Energy savings in soft wheat (*Triticum aestivum*) production in dryland systems

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Abstract

The objectives of this study were to determine the energy consumption in soft wheat production, and evaluate the possibility of energy savings. For this purpose, data were collected from 81 farms applying questionnaires via face-to-face interviews. Energy expenditures per hectare (MJ/ha) and specific energy consumption (MJ/kg grain produced) for four types of farms were studied. Results indicate that the total energy consumption varies from 9.7 to 11.1 GJ/ha. The share of fertilizers, seeds and diesel represents respectively 43.8%, 27.7% and 18.6%. Specific energy consumption is found to be 3.05 MJ/kg for small scale farms and 3.37 MJ/kg for large scale farms. According to these results and to farmer's attitudes, a prediction equation for each type of farm was established to analyze the possibility of energy saving. 8.6% for small scale farms, 20.6 % for large scale farm of total energy consumption could be saved by reducing the seed rate and fuel consumption. The potential energy that can be saved represents 29.6% of the total fuel consumed in soft wheat production. Specific energy consumption could also be reduced by 19.6 to 22.9%. Adoption of the options outlined above would reduce GHG emissions from Morocco's soft wheat farming by an estimated 119.1 kte CO_2 a year.

Keywords: Soft wheat, Energy balance, Energy saving, GHG emission

Résumé

Les objectifs de cette étude consistent à évaluer la consommation d'énergie directe et indirecte lors la production du blé tendre. Pour cela, une enquête a été menée auprès de 81 exploitations agricoles réparties en 4 catégories. Les résultats indiquent que la consommation d'énergie par hectare varie de 9,7 à 11,1 GJ. Les fertilisants, les semences et carburant représentent respectivement 43,8%, 27,7% et 18,6% de la consommation totale. Quant à la consommation spécifique, elle varie de 3,05 à 3,37 MJ/kg. En tenant compte de ces résultats et aux attitudes des agriculteurs, des équations de prédiction de la consommation d'énergie ont été établies. Les résultats montrent que la réduction de la dose de semis et de la consommation en carburant mènent à une économie d'énergie variant de 8,6 à 20,6 % .Ce potentiel représente l'équivalent de 29,6 % de la consommation du carburant dans la production du blé tendre au Maroc. La consommation spécifique pourrait également être réduite de 19,6 à 22,9% .L'adoption de ces pratiques réduira l'émission des gaz à effet de serre de 119,1 Kte CO_2par an.

Mots-clés: Blé tendre, Énergie, Gaz à effet de serre.

INTRODUCTION

Energy from fossils is an essential input of the modern agricultural production. Even if the sectors of energy and agriculture generate a relatively small part of gross value added, they are crucial in full-filling demands of growing population for energy and agricultural commodities. Global cultivated area and energy consumption almost doubled during the 20th century. Further increase of arable land and fossil energy consumption (even if limited) may cause detrimental effects to the environment. That is why improvement in energy efficiency of agricultural production is a way to rationalize the use of environment resources. Energy analysis, along with economic and environmental analyses, is an important tool to define the behavior of agricultural systems. Energy analysis started as a relevant subject in agricultural production in the 1970's as a result of the dramatic increase of oil-derivative prices. The consequences were the rationalization of energy consumption, the use of new energy sources, and the aim for more efficient working methods. The establishment of methodologies to identify and evaluate the different energy flows that take part in agricultural production is the basis of an energy analysis. Reduction of energy input implies specific economic and environmental effects. If the trade-off between those effects is positive it means that energy, economic, and environmental performances are improved simultaneously Gołaszewski (2014). Agriculture plays an important role in the Moroccan economy. Its contribution to GDP ranges between 15% and 17%, and it employs over 40% of the active population. The sector also provides indirect support for 60% of the population and generates almost 25% of export revenue (Ait El Mekki, 2006). Cereals represent one of the main sectors of

