

Annex 1: Interview notes and filled criteria tables

Criteria tables

Participant no. 1

Participant no. 1 stressed that the source of the materials used for mulching is important to be located near the application area. The reasons are related to the application's cost, time and most importantly, the sustainable use of resources.

He pointed out that in Spain wheat and corn are the most used materials since they are very easy to find. However, there is the probability that this material is needed for other activities, such as animal feeding. Moreover, the crop residues that are used for mulching are not available throughout the year.

He accepted the predefined criteria list as presented in **Error! Reference source not found..** He added four more criteria in this list, namely "Risk of erosion", "Sensitive areas" which relate to area prioritization. "Local communities" which relates to the local initiatives capacity to apply the techniques, and "Local materials".

Table 11: Criteria table-Participant 1

Selection criteria for mulching techniques	Indicators	Notes
Cost	Material(seeds, fertilizers, mulches, wood, stones etc) Labor Transport (of materials, equipment and people) Equipment of application	
Time (of application completion after fire event)	Preparation time and transport time (of materials, equipment and people) Time needed for application	This is the most important- dependent on the accessibility of material- dependent on when the material is stocked. In any case it is important that the material is easy to find and close (ore ecologically friendly). In Spain that is easy: lot of wheat etc.
Effectiveness	% of soil erosion decrease	
Risk of soil compaction	Whether machinery will have to go off-road for material collection or application	
Effects on carbon storage	Ability to protect the soil organic carbon from erosion	
Risk of enhancing invasive vegetation growth	Risk of containing exotic seeds	
Risk of inhibiting desired vegetation growth	-Whether it is shown to have a negative effect on native plant germination and growth	
Longevity	Weight- Risk of being blown by wind Attraction of grazing animals	
Risk of enhancing wildfire danger	Flammability of material	
Risk of erosion	Severity of the fire, remaining soil cover, slope	Mulching is especially necessary on those spots where the fire was very severe and there is no vegetation cover remaining and the slope is pronounced. In our opinion it is very important to concentrate the efforts and the founds on those areas that are most in risk of erosion.

<i>Sensitive areas</i>	<i>Protected areas, presence of endangered species, water sources, sites of social interest</i>	<i>Soil protection should be prioritized on sensitive areas that have environmental or social value and require special protection</i>
<i>Local communities</i>	<i>Presence on the area of environmental associations or owner agrupations would facilitate rapid social activities</i>	<i>Besides official mulching applications by the Forestry Services we believe that local initiatives can also help a lot because they can be very fast and efficient as recently demonstrated by the paper of Prats et al (2022). Organization of the population in associations or agrupations will facilitate coordination and operativeness.</i>
<i>Local materials</i>	<i>Utilization of local agroforestry materials for mulching will be desired aiming to reduce transportation, carbon footprint, and avoid introducing exotic species</i>	<i>We think that local materials should be preferred. However, mulching requires a lot of amounts of material and provisioning could be not that easy. One interesting point for high-risk areas such as Galicia or Algarve is that the local communities or the local governments have a big stock of material to be ready for use in case of fire. This seems not very difficult taking advantage of the frequent thinnings, prunings and vegetation clearings</i>

Participant no. 2

Participant no. 2 has a social science background therefore her insights were mostly related to her experience with cultural practices and rural policy in Portugal. She stressed that mulching as a technique is known in Portugal, but it remains at experimental stage. The main reason for that is its cost.

She also commented on the cultural aspect of the issue; in the past, when more diverse activities took place in the countryside, forest residues were often used in farms as a circular practice. Nowadays forest owners that are active at managing their land usually set fire to the forest residues. The idea of keeping the residues and applying them as mulch is culturally foreign to the local communities.

Moreover, she pointed that the key factor that would allow mulching to be an operational, widely used technique in the private Portuguese lands is awareness. More specifically awareness that would take the form of commitment by the local people and forest owners. That is currently far from the reality because there is no serious event linked to erosion, as is for example in Galicia where erosion from fire affected forests caused economic catastrophe for the muscle cultivation business. Adding to that, rural areas in Portugal are facing rural abandonment, highlighted by the fact that the areas are used for lumber production and not for activities that require constant presence from the owners. Finally, she mentioned that wildfires are causing problems that seem far more crucial to the local people than that of soil erosion.

