

Teaching from the Efficient 20 project



Advisor's brochure

Tips for encouraging farmers and foresters to reduce their fuel consumption



Counsellor's brochure

European Farmers and Foresters involved in contributing to an intelligent Energy Network towards the target of 20% reduction in fuel consumption.

Efficient 20 is an Intelligent Energy Project designed to encourage farmers and foresters to contribute to reaching the target set by the European Union of 20% energy saving compared to the projections by 2020. The focus is put on fuel oil used in farming machinery, which can represent more than 50% of the energy consumed in agriculture.

Advisors, farm support organisations and dealers could play a key role to help farmers and foresters to decrease the fuel consumption. This document is designed to give them some information coming from the experience gathered together during the Efficient20 project.

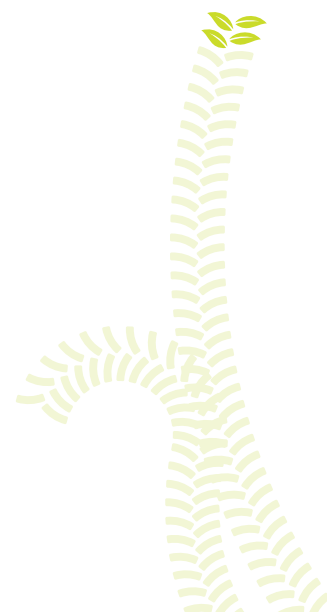
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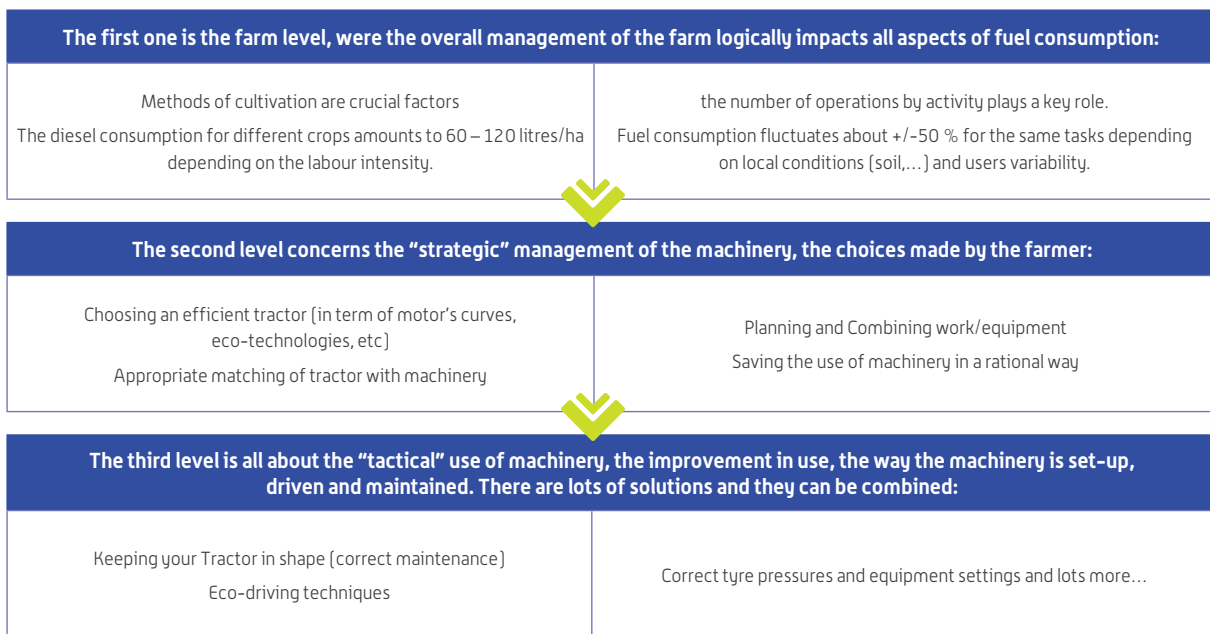
Reducing fuel consumption by 20%, it's possible!