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agricultural production in Morocco. Morocco's per capita consumption of wheat, estimated at 258 kg annually, is among the highest in the world. Morocco's economy is growing rapidly in all its sectors. Consequently, the energy demand has been increasing steadily. Morocco was consuming 18.8 Mt oe/y as primary energy in 2012. It's energy needs grow by 8%/yr on average. All energy imports (crude oil and oil products, coal, natural gas and electricity) amounted to 102.5 billion Moroccan Dirham in 2013,10.7 billion USD (or 27% of all the country's imports) IEA (2012).The country is heavily dependent on external sources, importing up to 93% of its energy supplies. Oil and petroleum products account for the largest part of Morocco's energy bill. In 2009, Morocco adopted a national energy strategy in order to improve security of energy supply and availability/affordability, while also addressing environmental and safety concerns. The strategy seeks to reach these goals by diversifying energy sources, optimizing the electricity mix, increasing local production particularly from renewable sources, promoting energy efficiency**.** This paper focuses on energy saving possibilities in Moroccan agriculture especially in soft wheat production in favorable rain fed regions.

MATERIAL AND METHODS

Energy assessment at the national level showed that wheat production in favorable production regions consumed 42.4% of the total energy input in cereals production in Morocco Ramah (2013).These regions utilized favorable rain-fed production systems and became the focus of this work.

The study was performed in central region of Khemisset province which is situated in the North East of Rabat between 33°-34° North and 5°-6° West. The choice of this zone is justified by the availability of a precise data base on cereals producers. A Life Cycle Assessment -like approach has been chosen, but the activities have been restricted to pre-farm gate activities and have thus excluded processing into consumer goods.

The energy efficiency indicator is best expressed as the ratio of energy use per cultivation area ($GJ.ha^{-1}$) and energy use per unit of product ($GJ.t^{-1}$). Specific Energy = Energy input in MJ/ ha/ crops output in $t.ha^{-1}$. A stratified random sampling method was used to determine survey volume. The stratification was based on farm size and employed four subgroups: 5-10 ha, 10-20 ha, 20-50 ha and >50 ha. With this technique, we have a higher statistical precision compared to simple random sampling. This is because the variability within the subgroups is lower compared to the variations when dealing with the entire population. The technique requires a small sample size which can save a lot of time, money and effort for us. Consequently calculated sample size in this study was 81. A preliminary investigation was conducted in order to define the variability of strata and sample size based on the following equation:

$$ni=(Ni\ \sigma yi)*n/(\sum Ni\ \sigma yi)$$

with the terms defined in Table 1.

The information related to the inputs and the yield related to the year of 2012 was extracted in the form of questionnaires.

The first part of our investigation consisted of interviews with individual farmers. The second part, fuel consumption data, characteristics of machinery used was collected from the contractors interviewed and from the manufacturer's specifications for tractors and implements. The total inputs for production of a unit area consisted of: plant protection products (herbicides, fungicides), fertilizers, diesel fuel, machinery, seeds and human power. The amount of energy consumption was calculated from the multiplication of the Input consumption and its energy equivalent per unit (extracted from scientific resources). The according to energy input and output,specific energy was calculated: Energy input($MJ.Ha^{-1}$)/yield of wheat ($kg.Ha^{-1}$). It should be mentioned that the free sources of energy (solar energy input for photosynthesis) were not accounted for.

All information on energy inputs and wheat yields was transferred into Excel spreadsheets and analyzed by the "Statistical Package for the Social Sciences" SPSS 21 program analysis of variance; the energy consumption per hectare and the specific energy were calculated. The significance level chosen before data collection is set to 0.05 (5%).

