FSSIM workshop

12-14 December 2011

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SEAMLESS

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Objectives:

1. Present FSSIM 2.0 as a tool for bio-economic farm level analysis
2. Train potential users within a "hands on" procedure
3. Create a network of users that can communicate on developments, and applications of FSSIM through the SEAMLESS association.
4. Get feedback from model users on potentials, limitations and issues that can be improved in next versions

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Program

Day 1 (12/12/2011)

Welcome (Prof. Dr. Ir. M.K. van Ittersum)	9:00	-	9:30
Introduction to Linear Programming	9:30	-	10:00
Exercise (solving LP in a graphical way)	10:00	-	10:30
Coffee break	10:30	-	10:45
Exercise (LP formulation)	10:45	-	12:15
Lunch break	12:15	-	13:00
Introduction to GAMS	13:00	-	13:30
Exercise (farmers problem in GAMS)	13:30	-	15:00
Generic programming	15:00	-	15:30
Coffee break	15:30	-	15:45
Exercise (farmers problem with a generic model)	15:45	-	17:00

Day 2 (13/12/2011)

Calibration with Positive Mathematical Programming	9:00	-	9:30
Exercise (Calibrating the farmer’s problem)	9:30	-	10:30
Coffee break	10:30	-	10:45
Farm System SIMulator	10:45	-	12:15
Lunch break	12:15	-	13:00
Exercise (Farmer’s problem in FSSIM)	13:00	-	15:30
Coffee break	15:30	-	15:45
Exercise (Farmer’s problem in FSSIM)	15:45	-	17:00

Day 3 (14/12/2011)

Exercise (application of FSSIM)	9:00	-	10:30
Coffee break	10:30	-	10:45
Exercise (application of FSSIM)	10:45	-	12:15
Lunch break	12:15	-	13:00
Exercise (application of FSSIM)	13:00	-	15:30
Coffee break	15:30	-	15:45
User community (FSSIM 2.0),future steps and feedback	15:45	-	17:00

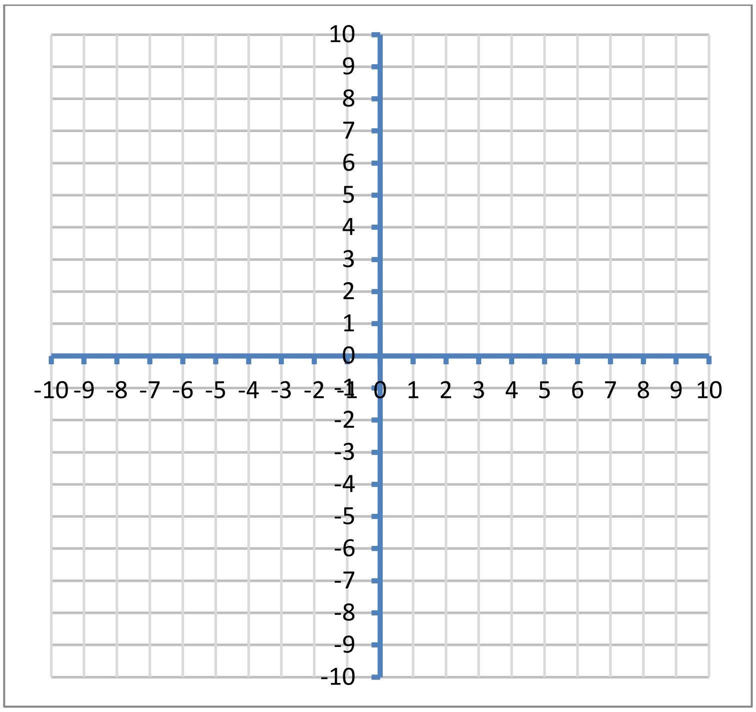
Exercise 1: Solving LP problems graphically (Claassen et al., 2007)

a) Solve graphically, the following LP problem:

$$\max \quad \{w = x_1 + 4x_2\}$$

Subject to:

$$\begin{aligned} x_1 + x_2 &\leq 6 \\ -x_1 &\leq -2 \\ x_2 &\geq 1 \\ x_1, x_2 &\geq 0 \end{aligned}$$



b) Give the shadow price of the constraints

c) Give an objective function that result in alternative optimal solutions.