With the economic and environmental problems concerning the dependency of our society on petroleum products comes an increasing pressure on agriculture viability, and for very good reasons: fuel used in farming machinery represents more than a third of the energy consumed in agriculture and fuel costs represent ca. 40 % of total costs of the tractor input

[with a utilization rate of 450 h/a]. So introducing fuel saving measures can play a significant part in reducing input costs and improving farm profitability, with environmental benefits at the end. Here are some of the technical achievements of the Efficient 20 project.

1.1 What are the main parameters which influence fuel consumption?

While most farmers do their best to work efficiently, there are usually possibilities at a different scale or level that could be studied. It's possible to synthesize the influencing parameters in three vertical levels, where every level impacts the following.



- 1 Adapted driving: 10% - 20% saving
- 2 Adapted implement: 5% - 8% saving
- 3 Adapted implement settings: Up to 30% saving
- 4 Adapted tyre pressure: 5% - 10% saving
- 5 Weight management: 5% - 8% saving
- 6 Engine maintenance: 5% - 10% saving

Various solutions are studied by the project:

- 1 Optimizing the use of a tractor in the field,
- 2 Impact of farm structure,
- 3 Specific measures of soil tillage,
- 4 Specific measures of forage harvesting,
- 5 Specific measures of transport,
- 6 The human factor.

→ More than eighty practical fuel saving suggestions to apply on a farm are available in one document.



Efficient20's tip: get the training handbook "D3.8 Strategies for saving fuel with tractors" on the project's website: <http://uk.efficient20.eu/category/resources/>.



1.2 How to test the consumption savings

The first step to improving your fuel efficiency is to know how much diesel you are currently using for each type of farming activity. Once you have made some precise measurements you can begin to monitor the effect of changing the way that you work.

74 Pilot groups of farmers and foresters across Europe were involved in consumption recordings during the project Efficient20. With the help of local partners, lots of different activities were studied and encouraging results were achieved for every retained solution.

- 1 Assessment of the initial consumption of the farm,
- 2 Comparison to standard values,
- 3 Potential of optimization, personal action plan designed,
- 4 Implementing the action plan in the farm,
- 5 Assessment of the final consumption of the farm,
- 6 Calculation of the consumption reduction achieved.

There are three ways to measure fuel usage:

- » Global fuel tank (refueling every time the tractor gets back to the fuel tank)
- » Plot measurement
- » Instantaneous measure (with electronic devices)

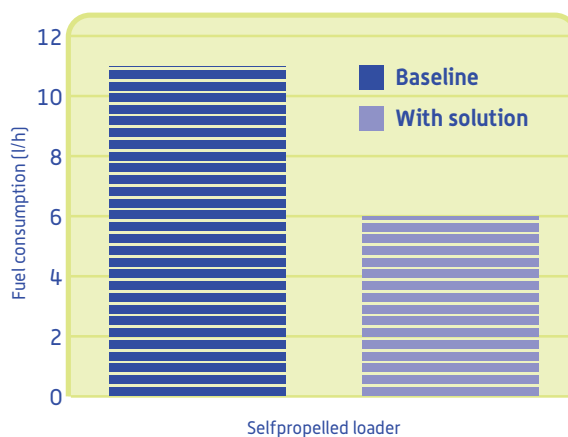
All the data (plot, operation, related consumption, ha realized, km traveled, ...) are recorded at every step

In the farms, the action plan gives the opportunity to observe comparative tests, where an initial consumption measurement (baseline) for a specific activity is followed directly (ideally on the same day and in the same field) by others measurements with tried out fuel-saving techniques (such as driving at the most efficient rpm, adjusting tyre pressures and using ballast to reduce wheel-slip and soil compaction).