Prediction equations were used in order to predict the energy saving in soft wheat production: $E0 = X0 + a\,X1 + b\,X2 + c\,X3 + d\,X4$ where a,b,c,d were respectively the energy conversion coefficient of nitrogen,phosphore,seed and diesel, X0 is the sum of energy used in pesticides,machinery and labor. X1 was the nitrogen quantity used, X2 the phosphorus quantity, X3 seed rate and X4 diesel consumption per hectare. Used data is based on the median that gives a more robust measure, of each group of farm type. The energy saving expressed in %, Es was calculated to be:(Ep-E0)*100/E0 where Ep is energy prediction calculated by varying seed rate and fuel quantity in conventional system and added the changing of energy used in pesticides, machinery in no till technique.

In order to predict specific energy reduction, our calculation was based on a survey result of 325 samples of soil analysis. The last part of our study consisted on GHG analysis which leads us to have an idea about the energy saving impact on the environment. The GHG emissions were calculated per hectare by multiplying the application rate of inputs by its corresponding emission coefficient (Table 2).

Table 1: Sample size

Stratum	5 to 10 ha	10 to 20 ha	20 to 50 ha	More than 50 ha	Total
Population size (Ni)	284	126	37	25	472
variability of the strata (σyi)	300	450	1200	1700	-
Final sample size (ni)	30	20	16	15	81

Table 2: GHG conversion coefficients in MJ (Biograce 2011)

	Coefficient
KG N	5.88
Kg P_2O_5	1.011
Kg K_2O	0.576
Pesticides /active ingredient	10.971
Seed/Kg	0.276
Machines/MJ	0.069
Diesel/MJ	0.088 MJ

RESULTS AND DISCUSSION

Energy inputs

About 171.5 to 186.6 kg of seed, 8 to 13 h human labor, 9.7 to 14.4 h machinery power and 45.2 to 58.4 L diesel fuel for total operations were used in wheat production on a hectare basis. The use of nitrogen fertilizer, phosphorus and potassium were 59 to 69.3 kg, 57.6 to 72.7 kg and 1.4 to 3.8 kg respectively. Pesticides 0.71 to 0.76 kg a.c. The total energy consumption varied from 9.7 to 11.1 GJ ha^{-1}, and there was no significant difference between the four farm categories presented in Table 3. The results are lower than results found in other countries such as Portugal (12.9), Deutchland (18.6), Greece (19.9), Poland (15.1), Netherlands (18.1), Finland (12) (AgrEE, 2012), Iran (14.9) (Azarpor 2011), Turkey (14.5) (Marakuglu, 2010) and Italy (15.4) (Alluvione, 2011).

Analyze per source

The difference between the energy sources was significant for all operations. The difference was significant between farm types in fuel,labor and machinery source.

Results show that fertilizers are the highest inputs and represent 41.6 to 45.2% of total inputs. Nitrogen, in particular, was the most important and comprised 75.6 to 80.1% of energy from fertilizers. The contribution of K and especially P was much lower (on average 19.9 to 23.6% and 0.4 to 1.5% of fertilizers, respectively). Seeds were second and covered 26.4 to 28.6% of total inputs. Fuel was the third input and represented 18.2 to 21.4% of total inputs. Weed and diseases control had a far lower importance and represented only 2.3 to 2.9% of total energy.

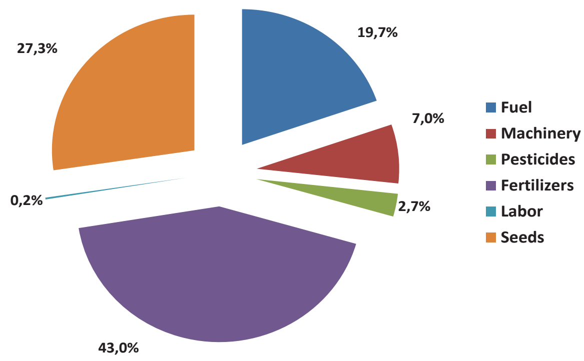

Figure 1: Average percentage of total energy input

Energy Input in Farm Operations

Seventy five percent of the total input energy as shown in Figure 2 consumed during the operation of fertilizing and seedbed preparation. Tillage operation consumed 52%,49.4%,47.6% and 44.9% of the total fuel used respectively for small farms, medium farms 10-20, 20-50 ha and large scale farms over 50 ha.