Exercise 2: A farmer's problem (De Ridder et al., 2006)

Consider a European farmer who specializes in growing grain, potatoes and sugar beet on 10 hectares. During the winter he wants to decide how much land to devote to each crop in order to maximize the total gross margin. The following data are available:

Table 1: Basic data for the farmer's problem

Crop	Labor requirements (hrs/ha)		Gross margin (€/ha)
	Spring	Autumn	
Grain	2	25	4500
Potatoes	24	20	5000
Sugar beet	158	5	6000
Available labor (hrs)	350	150	

Some additional constraints are:

- Grain can be cultivated on at most 1/2 of the total available land.
- Potatoes can be cultivated on at most 1/3 of the total available land.

- Sugar beet can be cultivated on at most 1/4 of the total available land.

a) Formulate the linear programming model of the problem above.
b) Develop and Solve the LP-problem with GAMS
c) Is there a period in which additional (casual) labour at 33 €/hour will be worthwhile? If so determine how much labour the farmer can buy holding out every certainty that each additional hour will raise his annual total gross margin. Adapt the model in such a way that its solution tells you how much labour the farmer should hire. Is renting land a profitable activity (use information from the previous model run)?
d) Suppose the farmer uses for each ha of grain, potatoes and sugar beets 200, 600 and 500 kg fertilizer respectively. The agricultural information service pleads for lower levels of artificial fertilizers. Substantial loss of nitrogen to the ground water would be inevitable. How much fertilizer should the farmer use according to the optimal plan?
e) Now the farmer wants to calculate a new plan in which the total amount of fertilizer is at a minimum level. However the total gross margin should be at least 36000 €. Formulate an appropriate LP-model and solve it with GAMS.
f) Suppose the farmer can get a subsidy of 6000 € for casual labour and/or renting additional land. The yearly land rent is 2000 €/ha while the average wage is 33 €/ha. Can you give an advice to the farmer on how he should spend this subsidy to maximize gross margin? What is the total fertilizer application?
g) Use "$ INCLUDE" statements, to separate the three main sections of the model (i.e. model declarations, model definition, and data initialization).
h) Potatoes and sugar beet require irrigation. Only 5 ha of the available land are irrigated (rented land is not irrigated). Each irrigated crop cannot exceed 2.5 ha. Adapt the model and calculate the new farm plan that maximizes gross margin (you will need to define a subset of irrigated activities).

Exercise 3: Calibrating the farmer's problem

Recent studies showed that, within a certain scenario, the gross margins of grain, potatoes and sugar beet will increase by 45, 20, 25 % respectively, because of expected yield increases and price changes.

a) Assuming that the farmer targets at maximizing gross margin; use the farmProblem1.gms file in the day2\Ex3_Farm_problem folder to simulate farmer's behavior and recover the optimal cropping pattern for the future scenario?
b) It appears that the current observed cropping pattern of the farm is 2.8, 2.5, 1.8 for grain, potatoes and sugar beet respectively (different from what is simulated by the model). What are some possible reasons for these differences?
c) Implement and use standard PMP to calibrate the model to the observed cropping pattern. Use the non-linear model to simulate the behaviour of the farmer in the future scenario. Create a parameter that includes the crop levels in different simulations.

Exercise 4: The farmer's problem in FSSIM 2.0

This exercise is a continuation of the farmer's problem in Exercise 2. One important difference is that activities are now defined as rotations (like they were taken into account in SEAMLESS). Two main rotations can be identified given the rotational constraints and the available crops (i.e. one 3 year rotation and one 4 year rotation). As it has been explained before for a 4 year rotation with different crops, we assume that each crop gets 0.25 ha per ha of activity. As a result, the profit or labour requirements of each activity is the sum of quarters of the crop specific coefficient (e.g. profit of a 4 year rotation = $0.25*Prof_{crop1} + \ldots + 0.25*Prof_{crop4}$. The coefficients of the two available rotations have been calculated in table 2 based on the information of table 1.

Table 2: input – output coefficients of the two rotations for the farmers problem exercise

		Area			
		GRAIN	POTA	SUGB	LEVEL
ROT1	g->p->g	0.667	0.333		*1*
ROT2	g->s->g->p	0.500	0.250	0.250	*1*

		Profit			
		GRAIN	POTA	SUGB	TOTAL
ROT1	g->p->g	3000	1667	0	*4667*
ROT2	g->s->g->p	2250	1250	1500	*5000*

		Labour requirements Spring			
		GRAIN	POTA	SUGB	TOTAL
ROT1	g->p->g	1.333	7.999		*9.333*
ROT2	g->s->g->p	1.000	6.000	39.500	*46.500*

		Labour requirements Autumn			
		GRAIN	POTA	SUGB	TOTAL
ROT1	g->p->g	16.668	6.666		*23.334*
ROT2	g->s->g->p	12.500	5.000	1.250	*18.750*

a) Give an explicit formulation of the model (exercise 2b). Activities are not single crops but rotations (you do not need explicit rotational constraints).