Participant no. 2 accepted the predefined list of criteria. She added three more criteria as shown below: “Social acceptance”, “Institutional-policy support”, and “Technological knowledge”.

Table 12:Criteria table-Participant 2

selection criteria for mulching techniques	Indicators	Notes
<i>Cost</i>	<i>Material(seeds, fertilizers, mulches, wood, stones etc) Labor Transport (of materials,equipment and people) Equipment of application</i>	

<i>Time (of application completion after fire event)</i>	<i>Preparation time and transport time (of materials,equipment and people) Time needed for application</i>	
<i>Effectiveness</i>	<i>% of soil erosion decrease</i>	<i>ICNF does not prioritize areas-effectiveness is directly related to this</i>
<i>Risk of soil compaction</i>	<i>Whether machinery will have to go off-road for material collection or application</i>	<i>Mulch before forest work-reduces compaction</i>
<i>Effects on carbon storage</i>	<i>Ability to protect the soil organic carbon from erosion</i>	
<i>Risk of enhancing invasive vegetation growth</i>	<i>Risk of containing exotic seeds</i>	
<i>Risk of inhibiting desired vegetation growth</i>	<i>-Whether it is shown to have a negative effect on native plant germination and growth</i>	
<i>Longevity</i>	<i>Weight- Risk of being blown by wind Attraction of grazing animals</i>	
<i>Risk of enhancing wildfire danger</i>	<i>Flammability of material</i>	
<i>Social acceptance</i>	<i>Potential adoption from forest owners (eg. % of forest owners already applying)</i>	<i>Farmers follow traditional techniques-they want their fields to be 'clean'- they set fire to the residues (sometimes they have to because of tree pathogens)-that is connected to when they had also a farm and the residues were used there (circular management)</i>
<i>Institutional- Policy support</i>	<i>Existence of funds</i>	<i>Could be an indicator of cost-time (bureaucratic processes take too long)</i>
<i>Technological knowledge</i>	<i>Need for machinery not commonly used</i>	<i>Knowledge is not wide about the matter. Only experts are aware</i>

Participant no. 3

The third participant emphasized the importance of the soil carbon storage issue. Erosion causes soil organic carbon to oxidize, therefore it is important to consider land management methods to prevent erosion phenomena without disturbing the soil. Plowing and terracing are methods that are known to disturb the soil causing loss of organic carbon stocks.

He accepted the predefined list of criteria, except the criterion “Risk of enhancing wildfire danger”. He specifically noted “(..)If the mulch is spread and in correct application rate there is no problem”.

He added one more criterion called “Acceptance”. This is related to perception and knowledge. According to him, established views and practices cannot change until knowledge sharing activities start happening amongst experts, administration officers, landowners, and other stakeholders.

He also added useful notes to all other criteria; for the “Cost” criterion, he pointed out some factors that affect the cost of the technique; these factors are slope, proximity of material source and process of material (e.g. it depends on the parts of the plants that are used). When it comes to “Effectiveness”, he mentioned the importance of the material shape by providing the example of pine needles and wood chips. Pine needles unlike wood chips, merge in one another, resembling a carpet on the soil. That does not allow water to penetrate and lift the material from its place. For the criterion related to

the “Risk for compaction”, he mentioned some ways that this effect can be alleviated. One way is to mulch on skid rails and avoid using machinery on soil with high moisture. Moreover, he mentioned that mulch bares no significant risk of “Inhibiting desired vegetation growth”. That could happen only at a very high application rate. Finally, the longevity of the mulch material was an important criterion for him. He noted that it depends on climatic conditions, soil attributes, the decomposition rate of the material, and the rate of application.