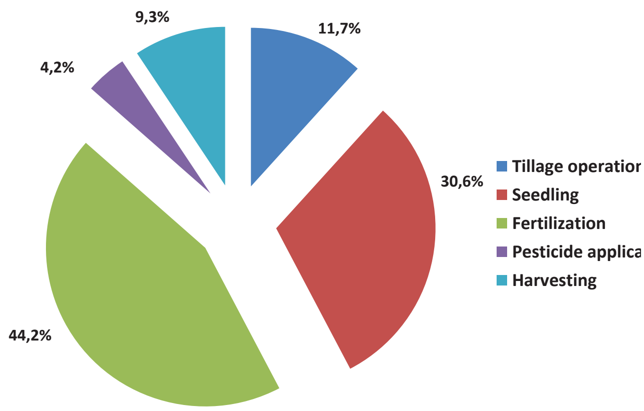

Figure 2: Average energy percentage per operation

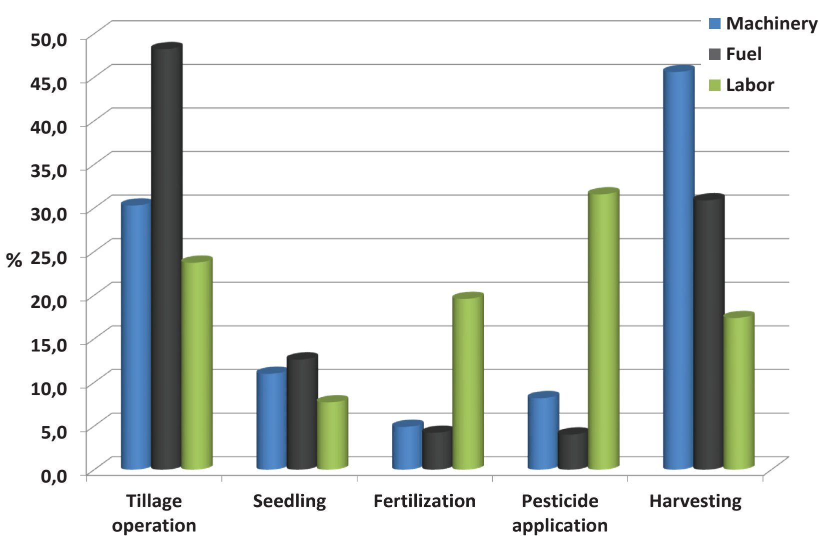

Figure 3: Percentage of fuel, machinery and labor energy consumption per operation