Here are some examples of comparative tests realized by farmers and foresters from pilot groups:



Fuel consumption with Eco-Driving



FRANCE



Coray (Finistère)

Pilot group: Farmer, Cuma de Bellevue

Type of work: Manure loading

Tractor/implement: JCB 536 Agri Xtra, 135 ch

Used solution:

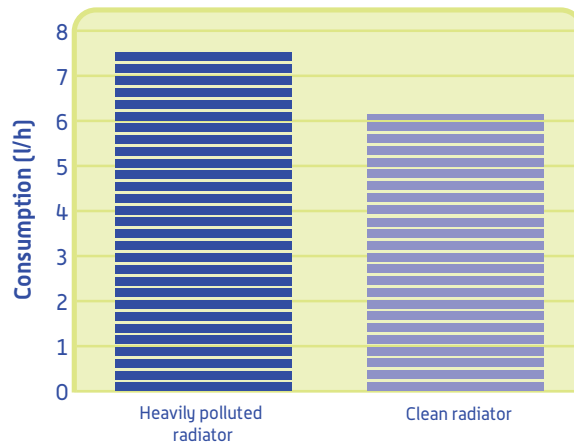
Eco-driving, between a nervous and smooth driving style respectively carried out in the morning and the afternoon of the same day


Saving:

43% of fuel saved for the same quantity of manure loaded in the same time



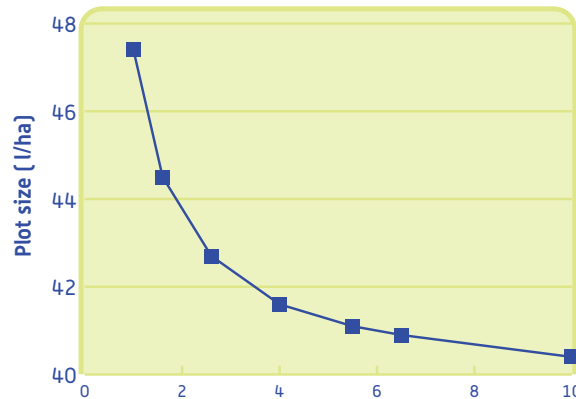
Fuel consumption with clean and heavily polluted radiator




<p>GERMANY </p>	<p>Pilot group: Forestry; Baden-Wuerttemberg</p>
<p>Type of work: Forest harvesting</p>	<p>Tractor/implement: Tractor Steyr 4110 Profi</p>
<p>Used solution: Cleaning of radiator (Engine maintenance)</p>	<p>Saving: Heavily polluted radiator compared to a clean one 20% fuel saving</p>



Fuel consumption



<p>AUSTRIA </p>	<p>Pilot group: Austrian Farmeres AT3</p>
<p>Type of work: sugar beet harvesting</p>	<p>Tractor/implement: Holmer T3, 260 kW, bunker 25 m , 6 rows</p>
<p>Used solution: The increasing plot size from 1.0 to 10.5 ha reduced the working time per ha for turning on the headland.</p>	<p>Saving: The increasing plot size causes a reduction of the fuel consumption from 47.4 to 40.4 l/ha [- 15 %].</p>

The comparative tests are very useful to give a quick view of the expected benefits of eco-solutions but they also provide a valuable way of convincing farmers and foresters, who much prefer to read about what other farmers are doing than to rely on purely academic research. That's why the project has produced a brochure with detailed accounts of nine different comparative tests achieved in nine different countries, with all the explanations of the different solutions

used (implement settings, adapted weight, eco-driving, tyre management, etc).

All these data together gives the possibility to study the consumption at different scale, from the comparative test on the field (with/without implementing saving action) to the global saving of the farm.

Efficient20 tip: get the Farmer's brochure "D5.3 Put your tractors on a diet – Fuel-saving achievements from efficient20 farmers"! Ask the Efficient20 local partners for a copy in your national language (see the "useful address" chapter)

1.3 The Efficient20 database

The Efficient20 partners have designed a database specially dedicated to the consumption studies, where all the pilot groups data are uploaded, standardized and accessible. The Efficient20 internet database is currently fed by:

74 Pilot Groups → 121 Farms → 235 members

There are also measurements from others actors of the project (Experts, research center ...).