In this exercise we focus on parameterizing the FSSIM model. The files of the FSSIM model that should be used for this exercise are located in ..day2\FSSIM_V2.0_ex4. First, data should be entered in the farmData.mdb file.

b) In the nuts2_region table create a new region by inserting a new id and give a name (choose one that you like)
c) Create a new farm in the farm table. Obligatory fields are the id, the farm type, the code_name, number of farm represented (set equal to 1) and the nuts_region (enter here the id of the region you entered before).
d) In the activity table you can enter the two rotations as separate activities. The activity can be seen also as the decision variable. Enter the rest of the activities.

id	description	motherAct	code_name
1	g->p->g		ROT_GPG

e) In the farm_resource table we should add the right hand sides of the constraints that are used (In the example below you can see how the right hand side of the available land constraint is added. The name field is the one that will be used in GAMS. It is not necessary, but I think it is convenient when all resources start with an "R_". Add the rest of the Right hand sides (resources)

id	name	units	description
1	R_AL	ha	The available land of the farm

f) In the coefficient tables we add all used coefficients i.e. the left hand side vector of the constraint. Below you can find the coefficient level which is used in the available land constraint ($ax \leq AL$). The coefficient is the "a" vector which will be set equal to 1(ha) for both activities (the two rotations) so $1*x_1+1*x_2 \leq AL$. It is not necessary, but I think it is convenient when all coefficients start with a "C_". Add the rest of the coefficients.

id	name	units	type	description
1	C_LEV	ha	General	The level of the activities i.e. 1 ha for all

g) In the constraint table we can create constraints as combinations of a coefficient and a resource. Below the available land constraint. Add the rest of the constraints. Rotational constraints are taken into account implicitly in the definition of the activities so you do not need to include them in the table.

id	c_name	coefficient	resource	sign	description	code_name
1	E_AL	1	1	L	The available land constraint coefficent C_	E_AL

h) Now you should create a new simulation in the simulation table. Give id = 1. The code_name is what is used in GAMS so keep it short (e.g. SIM1). The model field refers to the name of the model used in FSSIM to solve this problem. In this case we will use the basic FSSIM model i.e. "farmModelLP". The model_type is "LP" and the model file is "basicFarmModel.gms".
i) To include a farm in a simulation use the simulation_farm table. Add the farm that you created in the simulation. Use the ids of farms and simulations. Each farm in a specific simulation has access to different resources, different activities and i/o coefficients and different constraints which are specified in the

simulation_farm_resource, simulation_farm_activity_coefficient and simulation_constraint tables respectively.

j) In the simulation_farm_resource table you add data of the resources (right hand sides) for each simulation_farm combination (in this case there is only one combination since we have only one farm in one simulation).

k) In the simulation_farm_activity_coefficient table we enter data on the coefficients of specific activities. At the same time a farm is linked to specific activities. The coefficient for labour requirements in spring of activity 1 (ROT_GPG) for our farm in our simulation will be 9.333 hours/ha. Enter the data for all coefficients of the activities.

l) In the simulation_farm_constraint table, link constraints to farms in specific simulations. Farms can have different constraints in different simulations.

m) In the simulation_farm_weight table we define which indicators (i.e. the total simulated level of a specific coefficient e.g. total gross margin) are included in the objective function and we add a weight. In our case where gross margin is maximized and since we have gross margin as a coefficient we can set the weight of gross margin equal to 1. In case where we had the input and output levels as coefficients the weights would be the actual prices.

n) Use the experimentGenerator form to generate the files for this exercise. Open GAMSIDE, open project ..day2\FSSIM_V2.0_ex4\farmProject.gpr. Open experiment.gms file and run the model. You can find solution of the model in the IO.xls file.

o) What is the optimal gross margin? Which constraints are binding? How many ha of grain, potatoes and wheat is on the optimal solution? How should you adapt the farmData.mdb file so that you can get the simulated area of grain, potatoes and sugar beet as separate indicators.

p) Use the "cloneSimulation" form to create a clone of your first simulation. From the "cloned simulation" drop down list select "SIM1" and in the "code name" text box type "SIM2". You can adapt the description text box if you want. Press "clone simulation" and wait until you get a message box that confirms that the cloning has been succeeded. Click ok to the two message boxes that will pop up. If you check the simulation table you will find a new simulation with code name SIM2. The data of the new simulation is exactly the same with that of SIM1 (base year).