Table 13: Criteria table-Participant 3

Selection criteria for mulching techniques	Indicators	Notes (eg. most influencing factors)
Cost	Material (seeds, fertilizers, mulches, wood, stones etc) Labor Transport (of materials, equipment and people) Equipment of application	Accessibility: if the slopes are steep this increases the cost of the operation- long slopes > 100 m or steep > 15deg. Also local materials are cheaper. More expensive to choose specific parts of the plant.
Time (of application completion after fire event)	Preparation time and transport time (of materials, equipment and people) Time needed for application	
Effectiveness	% of soil erosion decrease	Shape of the mulch influence effectiveness: e.g. pine needles work better than small wood chips that don't merge and allow water (imbricadas)
Risk of soil compaction	Whether machinery will have to go off-road for material collection or application	To avoid the compaction: use mulch on the skid roads Before the application is better but much more expensive. The moisture is also an important factor; soil compaction is more severe when moisture is high
Effects on carbon storage	Ability to protect the soil organic carbon from erosion	
Risk of enhancing invasive vegetation growth	Risk of containing exotic seeds	Annual plants can grow and make soil cover (positive), without being invasive (no data). Perennials: when we use the bark there is no danger of invasive (eg no acacia- the seeds like the fire)
Risk of inhibiting desired vegetation growth	Whether it is shown to have a negative effect on native plant germination and growth	Depends on rate: eg 8t/ha may inhibit vegetation growth. The landowners want to have a 'clean' soil in order to work better with machinery.
Longevity	Weight- Risk of being blown by wind Attraction of grazing animals-not a problem, they only eat the seeds and seedlings, decomposition rate	Depends on degradation rate (material) , rate of application. Climate- if it's dry degradation rate is lower. If you have soils rich in OM, degradation rates are high.
Risk of enhancing wildfire danger	Flammability of material	Flammability-Not a problem (no data)- firefighters create piles of wooden material- if the mulch is

		<i>spreaded and in correct application rate there is no problem</i>
Acceptannce		<i>due to research being recent-knowledge is not widely communicated-traditional techniques</i>

Participant no 4

Participant no. 4 is active as a hydrologist in the US Forest Service. His views and priorities show both differences and similarities with those of the experts from the Iberian Peninsula. The reasons for the differences lie mainly on the different type and scale of natural areas, scale of wildfires and land property status.

He believes that the main disadvantage of mulching is its high cost. For this reason, the managers are very selective when it comes to soil stabilization techniques. He characteristically stated: *“Application of mulch materials is typically the highest cost in the US because large areas have to be treated by helicopter (..)”*.

Moreover, for him the “Risk enhancement of invasive vegetation” is an important issue. When invasive grass is used as mulch it is likely to degrade the area’s biodiversity status and serve as bad quality forage.

The statement he wrote on the compaction risk factor sheds some light on some aspects of machinery use: *“(..)If using a tractor or atv to transport/spread material off of roads, this will cause some compaction but maybe not enough to cause a change in soil properties (largely uncertain, and I don't know of any studies that measure this). For wood mulches produced on site, compaction is probably an issue because even one pass of a heavy machine like a log skidder can compact the soil.”*

For the “Effectiveness” criterion he wrote that at the time of application, all mulch materials have similar effectiveness, because the ground cover percentage is the most important factor determining effectiveness. The differences between the different kind of materials appear after some time, e.g. when seeds germinate.

Regarding the criterion “Risk of inhibiting desired vegetation growth”, his notes showed that the risk could be higher when a mulch material persists longer on the ground, before decomposing. He also noted that the material weight could play some role.

On the issue of “Longevity”, he mentioned the risk of removal of straw material by wind and on the issue “Increasing wildfire risk”, he noted: *“All mulching materials are flammable, so there is risk of increasing fuel loads. This risk decreases as the mulch degrades, and may not be a concern immediately after the fire (1-3?? Yrs) but may be an issue for wood mulch in longer term.”*

Table 14:Criteria table-Participant 4

Selection criteria for mulching techniques	Indicators	Notes
Cost	Material(seeds, fertilizers, mulches, wood, stones etc) Labor Transport (of materials,equipment	Highly variable. Application of mulch materials is typically the highest cost in the US because large areas have to be treated by helicopter. Application cost is highest for wood mulches, lowest for seeding, and on the high end of intermediate for agricultural mulches and hydromulch. Purchase cost including transportation to site is highest for agricultural mulch (wheat or rice mulch) or hydromulch and lowest for seed.