One measurement is one line of the database, but each line can be filled with up to 48 different type of information (tractor/implement full description, timing, surface, speed, settings,...), to provide a complete description of the work carried out and fuel consumption achieved

ID	Date	Member	Farm	Activity	Implement	Fuel	Solution	Worked area	Compare
390	10/29/2011	Letihon Olivier	Letihon Marc	Soil tillage	Plough Mounted 5 furrows	28.3	Eco-Driving	1.8	392
391	10/29/2011	Letihon Olivier	Letihon Marc	Soil tillage	Plough Mounted 5 furrows	27.1	Eco-Driving	1.7	392
392	10/29/2011	Letihon Olivier	Letihon Marc	Soil tillage	Plough Mounted 5 furrows	30.8	None	1.7	
393	10/29/2011	Letihon Olivier	Letihon Marc	Soil tillage	Plough Mounted 5 furrows	29.4	None	1.6	

Database Fuel Measurement per activity *	
Harvesting	479
Breeding	27
Transport	129
Soil tillage	883
Fertilization and crop protection	75
Loading	26
Manure and slurry spreading	68
Forest harvesting	321

All the eight activities retained are studied. The number of operations recorded per activity (given below) shows that there are more data for certain activities than others. Some activities give more possibilities for the tests (such as soil tillage and harvesting which are some of the most fuel demanding activities on a farm), or they are maybe more common in the participating farms.

All the Fuel saving solutions retained have been tested too, with some very encouraging average results. Some of them are really near to the Efficient20 20% target, especially if we remember that these are stand-alone solutions, and could be used in combination!

Database average fuel saving achieved *



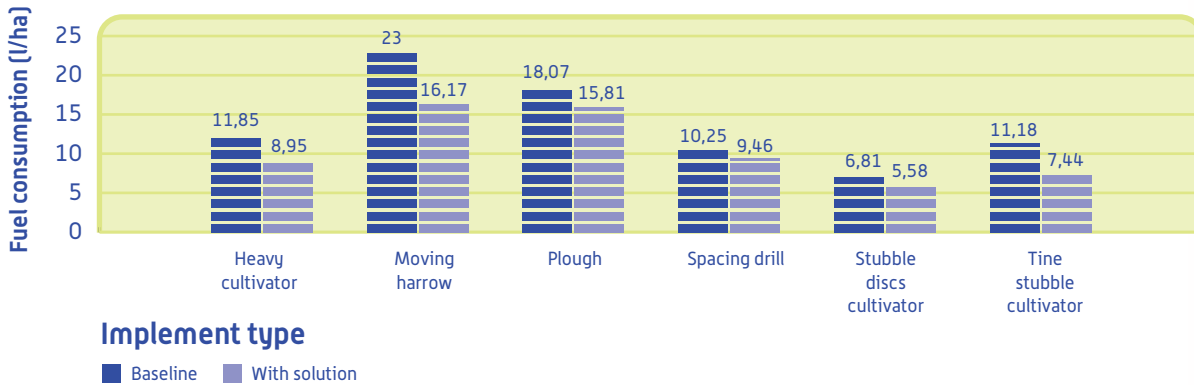
* based on December 2012 database

Each solution regroups different practical actions. For example, the "tyre management" actions are all about tyre pressure and tyre type choices, or "adapt implement's settings" solutions take in account actions like management of the working depth, replacement of used knives, optimization of the settings of the three point linkers, and much more.

In the "Reports" section, the online database gives some opportunities to study the data from different points of view, through the "fuel consumption by activity", "fuel consumption by solution" and "fuel consumption by implement" reports.

Filters (on "activity", "country", "unit to display", etc.) support further analysis. Here is an example for the fuel consumption achieved across all "soil tillage" operations where the "adapt implement's settings" solution was used. Six types of soil tillage implements are concerned and in some cases a 20% fuel saving is reached (example: "Moving harrow" presents a 30% reduction).

Fuel consumption by solution - adapt implement's settings (december 2012)



→ The database now shows its full potential with more than two thousand operations registered!