Table 3: Structure of energy use

5-10	Fuel		Machinery		Labor		N		P		K		Herbicides		Fungicides		Seeds		
	Qty	Energy	Qty	Energy	Qty	Energy	Qty	Energy	Qty	Energy	Qty	Energy	Qty	Energy	Qty	Energy	Qty	Energy	
Tillage operation	23.5	957	3.2	198	2.7	5.2													**1160**
Seedling	5.3	215	1	61	1	1.9											178.3	2791	**3069**
Fertilization	0.4	16	0.1	5	2.7	5.3	69.3	3659	57.6	864	3.8	45.6							**4595**
Pesticide application	0.2	8	0.1	9	4.7	9.2							0.6	242.19	0.2	48.06			**316**
Harvesting	15.8	645	5.3	327	1.9	3.8													**976**
Total	**45.2**	**1841**	**9.7**	**600**	**13**	**25.4**	**69.3**	**3659**	**57.6**	**864**	**3.8**	**45.6**	**0.6**	**242.2**	**0.2**	**48.06**	**178.3**	**2791**	**10116**
10-20	Fuel		Machinery		Labor		N		P		K		Herbicides		Fungicides		**Seeds**		
	Qty	Energy	Qty	Energy	Qty	Energy	Qty	Energy	Qty	Energy	Qty	Energy	Qty	Energy	Qty	Energy	Qty	Energy	
Tillage operation	22.8	927	3.3	202	2.6	5.1													**1134**
Seedling	5.8	238	1.2	76	0.9	1.7											177.8	2783	**3099**
Fertilization	1.7	68	0.5	31	2.1	4.2	59	3115.2	64.9	973.5	2.5	30							**4222**
Pesticide application	1	39	0.5	33	4.5	8.8							0.5	219	0.2	64.1			**364**
Harvesting	14.8	604	5.2	321	1.9	3.8													**929**
Total	**46.1**	**1876**	**10.7**	**663**	**12**	**23.6**	**59**	**3115**	**64.9**	**973.5**	**2.5**	**30**	**0.5**	**219**	**0.2**	**64.1**	177.8	2783	9747.4
20-50	Fuel		Machinery		Labor		N		P		K		Herbicides		**Fungicides**		**Seeds**		
	Qty	Energy	Qty	Energy	Qty	Energy	Qty	Energy	Qty	Energy	Qty	Energy	Qty	Energy	Qty	Energy	Qty	Energy	
Tillage operation	23	937	3.3	202	2.55	5													**1144**
Seedling	6.9	279.8	1.4	89	0.9	1.7											171.5	2684	**3055**
Fertilization	1.44	59	0.43	27	2.35	4.6	61.5	3247.2	63.9	958.5	5.5	66							**4362**
Pesticide application	2	80	1	64	3.4	6.3							0.5	199.96	0.3	79.03			**429**
Harvesting	15.1	613.2	5.3	330	1.9	3.8													**947**
Total	**48.44**	**1969**	**11.43**	**712**	**11.1**	**21.4**	**61.5**	**3247**	**63.9**	**958.5**	**5.5**	**66**	**0.5**	200	0.3	79.03	171.5	2684	9937
>50	Fuel		Machinery		Labor		N		P		**K**		**Herbicides**		**Fungicides**		**Seeds**		
	Qty	Energy	Qty	Energy	Qty	Energy	Qty	Energy	Qty	Energy	Qty	Energy	Qty	Energy	Qty	Energy	Qty	Energy	
Tillage operation	26.2	1066	4.3	267	2.7	5.3													**1338**
Seedling	7	285	1.4	89	0.7	1.4											186.6	2921	**3296**
Fertilization	4.9	198.2	1.25	77.7	1.48	2.9	66.4	3505.9	72.7	1090.5	1.4	16.8							**4892**
Pesticide application	4.9	198	2.1	129.3	1.6	3.1							0.5	189.2	0.3	71			**591**
Harvesting	15.4	627	5.3	330	1.9	3.3													**960**
Total	**58.4**	**2374**	**14.35**	**893**	**8.38**	**16**	**66.4**	**3506**	**72.7**	**1091**	1.4	16.8	0.5	189.2	0.3	71	186.6	2921	11078
Average	Fuel		Machinery		Labor		N		P		**K**		**Herbicides**		**Fungicides**		**Seeds**		
	Qty	Energy	Qty	Energy	Qty	Energy	Qty	Energy	Qty	Energy	Qty	Energy	Qty	Energy	Qty	Energy	Qty	Energy	
Tillage operation	23.875	971.75	3.525	217.25	2.6375	5.15	0	0	0	0	0	0	0	0	0	0	0	0	**1194**
Seedling	6.25	254.45	1.25	78.75	0.875	1.675	0	0	0	0	0	0	0	0	0	0	178.55	2794.8	**3130**
Fertilization	2.11	85.3	0.57	35.175	2.1575	4.25	64.05	3381.8	64.775	971.63	3.3	39.6	0	0	0	0	0	0	**4518**
Pesticide application	2.025	81.25	0.925	58.825	3.55	6.85	0	0	0	0	0	0	0.525	212.59	0.25	65.548	0	0	**425**
Harvesting	15.275	622.3	5.275	327	1.9	3.675	0	0	0	0	0	0	0	0	0	0	0	0	**953**
Total	**50**	**2015**	**12**	**717**	**11**	**22**	**64.1**	**3382**	**64.8**	**972**	**3.3**	**40**	**0.525**	**213**	**0.250**	**66**	**179**	**2795**	**10220**