	and people) Equipment of application	Processing cost is highest for wood mulches, intermediate for agricultural mulches and hydromulch, and lowest for seed.
Time (of application completion after fire event)	Preparation time and transport time (of materials,equipment and people) Time needed for application	Can be implemented relatively quickly, as systems are in place to arrange contracts, which is usually a very slow process. Treatment can typically start weeks to months after a fire. Seed is the lowest time to implement, agricultural mulch and wood mulches take a little longer because of transit time to the site or on-site preparation.
Effectiveness	% of soil erosion decrease	Initially, all mulches seem to work about the same for the same amount of % cover. Lighter mulches (ag mulch and hydromulch) degrade quickly so do not last as long as heavier mulches like wood mulch. Seed is initially ineffective until one or two years after germination, and even then may not reduce erosion
Risk of soil compaction	Whether machinery will have to go off-road for material collection or application	Not an issue for aerial application of seed or any of the mulches. If using a tractor or atv to transport/spread material off of roads, this will cause some compaction but maybe not enough to cause a change in soil properties (largely uncertain, and I don't know of any studies that measure this). For wood mulches produced on site, compaction is probably an issue because even one pass of a heavy machine like a log skidder can compact the soil.
Effects on carbon storage	Ability to protect the soil organic carbon from erosion	
Risk of enhancing invasive vegetation growth	Risk of containing exotic seeds	Some agricultural mulches may contain unwanted seeds, especially invasive grasses, and this has been a small problem in the US.
Risk of inhibiting desired vegetation growth	-Whether it is shown to have a negative effect on native plant germination and growth	Some evidence that agricultural and hydromulch don't really have an effect on native vegetation. Not clear about wood mulches, except that since they persist longer than the lighter mulches, there is more risk of affecting native vegetation growth.
Longevity	Weight- Risk of being blown by wind Attraction of grazing animals, decomposition rate	Straw mulches are often not used on steep slopes or in windy areas because of risk of removal by wind. This is not a problem for seed, hydromulch or wood mulches. Wood mulches degrade the slowest, and have persisted in at least one study for > 10 yrs.
Risk of enhancing wildfire danger	Flammability of material	All mulching materials are flammable, so there is risk of increasing fuel loads. This risk decreases as the mulch degrades, and may not be a concern immediately after the fire (1-3?? Yrs) but may be an issue for wood mulch in longer term.

Participant no. 5

Due to her social science background, participant no. 5 focused on the financial factors and preconditions of mulch application. She added three more criteria to the pre-defined list: “Financial Benefits for stakeholders”, “Knowledge”, “Increase of soil fertility, enhancing soil structure”.

Table 15:Criteria table-Participant 5

Selection criteria for mulching techniques	Indicators	Notes
Cost	Material (seeds, fertilizers, mulches, wood, stones etc) Labor Transport (of materials,equipment and people) Equipment of application	

Time (of application completion after fire event)	Preparation time and transport time (of materials,equipment and people) Time needed for application	
Risk of soil compaction	Whether machinery will have to go off-road for material collection or application	
Effectiveness	% of soil erosion decrease	
Effects on carbon storage	Ability to protect the soil organic carbon from erosion	
Risk of enhancing invasive vegetation growth	Risk of containing exotic seeds	
Risk of inhibiting desired vegetation growth	-Whether it is shown to have a negative effect on native plant germination and growth	
Longevity	Weight- Risk of being blown by wind Attraction of grazing animals	
Risk of enhancing wildfire danger	Flammability of material	
Financial Benefits for stakeholders	Subsidies-long term economic production	Incentives to apply, long-term or short-term benefits.
Knowledge	How to implement, availability of required equipment	Maybe knowledge exist but farmer/company/stakeholder does not know how to implement mulching.
Increase of soil fertility, enhancing soil structure	% SOM	Long term-cannot see benefits in short-term experiments

Participant no. 6

This participant stressed that mulching the forest ground is not only expensive, but it is as well culturally contradicting the views of landowners in Portugal. She added that environmental agencies and volunteers usually get united to plant new trees but not to apply mulch. That fact can serve as an indicator of knowledge sharing issues among the experts and the public.

As far as prioritization goes, she stated that the factors for area targeting can be classified as: a) on-site characteristics, such as soil type and slope, and b) off-site characteristics such as presence of infrastructure, agricultural fields, and water reservoirs.

There are some additional factors, relevant to land management practices. She gave the example of the will of the farmers to plough their land. Overall, she accepted the predefined list and added two criteria: namely “Communication”, and “Institutional and bureaucratic procedures”. The first refers to knowledge sharing and dissemination. The second refers to policies that would encourage and facilitate the measure application.