q) Adapt simulation 2 to account for the possibility of hiring labor with a price of 33 €/hour. Use the experimentGenerator form to select both simulations and generate the files. Run the model using GAMSIDE.

r) Monocrop activities (rotations of a single crop) is possible but with a substantial yield reduction. Growing a crop as mono-crop leads to 50% lower profits than when crops are grown in one of the two rotations. Adapt simulation 2 to account for mono-crop activities.

s) Use the standard PMP to calibrate the model to the base year situation. You will need two new simulations for this. Create a clone of "SIM2" (e.g. SIM3) which will be the simulation of the first phase of PMP. You will need to create the calibration constraints. For this you should add the observed crop levels in the "farm_resource" table and the "simulation_farm_resource" table. In the "constraint" table you can link the crop levels coefficient to the observed crop levels and create new constraints. Set the constraints signs as "CLB" to state that those are calibration constraints. Do not forget to link the calibration constraints with simulation 3 in the "simulation_farm_constraint" table. You will also need to adapt the "simulation" table. The model is called "farmModel_Calibr1" and the model file is "plugIns\PMP_standard_Howitt1995\models\model_firPh.gms". Plugin 3 (in the plugin table) should be linked to simulation 3 in the simulation_plugin table. Set pluginResultFile = pmp_std_resRep_firPhase.gms and pluginSpecDatfile = pmp_std_dat_firPhase.gms.

t) Create a new simulation (SIM4) for the second phase of PMP (this can be a clone of simulation 3, but without the calibration constraints). Make the required adaptations. An example of the settings of the simulation table is given below.

codeName	runNow	model	modelType	modelFile
SIM4	☑	farmModel_Calibr2	NLP	plugIns\PMP_standard_Howitt1995\models\model_secPh.gms

The simulation_plugin table for simulation 4 will be the following.

simulation	plugin	pluginResultFile	pluginSpecDatfile
3	3	pmp_std_resRep_firPhase.gms	pmp_std_dat_firPhase.gms
4	3		pmp_std_dat_secPhase.gms

Exercise 5: Assessing the consequences of climate change in Flevoland

Flevoland is a modern agricultural area in the Netherlands. Arable farming on clay soils is the main agricultural activity. Less common are sandy and loamy soils. The main crops in the area are: potatoes (ware and seed), sugar beet, onions, soft wheat and silage maize. The goal of this exercise is to introduce the FSSIM model with a simple experiment focusing on assessing the consequences of climate change on arable farms. For that reason we use information on crop management data that was collected during a survey conducted within the SEAMLESS project (Zander et al., 2009).

Two different arable farm types have been identified in Flevoland (Andersen et al., 2007) that differ from each other mainly on the intensity level (economic output/ha). The average available resources for the two different farm types are presented in Table 3. Some crop specific management data is presented in Table 4. The crops are grown in rotations. The most common current rotations are presented in Appendix 2.

In our exercise, an arable agricultural activity is defined as a rotation (crop sequence) grown on a specific soil type (i.e. clay, sand or loam). All rotations can grow on all soil types and all crops of a rotation are assumed to grow on the same soil type. To account for possible interactions between crops in time and space we assume that the share of each crop in the rotation is equal to the area of the activity (1ha) divided by the number of periods. In a four year rotation with different crops each crop gets 0.25 ha of crop / ha of activity. If a crop occurs 2 times in a four year rotation then it gets 0.5 ha /ha of activity. The example of a four year rotation is presented in Figure 1 (different colour corresponds to different crop) and has been discussed in a previous presentation.

Table 3: Available farm resources and observed cropping patterns

Intensity level of the farm :	Medium intensity FT_3203	High intensity FT_3303
Available land clay (ha)	47.3	49.9
Available land sand (ha)	6.9	6.4
Available land loam (ha)	1.2	1.2
Available family labour (ha)	2899	3812
Sugar beet quota (tons)	770	508
Observed cropping pattern (ha)		
Onion	4	13
Potatoe ware	15	10
Potatoe seed	10	12
Soft wheat	6	6
winter wheat	6	6
Silage maize	1	1
Sugar beet	12	8
Setaside	1.5	1.5
Total area	55.5	57.5

Table 4: Crop specific information on important management data (Zander et al., 2009)