For all farm sizes, energy included in the fertilization represented the highest input (43.3 to 45.4% of the total input)followed by seedbed preparation (29.4 to 32%). Comparing the size of land holdings, the energy requirements for tillage decreased towards higher size of farm. It revealed that farmers who have large land holdings use more energy for soil tillage, sowing and harvesting. Results showed that the total energy input per unit area in small fields was 9.5% smaller than that of large fields. Fuel consumption per hectare increased with increasing farm size. The energy consumed by machinery varied from 2.4 GJ ha^{-1} in small scale farms to 3.3 GJ ha^{-1} in large scale farms, 70 to 88.1% is consumed during tillage and harvesting operation (Figure 3). Statistical analysis showed that difference is significant between farm sizes only in the operation of pesticide application.

Specific energy consumption in GJ/t

Specific energy shows the amount of energy spent to produce a unit of marketable product. It was slightly higher 3.37 GJ/t in medium scale farms as compared to small farms (3.07), large scale farms (3.05) (Table 4).

Table 4: Specific energy results

Farm size	5-10 ha	10-20 ha	20-50 ha	>50 ha
Total inputs MJ/ha	10116	9748	9937	11078
Outputs in Kg/ha	3300	2890	3145	3630
Energy intensity MJ/t	3.07	3.37	3.16	3.05

Energy saving prediction

Quantification of energy savings

Results showed that fertilizers,fuel and seeds are the most energy consuming (89.4 to 91% of total energy inputs per hectare). The seed rate used by farmers varies from 170 to 190 kg/ha. The fuel consumed varies from 46.4 to 58.1 L/Ha. The quantity of seed could be saved using 1000 kernel weight for calculating seed rate. Taking in consideration that the majority of interviewed farmers use exclusively more than 170 kg of seed rate per hectare. Conclusively for our study energy saving could be obtained mainly through reducing seed rate and fuel consumption reduction. The energy consumed per category of farm, equations cited below were based on results of our investigation.

Equation 5-10 ha: **898.2+ a 65.8+ b 69+ c 180 + d 46,4**

Equation 10-20 ha: **981.7+ a 60.5+ b 69+ c 170+ d 46.8**

Equation 20-50 ha: **1010.8+ a 60.5+ b 69+ c 180+ d 47.4**

Equation >50 ha: **1118.3+ a 60.5+ b 69 +c 190+ d 58.1**

The variation of seed rate and fuel consumption factors implies the change in the energy input assuming all other factors fixed there is a higher potential for decreasing energy input. Results calculations showed that if all farmers operated efficiently by reducing seed rate (S)by 20 to 40 kg.ha^{-1} would result in a reduction of total energy consumption from 3.2 to 5.9% . These estimations are not based only on technical data but also on farmer's practices and agronomic possibilities. The results revealed that using direct seeding (DS) technique could lead to an energy saving varying from to 8.6 to 14.7% (Table 6). Among the variables included in the equations, seeds and fuel were

Table 5: Fuel quantity saved

Farm type	5-10	10-20	20-50	>50
Potential % reduction	-13.2	-13.2	-15.0	-20.6
Area in Ha	270000	255000	210000	320000
Initial fuel consumption in MJ/ha	10116	9748	9937	11078
Energy saved/ha	-1339	-1281	-1490	-2282
Total in MJ	-361626768	-326874810	-313015500	-730261760
Equivalent liters of fuel	-8885178	-8031322	-7690798	-17942549
Total	-42549848			
% of fuel saved	**-29.6**			