Table 16: Criteria table-Participant 6

Selection criteria for post-fire management techniques	Indicators
Cost	Material(seeds, fertilizers, mulches, wood, stones etc) Labor Transport (of materials,equipment and people) Equipment of application
Time (of application completion after fire event)	Preparation time and transport time (of materials,equipment and people) Time needed for application
Risk of soil compaction	Whether machinery will have to go off-road for material collection or application
Effectiveness	% of soil erosion decrease
Effects on carbon storage	Ability to protect the soil organic carbon from erosion
Risk of enhancing invasive vegetation growth	Risk of containing exotic seeds
Risk of inhibiting desired vegetation growth	-Whether it is shown to have a negative effect on native plant germination and growth
Longevity	Weight- Risk of being blown by wind Attraction of grazing animals- ability of not be washed by rain
Risk of enhancing wildfire danger	Flammability of material
Communication	
Institutional-bureaucratic procedure	

Participant no. 7

Participant no. 7 is active in the US Forest Service. He elaborated on the importance of the pre-defined protocols that must be followed by emergency response groups. The steps include fire severity mapping, erosion modelling, and cost-benefit analyses. He stressed that it is important that all decisions are taken and implemented in coordination between the stakeholders in the area because of the interests are often contradictory. E.g. stabilization measures interfere with logging activity. According to him, increasing forest fuel when mulching is not an issue. The risk of material being blown by wind can be an issue but only on the mountain ridgetops. Finally, in order to alleviate the compaction effect of machinery the skid rails should be mulched. He added one criterion to the predefined list, which is about the availability of people and equipment for mulch application.

Table 17: Criteria table-Participant 7

Selection criteria for post-fire management techniques	Indicators
Cost	Material(seeds, fertilizers, mulches, wood, stones etc) Labor Transport (of materials,equipment and people) Equipment of application
Time (of application completion after fire event)	Preparation time and transport time (of materials,equipment and people) Time needed for application
Risk of soil compaction	Whether machinery will have to go off-road for material collection or application
Effectiveness	% of soil erosion decrease
Effects on carbon storage-soil health	Ability to protect the soil organic carbon from erosion
Risk of enhancing invasive vegetation growth	Risk of containing exotic seeds
Risk of inhibiting desired vegetation growth	-Whether it is shown to have a negative effect on native plant germination and growth
Longevity	Weight- Risk of being blown by wind Attraction of grazing animals
Risk of enhancing wildfire danger	Flammability of material
Availability of experts and equipment	

Participant no. 8

Participant no. 8 stated two main factors to be taken under account when targeting areas for mulching: that is fire severity and slope. She mentioned some secondary factors, namely rainfall, soil characteristics and the presence of infrastructure downstream.

When it comes to the factor of “Longevity”, she mentioned that the ideal endurance level of the applied material depends on how long the material is needed on place. That depends on the vegetation recovery regime of the area; when vegetation growth is stimulated, ground cover is increasing. At this point mulch is no longer needed to stabilize the soil.

She rejected the criterion related to fuel increase, and she added two more criteria in the predefined list. a) 'Technical knowledge related to implementation', indicated mainly by the level of Availability of trained/experienced workforce b) 'Willingness to apply from local authorities and owners'.

Table 18: Criteria table-Participant 8

Selection criteria for post-fire management techniques	Indicators	Notes
Cost	Material(seeds, fertilizers, mulches, wood, stones etc) Labor Transport (of materials,equipment and people) Equipment of application	
Time (of application completion after fire event)	Preparation time and transport time (of materials,equipment and people) Time needed for application	
Compatibility Land use-management techniques		
Effectiveness	% of soil erosion decrease	
Effects on carbon storage-protection of som, soil quality	Ability to protect the soil organic carbon from erosion	
Risk of enhancing invasive vegetation growth	Risk of containing exotic seeds	
Risk of inhibiting desired vegetation growth	-Whether it is shown to have a negative effect on native plant germination and growth	only if you apply very large application rate-cover
Longevity	Weight- Risk of being blown by wind Attraction of grazing animals	we want it to be there while it is needed- if vegetation recovers fast this is not an important criterion
Technical knowledge related to implementation	Availability of trained/experienced workforce, how much it is applied already	
Willingness to apply from local authorities and owners	Acceptability	

Participant no. 9

Participant no. 9 is active in forest management groups of a regional government in Spain. Therefore, he was highly knowledgeable when it came to practical issues. He stressed that mulching is the most effective measure against post-fire stabilization. According to his experience from this area, agricultural straw mulch is highly available, light, and effective. The only disadvantage that he mentioned is that high quantity is needed relatively to other mulch materials.

