. environmental protection
 2. economic feasibility and
 3. social acceptance
- o Sustainable bioenergy is too complex even for a single bioenergy expert
- o Bioenergy projects interact with the community during the whole lifetime of the project, especially when relates to the landscape and land governance

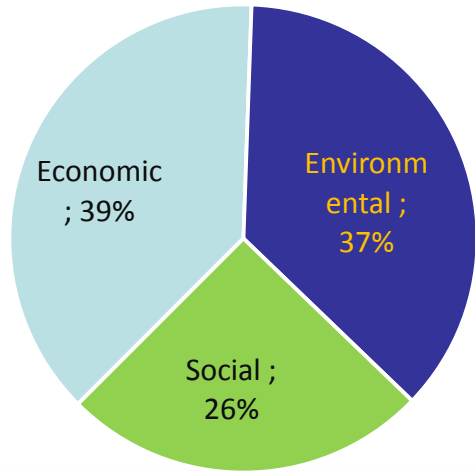
Sustainable bioenergy policy...

- o ... is a topic with multiple (inhibiting, boosting or neutral) goals that varies by supply chain and a single project
- o ... is a question of authority
- o ... calls for multi-criteria decision-making aid (MCDA) (analysis) to outline the policy that reflects not only the technical viability but also the perception of 3D sustainability

Methodology

- o Fuzzy analytical hierarchical process (fAHP) has been chosen as MCDA
- o SRC considered as an example for the methodology
- o Questionnaire made upon Sustainability of SRC manual (IEE SRC+ project (2013-2016)) www.srcPlus.eu
- o 3 targeted groups of bioenergy policy related experts/decision-makers:
 - IEA Bioenergy Task 43
 - Canada
 - Croatia

Results (or what a decision maker will get)

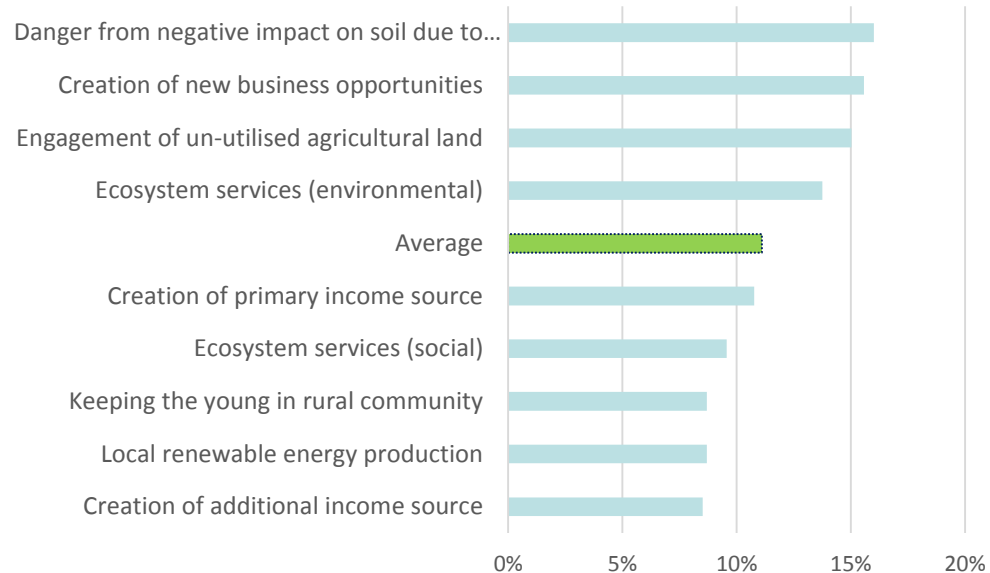


SRC policy should rely on economically feasible land slots at un-utilised agricultural land that ensure and/or allows bioenergy production and economically feasible ecosystem services.

Leading authority: energy/economy/agriculture

Steer the SRC policy towards : larger size land slots overburden with nutrients (N,P) in vicinity of water supply or WWTP.

Exclude land slots in vicinity to nature vulnerable areas that do not combine ecoservices.



Policy implementation:

- provide unbiased information to the private sector stakeholders;
- clear and easy to monitor system boundaries in terms of preventing danger from negative impacts on soil.
- Define land slot using a GIS/ARCOD and according to national features (yield, size...)