Using the database enables to:

- 1 Compare chosen fuel usage with that recorded by other farmers carrying out similar work,
- 2 See fuel savings being achieved through applying various fuel-saving techniques,
- 3 See the impact of changing the way of work on fuel economy.

Efficient20's tip: get access to the internet database, sign up on the project's website : <http://efficient20.eu/appfarms/>

The National Research Institute of Science and Technology for Environment and Agriculture (IRSTEA), as one of the French partners of the project, is leading a scientific data analysis of the database measurements. This study in two steps (by implements, by solutions) will lead to European references. Analysis aims to study fuel costs of agricultural operations, not only in terms of fuel consumption but also considering the working capacity (ha/h) in other words, in terms of integrated (global) efficiency. Here is a first attempt of analysis and reflexion made with the database in August 2012 for the "plough" activity with comparison between the baseline, the "Ecodriving" solution and the "Tyre management" solution.

Solution	Tests	Power of tractors (hp)	Tested area (ha)	Working capacity evolution [%]	Fuel reduction [%]
None	115	153	600	/	/
Ecodriving	28	162	170	-4	-19
Tyre management	9	162	23	0	+2

"Power of tractors", "Working capacity evolution" and "Fuel reduction" are average results.

We can see that the "Eco-driving" solution gives good fuel savings and the 20% saving objective seems to be nearly achieved in this case, but the working capacity does not seem to be improved. Due to high variability in the results of the "Tyre management" and low number of tests there are difficulties of interpretation results. But the database feeding is still going on, Efficient20 is working to demonstrate that solutions with global efficiency exist. "Work costs less and is faster", that's what we call a global efficient

activity; when the fuel saving management leads to an efficient work in every way you see it (and it's finally what the farmers and foresters are interested in)

Efficient20 tip: get the "D2.5 Data Analysis"! Ask the Efficient20 local partners for a copy (see the "useful address" chapter) or visit the project website <http://efficient20.eu/>

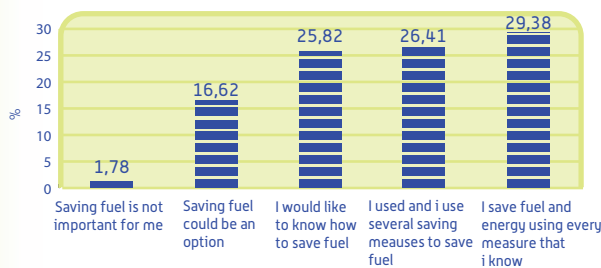


How to help users reduce their fuel consumption

2.1 Evaluating the level of knowledge about fuel consumption by users

One of the aims of the Efficient 20 Project is to increase the knowledge and the raising awareness of the farmers in relation to saving fuel in agricultural tasks, and for this reason a first global evaluation has been carried at the beginning of the project that helped us to know what the situation was. On another side, a more technical oriented evaluation was made because it is also important to evaluate the level of understanding by users of new equipment in agricultural tractors and machinery.

One of the most interesting results obtained thanks to the questionnaire analysis is that nearly the half of the farmers and foresters surveyed would like to save fuel without knowing how to do it.



2.2 Adapting the message to the audience

Regarding the results of the questionnaires, it is crucial that the way to broach fuel consumption and reduction is adapted to the audience. It was shown that, in the agricultural sector, both motivation and acquisition of new knowledge of participants should be increased.

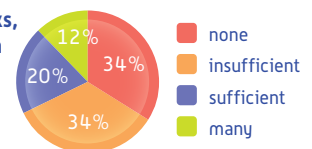
For example, motivation actions should try to:

- 1 Highlight the impact of fuel saving actions: economic, competitive, production, environmental..., in order to know the potential improvements and impacts at personal level,
- 2 Know the fuel consumption per task, in order to reveal how important the fuel cost is within the economic results, making the adoption of measures more attractive (database).