He also stressed the importance of predefined protocols for emergency stabilization: in his agency the area prioritization protocol takes under account mainly the slope (the threshold that indicates high slope is 40%) and distance from streams.

Participant no. 10

Participant no. 10 is also professionally active in Spanish regional government. She emphasized that land ownership status is a crucial factor that determines permission acquiring processes, funding, and

social acceptance. Moreover, she said that soil burn severity is one of the most important indicators to be taken under account when targeting areas; the higher the soil burn severity, the higher the need for emergency measure application. According to her, the protocols that are in use consider the soil burn severity status of each area, and not the vegetation burn severity status. That is because soil infiltration capacity, aggregate stability, ash presence, etc. are dependent on the intensity of the fire at ground level. For example, when a fire affects mainly the crown of the trees, soil characteristics and ground cover are much less affected.

She added that there is no significant risk of mulch taken away by wind or rain, if the application rate is adequate, e.g., 2.5-3 ton/ha.

Participant no. 11

Participant no. 11 is an expert on plant physiology, but his insights were not limited to biophysical matters. One of the issues that he stressed was that erosion is causing loss of fertility. Fertility (or “soil productivity”) is directly related to the quantity of topsoil that remains on place.

Coming to mulching techniques, he mentioned that mulching is a stabilization technique different than others because its function is to prevent erosion from happening, instead of collecting eroded sediment downstream. One of the reasons that impede the wide acceptance of mulching is that its effects are not “spectacular” or “evident”, especially when its application is delayed. He stated that this is one of the factors that lessen the willingness to apply mulch. According to him, lack of willingness, not lack of technical knowledge is the core of the problem.

According to the interviewee’s experience, the risk of increasing forest fuel by mulching is not a significant issue. Also, when it comes to straw, there is a very low risk of it being washed off by intense rainfall. However, forest plant residues are ideal for increasing the levels of soil organic matter.

Participant no 12

Participant no 12, as a microbiologist, spoke with much emphasis on the microbiological attributes of the fire affected soil and the effects of mulching on soil biota. More specifically, she spoke about the importance of Carbon to Nitrogen ratio (C:N) and the mulch material decomposition time for the communities of soil biota.

After a fire, microbial communities are easily regenerated, unlike fungal communities. High C:N ratio amendments favor fungi growth; therefore, this characteristic of mulch is a factor that should be taken under account when applying mulch.

Furthermore, the interviewee elaborated on seeding techniques: seeding is not to be implemented without mulch amendments. That is because the germination and growth of the seeds are stimulated by moisture and rainfall. Vegetation cannot produce a sufficient soil cover before the first rainfalls of autumn, which means mulch is necessary. Moreover, according to her experience in Spain, soil seed banks are not negatively affected by wildfires. Therefore, restoration activities should not focus on planting new seeds.

Participant no. 13

Participant no. 13 is an expert on post-fire management related policies. She explained how land ownership status affected acquiring permission, coordination, and implementation of actions. She elaborated on the lack of structured strategy, e.g., in the form of predefined protocols in Portugal. She mentioned that the priorities of the authorities and the stakeholders are fire prevention and combat.

She explained that the post-fire actions in Portugal are problematic because of the procedures that determine them. After a fire that exceeds a specific number of hectares takes place, ICNF conducts a report and waits for proposals made by the individual associations, owners, or municipal land managers. The proposed actions can be fragmented across the landscape, since area targeting is based on land ownership instead of criteria related to the effectiveness of the technique.

Participant no. 14

Participant no. 14 is working on matters of nature conservation in Portugal. He offered some insights about the structural political, economic, and cultural obstacles for a more sustainable post-fire management. He explained how top-down policy strategies are rendering nature conservation challenging; for example, there is an abundance of subsidies connected to economical exploitation of the forest for lumber, but very few subsidies that fund post-fire soil protection measures.

Regarding the criteria table, he rejected the criterion related to the increase of forest fire probability and added two more criteria to the pre-defined list: "Proximity to material source" and "Willingness (and readiness) of stakeholders to apply the technique".