Table 6: Energy reduction in %

	5-10	10-20	20-50	>50
Fertilization management	-8,6	-12,7	-11,2	-9,9
Fertilization management-Seed rate	-12,5	-15,1	-14,9	-14,6
Fertilization+Direct seeding	-15,7	-20,3	-19,3	-21,7
Seed rate-Direct seeding	-13,2	-13,2	-15,0	-20,6
Fertilization management Seed rate -Direct seeding	-19,6	-22,7	-22,9	-26,34
Seed rate	-4,6	-3,2	-4,7	-5,9
Direct seeding	-8,6	-9,9	-10,3	-14,7

found as the most important variables which influence energy economy in soft wheat production.

The total energy that could be saved is converted to fuel quantity in order to have an idea about the fuel quantity saved. The table below shows the maximum energy that can be saved using zero tillage technique and reducing seed rate to 150 Kg/ha.

The final result indicates that the total energy that could be saved represents 29,6 % of energy used in fuel consumption in the production of soft wheat production in Morocco.

Specific energy consumption reduction

According to soil analysis of 325 samples in the area were the survey was conducted, the recommended formula is: 87 kg N,32 Kg P and 40 Kg K, farmers then used more phosphorus than needed, and less nitrogen and potassium. Nitrogen use is too low and varied from 60.5 to 65.8 kg, phosphorus 69 kg. So even the input energy will be higher, the specific energy per ton will be less, cause of improving the yield by assuming that 3 kg of nitrogen lead to a gain of 100 kg production. The specific consumption could be reduced by 8.6 to 26.3% for large scale farm by reducing seed rate and using direct seeding operation (Table 6).

Green house emissions analysis

The results of CO_2 emissions of soft wheat production are given in Table 7.

GHG emissions were calculated from the resource use inventory and multiplied by their appropriate emission factor.

Total energy involved,computed as C equivalent, was 726.8 kg CEq/ha in small farms and 795.3 kg CEq/ha in large farms. The Emission per grain produced varied from 219 to 230 Kg CO_2e/t. Results indicated that the highest share of CO_2 emissions was attributed to fertilizers 58 to 64% followed by diesel fuel with 22 to 26%seeds 6.5 to 7.4% (Figure 4). Ali Mohammadi reported a total emission of 1171.1 kg CO_2eq ha^{-1} in irrigated areas Mohammad (2014).While Alireza Khoshroo reported 280.6 kg CO_2eq ha^{-1} for wheat production in rainfed areas Khoshroo (2014). Khakbazan *et al*. calculated the CO_2 emissions from wheat production and found that it can be ranged from 410 kgCO_2eq ha^{-1} to 1130 kg CO_2eq**.** Rajaniemi *et al.* 2300 kg CO_2eq.ha^{-1} for conventional technique and 2250 for direct seeding in Finland (Rajaniemi et al.).The emissions per ton of grain produced was calculated to vary from 134 to 149 Kg CO_2e/t, these values are less than emitted in wheat production in New Zealand (340 Kg CO_2e/t; Safa, 2012) and in Finland (590 Kg CO_2e/t; Rajaniemi, 2011). Analysis of GHG emission showed that total emission that can be saved is estimated to be 119 097 Tons C Eq annually in soft wheat production in rainfed areas.

Table 7: Greenhouse gas (GHG) emission

Farm type	Area en Ha	Initial ghg Emission kg eCO_2/Ha	Ghg Emission Direct seeding kg eCO_2/Ha	Difference	Total Te CO_2 saved
5-10	270000	726.8	638.98	87.82	23711.4
10-20	255000	664.5	568.68	95.82	24434.1
20-50	210000	693.6	593.45	100.15	21031.5
>50	320000	795.3	639.30	156.00	49920.0
					119097.0