		Production (tons/ha)	Crop protection (€/ha)	Labour requir. (hrs/ha)	Nitrogen use (kg N/ha)	Phosphate use (kg P/ha)	Potassium use (kg K/ha)	Other input (€/ha)
Crop	**Soil type**	**C_PRD_CROP**	**C_CRPR**	**C_LABR**	**C_NITR**	**C_PHOS**	**C_KALI**	**C_OINP**
Onions	CLAY	58.4	580	37.6	220	52	105	1517
	LOAM	52.4	580	37.6	220	52	105	1517
	SAND	46.4	619	37.9	220	52	100	1399
Potatoe ware	CLAY	56.8	519	27.5	255	52	105	1263
	LOAM	53.4	519	27.5	255	52	105	1263
	SAND	50	539	25.8	255	9	120	1245
Potatoe seed	CLAY	38.7	1181	90	180	52	105	2194
	LOAM	30.3	1181	90	180	52	105	2194
	SAND	21.9	809	71	180	52	120	1484
Sugar beet	CLAY	65.5	125	19.6	170	35	35	942
	LOAM	58.25	125	19.6	170	35	35	942
	SAND	51	197	17.8	170	39	120	942
Maize silage	CLAY	40.8	82	7.1	185	52	45	914
	LOAM	40.05	82	7.1	185	52	45	914
	SAND	39.3	86	5.6	185	52	75	941
Soft wheat	CLAY	7.8	194	9.6	175			255
	LOAM	7.1	194	9.6	175			255
	SAND	6.4	134	8.5	175	4	75	288
Winter wheat	CLAY	8.7	152	10.4	205			259
	LOAM	8.1	152	10.4	205			259
	SAND	7.8	241	9.6	165	9	80	277

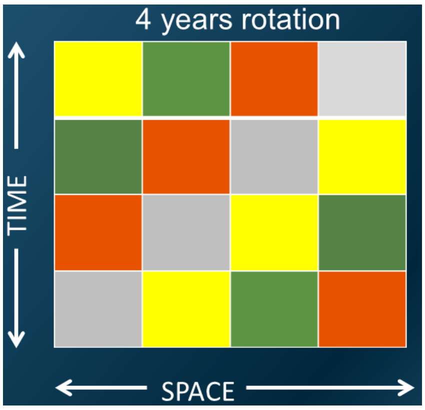


Figure 1: Representation of a 4 year rotation in time and space.

Arable farmers in Flevoland maximize the total gross margin subject to a set of resource and policy constraints.

a) Which constraints have been included in the base year simulation? You can find this information using the P_SF_LCR and P_SF_GCR queries or the simulation_farm_constraint table in the farmData.mdb file.
b) The labour constraint is now a "hard" constraint implying that the total labour requirements cannot exceed the available family labour. However, hired labour is possible in the region (wage 11.5 €/ha). Adapt the labour constraints in a way that hired labour is also allowed.
c) Hired labour cannot exceed 1000 hours/year because of labour availability. Construct and include this constraint in the model specification of the base year simulation (use the C_HLABR1 coefficient).
d) In Flevoland, there is a quota on sugar beet production. You can find the sugar beet quota of each farm type in Table 3. Sugar beet quota can be exceeded but the farmers receive no compensation for exceeding quantities. Create and include the sugar beet quota constraint in the base year simulation (SIM1).
e) Run the model through GAMS-IDE and the Experiment.gms file. What is the simulated gross margin and cropping pattern of the two farms? How much labour is hired? What are the main limiting resources? Is sugar beet quota a binding constraint?
f) Farmers in Flevoland often rent land and grow mono-crop activities (i.e. one year rotations of a single crop). Use the information on Table 4 to create those mono-crop activities and insert them in the farmData.mdb file. You will have a new activity for each combination of crop and soil type. Insert relevant coefficients in the simulation_farm_activity_coefficient table. Do not forget the C_LEV, C_LEVcly, C_LEVlom, C_LEVsnd, C_SUBS, C_PRD_crop and C_ARE_crop coefficients. Mono-crop activities can only grow on rented land so there is an additional cost of 500€ per ha of mono-crop activities. The level of mono-crop activities cannot exceed 50% of the total available land. Adapt the model to account for these additional costs and the 50% restriction on the simulated level of mono-crop activities.
g) The observed cropping patterns (Table 3) are different from the simulated activity levels. This is mainly due to additional non-linear costs related to limited capacity for management and machinery use. Use the standard PMP plugin to recover a non-linear objective function and calibrate the model to the observed activity levels. You will have to create two new simulations using the cloneSimulation form (see exercise 4, sub-questions s and t).