Table 7 Defuzzified BNP value of criteria and corresponding alternatives - IEA Bioenergy Task 43

| Policy criteria | Weight | Alternatives | Weight within the policy goal | Aggregated weight |
|-----------------|--------|--|-------------------------------|-------------------|
| Economic | 0.3852 | Creation of new business opportunities | 0.3979 | 0.1559 |
| | | Creation of additional income source | 0.3278 | 0.0852 |
| | | Creation of primary income source | 0.2869 | 0.1078 |
| Social | 0.2562 | Keeping the young in rural community | 0.3331 | 0.0870 |
| | | Local renewable energy production | 0.3333 | 0.0869 |
| | | Ecosystem services | 0.3667 | 0.0957 |
| Environmental | 0.3709 | Engagement of un-utilized agricultural land | 0.3995 | 0.1503 |
| | | Danger from negative impact on soil due to inadequate agro-technique | 0.4257 | 0.1602 |
| | | Ecosystem services | 0.3656 | 0.1375 |

Background
(or material that scientist and experts are interested in)

Table 6 Aggregated fuzzy weights of alternatives per targeted expert group

| Alternatives | IEA Bioenergy Task 43 | Canada | Croatia |
|-----------------|--------------------------|--------------------------|--------------------------|
| \bar{W}_{A11} | (0.1095, 0.1496, 0.2085) | (0.0720, 0.1238, 0.1610) | (0.0945, 0.1235, 0.1675) |
| \bar{W}_{A12} | (0.0619, 0.0821, 0.1116) | (0.0583, 0.0991, 0.1295) | (0.0650, 0.0831, 0.1110) |
| \bar{W}_{A13} | (0.0799, 0.1035, 0.1399) | (0.0581, 0.0972, 0.1255) | (0.1005, 0.1268, 0.1672) |
| \bar{W}_{A21} | (0.0589, 0.0815, 0.1206) | (0.0376, 0.0593, 0.0832) | (0.0898, 0.1129, 0.1495) |
| \bar{W}_{A22} | (0.0599, 0.0819, 0.1191) | (0.0749, 0.1174, 0.1630) | (0.0720, 0.0891, 0.1161) |
| \bar{W}_{A23} | (0.0656, 0.0898, 0.1317) | (0.0610, 0.0956, 0.1316) | (0.0728, 0.0903, 0.1184) |
| \bar{W}_{A31} | (0.1091, 0.1436, 0.1981) | (0.0744, 0.1173, 0.1727) | (0.1069, 0.1356, 0.1814) |
| \bar{W}_{A32} | (0.1158, 0.1528, 0.2119) | (0.1015, 0.1504, 0.2155) | (0.0981, 0.1248, 0.1672) |
| \bar{W}_{A33} | (0.1000, 0.1310, 0.1816) | (0.1044, 0.1551, 0.2228) | (0.1055, 0.1335, 0.1782) |

Table 5 Aggregated fuzzy weights of main policy criterion per targeted expert group

| Criterion | IEA Bioenergy Task 43 | Canada | Croatia |
|----------------|--------------------------|--------------------------|--------------------------|
| \bar{W}_{C1} | (0.3333, 0.3805, 0.4417) | (0.2361, 0.3049, 0.3546) | (0.2786, 0.3138, 0.3636) |
| \bar{W}_{C2} | (0.2263, 0.2531, 0.2892) | (0.2100, 0.2723, 0.3164) | (0.2598, 0.2923, 0.3386) |
| \bar{W}_{C3} | (0.3310, 0.3664, 0.4154) | (0.3431, 0.4228, 0.4863) | (0.3532, 0.3939, 0.4513) |

+ definition of land slots

Preferred land slots under the Economic criteria

- Production of biomass supply by SRC plantation or providing ecoservices through SRC plantations at the open market must be an attractive investment that generates acceptable profit in comparison to the other entrepreneurial opportunities in the region.
- As any other business, this is achieved by cost minimisation and/or profit maximisation, constrained by government regulations (e.g. environmental protection, good agriculture practice).