Table 19: Criteria table-Participant 14

Selection criteria for mulching techniques	Indicators
Cost	Material(seeds, fertilizers, mulches, wood, stones etc) Labor Transport (of materials,equipment and people) Equipment of application
Time (of application completion after fire event)	Preparation time and transport time (of materials,equipment and people) Time needed for application
Effectiveness	% of soil erosion decrease at time of application
Risk of soil compaction	Whether machinery will have to go off-road for material collection or application
Enhancing carbon storage capacity	Ability to protect the soil organic carbon from erosion
Risk of enhancing invasive vegetation growth	Risk of containing exotic seeds
Longevity	Weight (High Risk of being blown by wind) and decomposition rate
Requiring low technical knowledge	Availability of workers that have the necessary expertise
Proximity to material source	Distance of material source

Willingness of stakeholders to apply	Readiness of local stakeholders to apply the technique
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Participant no. 15

The fifteenth participant is working in Spain as a researcher of Geography and Planning. He provided useful information in issues of theory and practice. He introduced ash color as a relevant criterion to area prioritization; the level of toxicity and disturbance is understood through ash inspection. In many cases, it is better to leave the soil undisturbed and allow ashes to be incorporated by time. He also mentioned the slope degree and aspect as factors that influence area targeting decisions.

Furthermore, he stated that most studies are focusing on fire affected soils chemical properties rather than its physical ones. Compaction for example is, according to him, not studied thoroughly enough.

When it came to the criteria for mulching technique selection, he rejected the criterion related to forest fuel increase as well as the criterion about impedance of vegetation growth. He added the following three criteria on the table a) Requirement on technical knowledge, b) Willingness of stakeholders to apply, and c) Impact on soil fertility

Table 20: Criteria table-Participant 15

Selection criteria for mulching techniques	Indicators
Cost	Material(seeds, fertilizers, mulches, wood, stones etc) Labor Transport (of materials,equipment and people) Equipment of application
Time (of application completion after fire event)	Preparation time and transport time (of materials,equipment and people) Time needed for application
Effectiveness	% of soil erosion decrease at time of application
Risk of soil compaction	Whether machinery will have to go off-road for material collection or application
Enhancing carbon storage capacity	Ability to protect the soil organic carbon from erosion
Risk of enhancing invasive vegetation growth	Risk of containing exotic seeds
Longevity	Weight (HighRisk of being blown by wind) and decomposition rate
Requiring low technical knowledge	Availability of workers that have te necessary expertise
Proximity to material source	Distance of material source
Willingness of stakeholders to apply	Readiness of local stakeholders to apply the technique
Positive impact to soil fertility	

Participant no. 16

The sixteenth participant is a researcher in Spain who is experienced in measurements of erosion rates in experimental conditions.

He stressed the importance of soil burn severity indicators when assessing the effects of fire in an area. An interesting insight is that it is often observed that moderately burned soils show higher water repellency substances than highly burnt soils, since the temperature destroyed the repellent substances.

According to his experience, the risk of promoting the growth of invasive vegetation by mulching is not an issue. Compaction on the other hand could be an issue if heavy machinery is used. He did not reject the idea of the risk of increase of fuel in a forest by mulching. He expressed the importance of evaluation of every action and its implications on fuel increase.

Participant no. 17

Participant no. 17, due to language obstacles, completed the written part of the interview. He accepted the predefined list and added the criterion of "Participation in application". That is connected to how much the public can be involved in applying the technique. In his experience, the engagement of volunteers lessened the measure's cost. Also, the active participation he experienced lessened the time needed to mulch the targeted areas.

Table 21: Criteria table-Participant 17

Selection criteria for mulching techniques	Indicators	Notes
Cost	Material(seeds, fertilizers, mulches, wood, stones etc) Labor Transport (of materials,equipment and people) Equipment of application	
Time (of application completion after fire event)	Preparation time and transport time (of materials, equipment and people) time needed for application-whether contractors are hired	As these actions are usually carried out by the administration, a factor that I see as important in the speed of action is whether you have your own means (qualified personnel and material) or if you hire companies. In the case of Galicia, the fire service does not have personnel trained in these tasks or equipment such as the BAERS in the USA. This work of BAER is carried out by research personnel from Lourizan, but when there are many fires they do not give a wide berth. As they do not have personnel specialized in applying the mulch, companies are hired and this supposes a delay of up to three months because there is a lot of bureaucracy to have money available. With our own personnel it takes less time, in the case of --- and with Volunteers we only took two weeks to apply the mulch, but the administration took more than 3 months to act in the area.
Effectiveness	% of soil erosion decrease	
Risk of soil compaction	Whether machinery will have to go off-road for material collection or application	
Effects on carbon storage	Ability to protect the soil organic carbon from erosion	