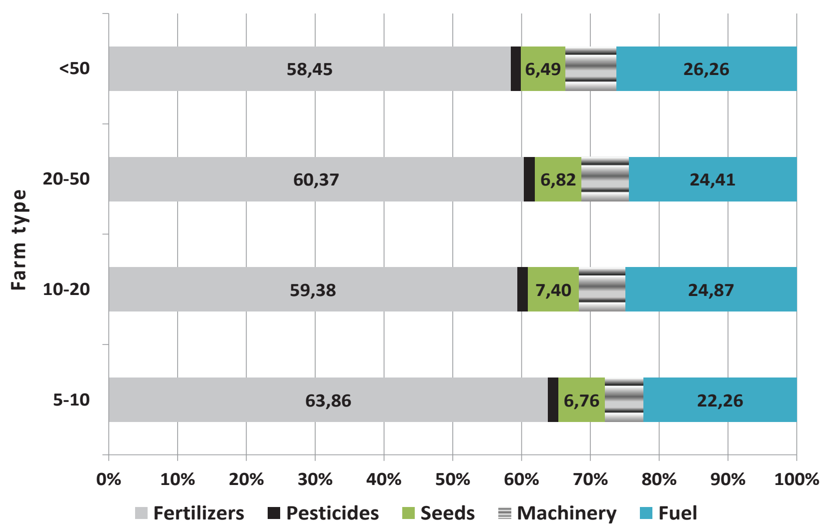

Figure 4: Share of inputs in total GHG emissions

CONCLUSION

Energy input in soft wheat production was similar for the four farm types studied, it varied from 9.7 to 11.1 GJ/Ha. The indirect energy embodied in fertilizers and seeds followed by direct energy in fuels are the major energy input among all the energy inputs for growing soft wheat in Morocco. Their share varied from 89.4 to 91%.Specific energy was 3.05 to 3.37 GJ/T. The prediction equations showed that there is a potential for energy savings in wheat production and trade-off effects between energy savings and GHG-emissions. The potential is evaluated to 13.2% to 20.6%.

Assuming 1.055 million hectares of soft wheat land, under no-till, and all farms using 150 kg of seeds per hectare, there will be an energy saving of 1.73 millions Gigajoules, converted in fuel that means that 42.5 million liters can be saved annually which correspond to 29.6 % of annually used fuel in wheat production in Morocco. This savings is valued about 320 million MAD. Specific consumption could be reduced from 8.6 to 26.3%.The total GHG emission estimates ranged from 664.5 to 795.3 kg eCO_2 /Ha for winter soft wheat. The calculations showed that the two major contributors to the final result were the GHG emissions associated with fertilizer production and fuel. These two emissions accounted for 80 to 90% of the total emissions.

Results of investigating land size lead to note that large farms have higher productivity and use more energy than small farms and presented a large gap of energy saving. Reaching these results could be done by establishing some strategies such as providing better extension and training programs for farmers in order to increase energy efficiency of wheat crop production in the region. Farmers should be trained with regard to the optimal use of inputs, especially fertilizer's and employing new production technologies: no till techniques.

Local agricultural extension centers in the region have an important role in these cases to establish the more energy efficient by implementing farm field schools which is a form of adult education that evolves from the concept that farmers learn optimally from field observation and experimentation in regular sessions from planting to harvest. The results must be disseminated to farmers by extension agents thought the national office of agricultural extension in order to promote no tillage system, accurate fertilizer management, crop rotation with legumes in order to save N fertilizer, pesticide management, preventive weed control and use of selected seed rate according to kernel per thousand, fuel management by training the operator who play the most influential part. The operator decides how to adjust the implement, the speed and the efficient operation of the tractor or self propelled working machine.

This study showed how efficient energy is being used, identified energy and saving opportunities and highlighted potential improvements in productivity and quality in Moroccan's soft wheat production .According to our study's results, there is a high potential for energy savings in agricultural sector, so a future research must be focused mainly on irrigated agricultural crops such as citrus, tomatoes growing greenhouse and super intensive olive growing.

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