Indeed, the best way to improve the acquisition of knowledge is with training, courses and journeys. The training courses and actions should be developed according to the elements marked as more influential in reference to the fuel consumption, in order to optimize the obtained results. The main factors mentioned by farmers are linked to

This must be related to the fact that the amount and availability of practical principles and techniques on eco driving in agriculture is poor (from professional press, media and manufacturer through manuals or training).

Do you know any guidebooks, which provides guidance on economic operation of machinery and eco-driving techniques in agriculture?



These first results confirmed the relevance of projects such as Efficient20.

This action also identified farmer's low level of motivation (57%) to save fuel, as well as the low reinforcement level (which tried to analyze their knowledge and awareness about the importance of adopting fuel saving measures).

Identifying the strengths and the weaknesses of farmers and foresters involved in fuel saving is obviously the first step to determine concrete objectives with them!

machinery (use, driving style, speed) and to land (conditions and kind).

In order to increase the knowledge of participants about the consequences of their actions, it would be interesting to develop the training actions with farmers (the more knowledgeable the better), telling the audience about their experience, because it will make it easier to adopt saving measures for farmers who haven't adopt any yet, and it will reinforced those who are already applying some measures.

In order to apply this kind of message there are many possibilities:

- 1 Presentation (combined with other activities),
- 2 Visit with experts, manufacturers, research centre,
- 3 Quiz,
- 4 Contest of eco-driving...

Efficient20 tip: get the "D6.4. Analysis questionnaire by country"! Ask the Efficient20 local partners for a copy (see the "useful address" chapter) or visit the project website <http://efficient20.eu/>

2.3 It is important to know about your fuel consumption

As shown before, measuring fuel consumption is the first step towards fuel's reduction. To investigate the potential for further savings it is necessary to record the data of the actual situation by logging the fuel consumption relating to each plot and each operation on the farm. This must be performed for each single step, written by hand or electronically on a simple form. Based on that an overview can be achieved of all the procedures and their corresponding fuel consumption. Therefore a basis for further efficient saving measures is formed.

In order to know about the consumption of tractors or other self-propelled machines, user can:

- 1 Estimate the consumption manually by monitoring refill volumes,
- 2 Install relevant fuel monitoring instruments like turbines (flow measurements),
- 3 Use an on board computer that are able to display consumption.

This last solution takes an important place as more and more equipped tractors arrive on the market. The table below gives an overview of currently available tractor models that can provide data over the consumption (standard or optional, based in the information provided by the manufacturers).

Brand	Model	Current consumption (L/h and/or L/ha)	Total consumption (L)	Average consumption (L/h or L/ha)
Case	Maxxum	•	•	•
	Puma	•	•	•
	Puma CVX	•	•	•
	Magnum	•	•	•
	Steiger	•	•	•
Fendt	Vario 200-300	•	•	•
	Vario 400-800	•	•	•
	Vario 800-900	•	•	•
John Deere	6030 Premium	•		
	7030 Premium	•		
	8R range	•		
Claas	ARION 400-600 CIS	•		
	ARION 500-600 CEBIS	•	•	
	Axion 800 CIS	•		
	Axion 800 CEBIS	•	•	
	Xerion	•	•	
Lindner	Geotrac 84-104		•	•
	Geotrac 114-124		•	•
DeutzFahr	Agrotron TTV	•	•	•
	Agrotron M Profiline	•	•	•
	Agrotron X	•	•	•
Massey Ferguson	MF6400	•	•	•
	MF7400	•	•	•
	MF8600	•	•	•

While some computers feature a wide range of display options, others are only capable of showing current consumption [l/h]. Sometimes, displays are often not installed at all in the low power machines or are only available at extra cost. The forest machines (John Deere, Komatsu (VALMET), Ponsse) provide in general a wide range of information.

The advanced systems currently available on the market have brought about a significant reduction in the workload and therefore an increase in comfort. Sadly, about 60% of farmers didn't use on-board computer display information about fuel consumption; they find the information too complicated to use. That's why an in-depth training is re-

quired before the user can fully utilize all functionalities of the computer. As 70% of farmers welcome assistance from dealers, manufacturers and dealers must provide on-going help with questions and problems. Clearly structured and easy-to follow user manuals also play an important role in this context. This could be a starting point for improvement.