Risk of enhancing invasive vegetation growth	Risk of containing exotic seeds	
Risk of inhibiting desired vegetation growth	-Whether it is shown to have a negative effect on native plant germination and growth	
Longevity	-Weight- Risk of being blown by wind -Attraction of grazing animals	
Risk of enhancing wildfire danger	Flammability of material	
Participation in application		The factors that influenced the speed and efficiency were the presence at that time of people with training and enthusiasm (---) and the active participation of the local administration (Mayor). The factors that influencing public acceptance and participation I think was in the local population having lived through the fire and in volunteers from other areas their sensitivity to the natural and human damage of the fires. The involvement of the mayor at all times also weighed heavily in the participation of the local people.

Participant no. 18

He also completed the written part of the interview. He accepted the written list and added three new criteria to the table a) “Accessibility”, which is the easiness to approach an area due to its proximity to the road network, b) “Acceptance”, or the willingness of the society to use mulching, c) “Social Governance”, which is about the structure and strength of institutions, organizations etc. to make decisions and implement actions. Also, it is related to how they interact with each other and with the wider public.

Table 22: Criteria table-Participant 18

Selection criteria for mulching techniques	Indicators
Cost	Material(seeds, fertilizers, mulches, wood, stones etc) Labor Transport (of materials, equipment and people) Equipment of application
Effectiveness	% of soil erosion decrease
Time (of application completion after fire event)	Preparation time and transport time (of materials, equipment and people) Time needed for application
Risk of soil compaction	Whether machinery will have to go off-road for material collection or application, or post-fire logging
Effects on carbon storage	Ability to protect the soil organic carbon from erosion
Risk of enhancing invasive vegetation growth	Risk of containing exotic seeds
Risk of inhibiting native/desired vegetation growth	-Whether it is shown to have a negative effect on native plant germination and growth

Risk of enhancing wildfire danger	Flammability of material
Longevity	-Weight- Risk of being blown by wind -Attraction of grazing animals
Accesibility	Easiness of application due to the road network
Acceptance	How the technique is accepted by society (If they are willing to use).
Social governance	How the different social actors interacts, if there is a democratic network between neighbors and if they are organized in many social institutions. If the problems of the society can be addressed through not only by the local government, but also forest, agriculture, touristic associations and other social partners are involved (Forest technicians, Education institutions, forestry companies, private and public sectors).

Table 23: All social criteria added by the participants

Participant no.	Criterion name	Notes from participant
1	Acceptance	How the technique is accepted by society (If they are willing to use).
1	Social governance	How the different social actors interact, if there is a democratic network between neighbors and if they are organized in many social institutions. If the problems of the society can be addressed through not only by the local government, but also forest, agriculture, touristic associations and other social partners are involved (Forest technicians, Education institutions, forestry companies, private and public sectors).
1	Local communities	Besides official mulching applications by the Forestry Services we believe that local initiatives can also help a lot because they can be very fast and efficient as recently demonstrated by the paper of Prats et al (2022). Organization of the population in associations or agrupations will facilitate coordination and operativeness.
2	Social acceptance	Potential adoption from forest owners (eg. % of forest owners already applying)
2	Institutinal- Policy support	Existence of funds
2	Technological knowledge	Need for machinery not commonly used

3	Acceptance	Due to research being recent-knowledge is not widely communicated.
5	Knowledge	Maybe knowledge exist but farmer/company/stakeholder does not know how to implement mulching.
6	Communication	
6	Institutional-bureaucratic procedures	
8	Willingness to apply from local authorities and owners	Acceptability
8	Readiness of local stakeholders to apply the technique	
15	Requiring low technical knowledge	
15	Availability of workers that have the necessary expertise	
15	Willingness of stakeholders to apply	
15	Readiness of local stakeholders to apply the technique	
17	Participation in application	The factors that influenced the speed and efficiency were the presence at that time of people with training and enthusiasm (---) and the active participation of the local administration (Mayor).
17	Acceptance	How the technique is accepted by society (If they are willing to use).
18	Social governance	How the different social actors interact, if there is a democratic network between neighbors and if they are organized in many social institutions. If the problems of the society can be addressed through not only by the local government, but also forest, agriculture, touristic associations, and other social partners are involved (Forest technicians, Education institutions, forestry companies, private and public sectors).