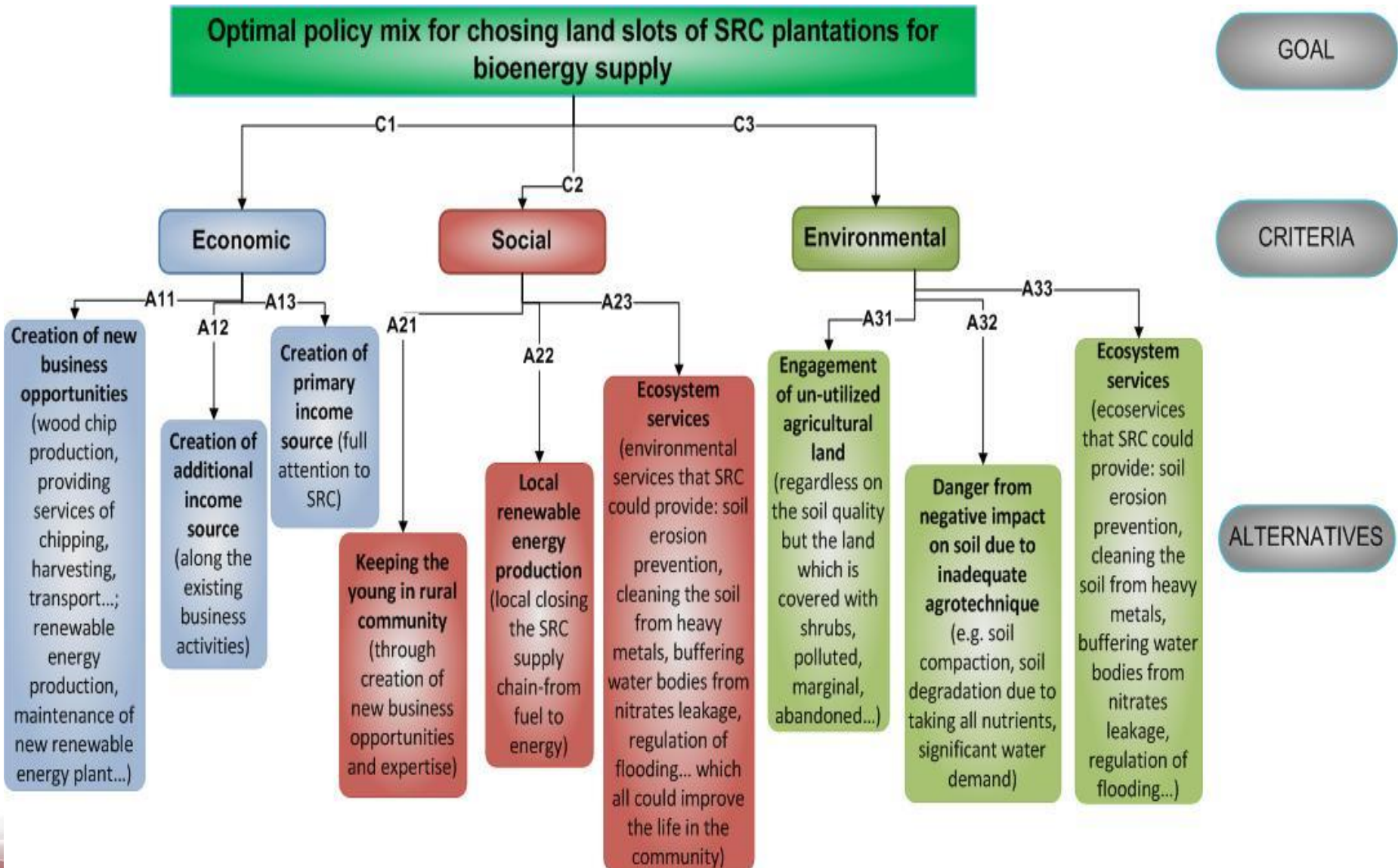
Preferred land slots under the Social criteria

- o Production of bioenergy is perceived as a by-product of a social effect that is intended to be achieved by planting SRC.
- o Overall costs of SRC plantation are to be equal or similar to the social measure(s) tackling the same issue (e.g. employment, specific health issue, preventing the youth exodus).
- o Community (public sector, including para-public companies) is the lead party in this case: from identifying the social issue that can be addressed by establishing SRC plantations to launching the overall (local) supply chain or somehow ensuring mid-term demand for bioenergy produced.
- o The rational spending of taxpayers' money is still an important part of the decision but the profit maximisation is constrained by the targeted social effect and can be equal to zero.
- o Land slots that have better commercial alternatives than establishing SRC plantations should be left to generate profit as social criteria allow wider span of suitable land slots.