Efficient20 tip: get the "D 3.3 Detailed review of embedded computers"! Ask the Efficient20 local partners for a copy (see the "useful address" chapter) or visit project website <http://efficient20.eu/>

2.4 How to organize an eco-driving session

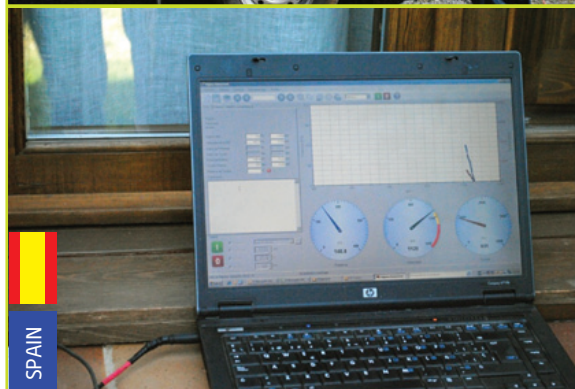
One of the best ways to increase the motivation and the capacity of farmers and foresters is to develop training sessions especially speaking about fuel consumption: eco-driving session.

The content of an eco-driving session should include both theoretical and practical parts. In average the duration of one session is at least one day for participants with technical skills.

The theoretical part should be as interactive and lively as possible with practical examples in order that participants stay attentive.

Highlighting the main factors which effect fuel consumption helps to justify each of the fuel saving techniques. The following topics can be included in the theoretical part:

- 1 Introduction (fuel price, cost of ownership of a tractor, benchmarks for fuel consumption)
- 2 Characterisation of a tractor engine and gear box,
- 3 Effect of engine speed,
- 4 Impact of farm structure,
- 5 Specific measures in soil tillage,
- 6 Specific measures in forage harvesting,
- 7 Choice of the optimal transport vehicle,
- 8 Measuring the fuel consumption,
- 9 Crucial factor man...



› Tests using equipment to display engine power/ torque curve (in-field test-bench)

"Using this special measuring equipment was interesting, because it allowed farmers understand how an engine works and what the relation between engine speed and energy consumption and power is." (APEA)

The practical part of the training session included activities which aim at showing some examples of fuel reduction by comparison of consumption between situations. This can be done for several agricultural or forestry works like transport, loading, soil tillage, spreading, harvesting... depending on the interest of participants.



› Folder with explanations are given to participants for the theoretical part of the training session

"Eco driving session was useful because attendants had theoretical presentation of possibilities for lowering fuel consumption and practical driving part with significant difference in fuel consumption." (Agricultural Institute of Slovenia)

The fuel savings measures that can be easily tested are:

- 1 Effect of the state of maintenance at a test bench (dynamometer),
- 2 Effect of working depth, ballasting, tyre pressure,
- 3 Effect of driving style,
- 4 Effect of Eco PTO,
- 5 Effect of machine adjustment.

It is interesting when participants could test their own way of driving and compare it to the others or to themselves after advice given by the trainer. They are often surprised about the variability in fuel consumption among different drivers under the same conditions, and about the large effect of eco-driving.

Because the economic aspect is important, it is essential that eco-driving does not cause an increase of working time requirement (to avoid increase of labour and machine costs). Thus, practical examples should show that it is possible to keep the same speed with less fuel consumption.

→ *The given advice and explanations come from the experience from more than 30 driving sessions organized in 8 different countries gathering together nearly three hundred participants during the Efficient20 project.*

Efficient20 tip: get the "D 3.9 General Report on Training Sessions"! Ask the Efficient20 local partners for a copy (see the "useful address" chapter) or go to the project website <http://efficient20.eu/>

› **Comparative test on ploughing with an on board fuel consumption monitor**

"It is important that participants collect their own experience" (AILE)"



2.5 Local useful address

UK Local partner

Ruralnet FUTURES

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