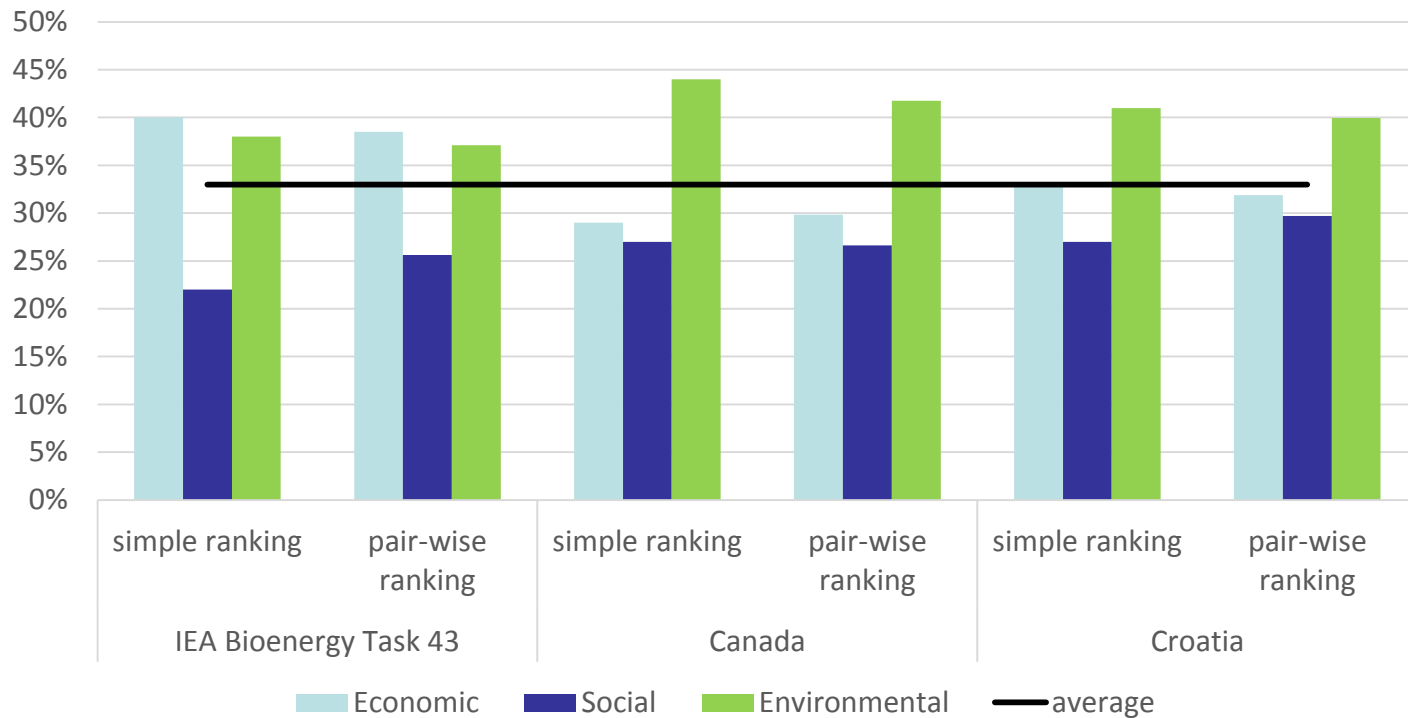
Preferred land slots under the Environmental criteria

- o Features of land slots under social and environmental criteria greatly overlap, especially in the framework of low carbon economy.
- o Still, only land slots that allow ecoservices from SRC plantations are those land slots that fall under environmental criteria due to their demand for environmental prevention, protection or remediation measures.
- o Overall cost (including externalities) of SRC plantation are equal or similar to the environmental protection measures that achieve the same effect (e.g. preventing the soil erosion by placing a PVC net, other soil remediation/water purification techniques) and its carbon footprint justifies the implementation to the alternatives.

SRC policy and criteria as fAHP:

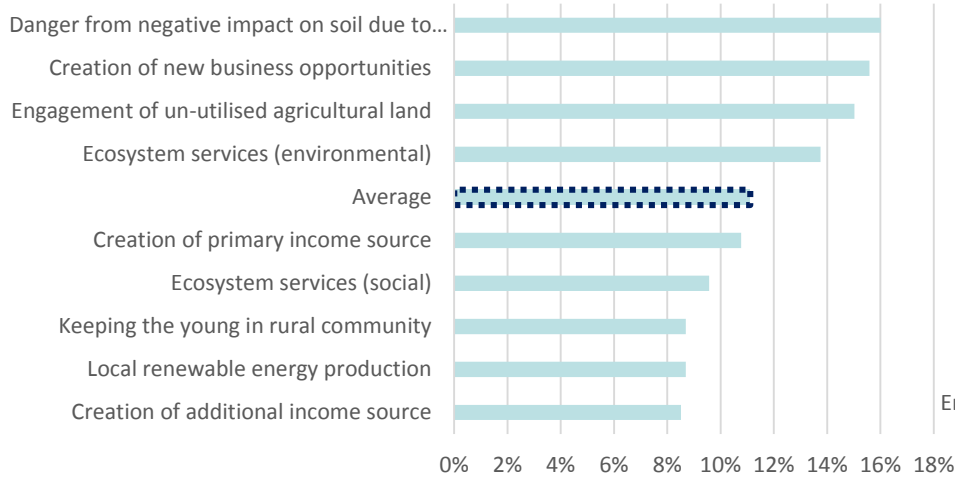


Bioenergy policy must vary across the areas of implementation*



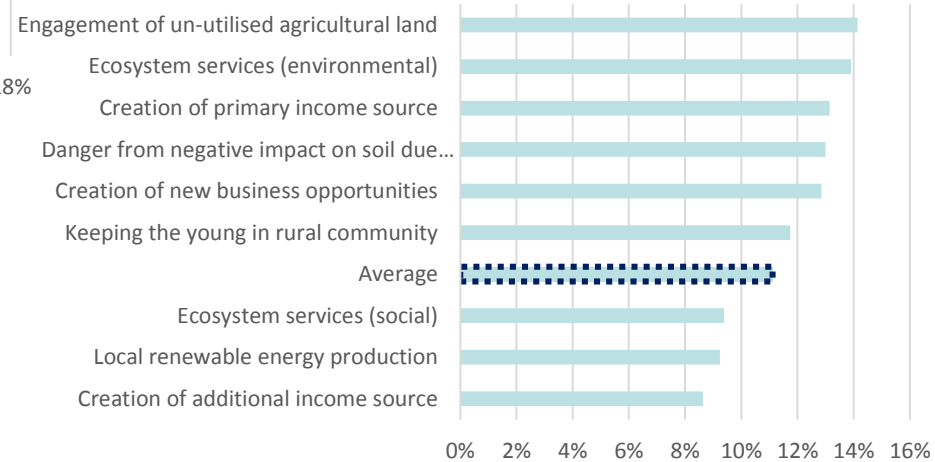
*what a scientist would like that decision-makers know

Task 43

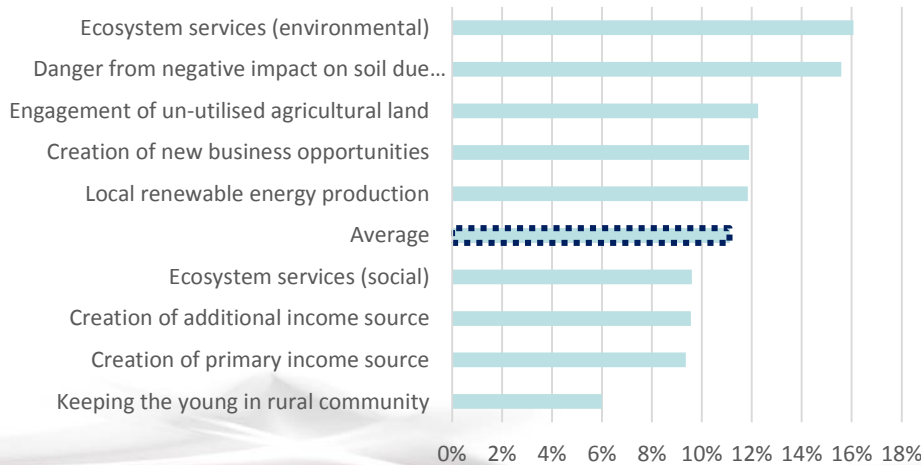


The differences between policies defined by preferences

Croatia



Canada



3 priorities related to SRC surfaced:

Table 10 Ranking of priorities per targeted expert group

| Rank | IEA Bioenergy Task 43 | Weight | Canada | Weight | Croatia | |
|------|---|--------|---|--------|---|--------|
| 1 | Danger from negative impact on soil due to inappropriate agricultural practice | 0.1602 | Ecosystem services (environmental) | 0.1686 | Engagement of un-utilised agricultural land | 0.1413 |
| 2 | Creation of new business opportunities | 0.1559 | Danger from negative impact on soil due to inappropriate agricultural practice | 0.1642 | Ecosystem services (environmental) | 0.1390 |
| 3 | Engagement of un-utilised agricultural land | 0.1503 | Engagement of un-utilised agricultural land | 0.1340 | Creation of primary income source | 0.1315 |
| 4 | Ecosystem services (environmental) | 0.1375 | Local renewable energy production | 0.1219 | Danger from negative impact on soil due to inappropriate | 0.1300 |

Conclusions

- o The analysis proves the **necessity for a unique approach** when tailoring a SRC policy
- o **Allows focusing** on the perceived priorities of the bioenergy supply chain in question
- o **Involves all stakeholders** in the decision-making process
- o **Provides decision-making elements in a form suitable** to dynamic environment
- o **Enables a dialogue** with the decision-makers
- o Helps to decision-maker **to designate a responsible body**
- o It is reasonable to assume that this **methodology is applicable for other bioenergy supply chains**

Full report and paper coming up!

Discussion, comments or suggestions are welcomed and to be addressed towards:

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