In 2050, because of the climate change (higher temperatures, longer growing periods and increased concentration of CO2 in the atmosphere), it is expected that crop yields will increase, new crops (and consequently activities) will become available to farmers and as a result prices of inputs and outputs will change.

Table 5: Expected changes of yield and fertilizer inputs due to climate change in 2050

	Yield change (%)	Fertilizer change (%)	Price change (%)
Spring soft wheat	14	17	50
Winter soft wheat	14	17	50
Potatoes ware	7	9	20
Potatoes seed	7	9	15
Sugar beet	30	37	18
Onions	20	25	22
Silage maize	14	17	20

h) Create a new simulation that is a clone of SIM3 (second phase PMP) using the cloneSimulation form (name the new simulation as SIM4). To assess the consequences of yield changes due to climate change we will adapt the coefficients of crop production for simulation 4 according to the expected yield changes for 2050 (Table 5). You can do this by using the "adaptCoefficient" form. Select coefficients and the corresponding factor of change. For example to adapt the yield of wheat you will select the C_PRD_SWHE coefficient and you will set a factor of 1.14 (since according to Table 5 the yield of wheat increases by 14%). You can select and add all crops and expected yield changes in the list. In the "Applied in Simulation" drop down list select SIM4.

i) Increased yields will result in increased requirements of N fertilizers. The nitrogen use in 2050 is already included in the database as a different coefficient (C_NITR50). You only need to add the N requirements for the mono-crop activities that you have added previously. Adapt the model to account for costs of fertilizers in 2050 (and not base year) (use information from Tables 4 and 5).

j) Create a new simulation (as a clone of Simulation 4), to assess the effect of expected price changes. Adapt output prices according to Table 5 (price of other outputs increases by 20%) and assume that input prices will also increase by 40%.

k) What is the effect of 20% more available land? Use the "adaptResource" form.

l) What are the effects of abolishing sugar beet and set-aside policy?

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Appendix I

Exercise 6: another exercise of LP formulation (De Ridder et al., 2006)

A farmer owns four pieces of land (a,b,c,d) for growing three crops (P,Q,R). the pieces of land do not have equal fertility, which results in differences in quantity and quality in the harvested amount of crops per piece of land. On every piece of land more crops can be grown at the same time. The relevant data are given in the following table:

		quantity			quality		
Piece of land	Size in ha	Yield (in tons/ha)			Selling price (in $/kg)		
		P	Q	R	P	Q	R
a	2	1.7	1.4	0.9	1.6	1.2	1.8
b	1.5	1.6	1.7	1.2	1.4	1.3	2.0
c	1.2	1.3	1.2	0.8	1.7	1.0	2.0
d	2.6	1.0	1.1	0.6	1.2	1.1	1.7
Minimum per year (in tons)		1.9	1.6	1.3			
Maximum per year (in tons)		7.3	6.8	5.7			

The farmer wants to maximize total sales. Formulate this problem as an LP problem.

Exercise 7: another exercise of LP formulation (Claassen et al., 2007)

A supermarket chain has two distribution centers (DC's).
In DC-A 5000 units of a product are stored.
In DC-B 7000 units of a product are stored.
The two DCs deliver the products to 4 shops. Relevant data are given in the table:

	1	**2**	**3**	**4**
A	25	40	55	90
B	75	15	60	30
Demand	2500	1500	2000	4000

For example, the demand of shop 1 is 2500 units and the transportation costs per unit of product from DC-A to store 1 is 25 € etc. The supermarket chain wants to minimize the total transportation costs. The demand should be delivered and the stock of the distribution centers should be taken into account. Formulate the LP model of this problem.

Exercise 8: A blending problem (Claassen et al., 2007)

A refinery purchases three types of gasoline and blends them into two types of fuel. The blending process causes no losses.

Gasoline	Octane number	Available number of barrels	Cost-price per barrel
1	78	5000	5.75€
2	86	7500	7.45€
3	96	6300	9.95€

Fuel	Minimum octane number	Selling price per barrel	Demand
A	92	25.15€	At most 10000 barrels
B	85	15.75€	At least 12000 barrels

Gasoline that is not used to make fuel is sold without further blending for 10.25 € per barrel if the octane number is <90 or for 12.25 per barrel if the octane number is ≥90. Give an LP-formulation of the problem if the refinery is maximizing profit.

Appendix II

Current rotations in Flevoland					
Period 1	**Period 2**	**Period 3**	**Period 4**	**Period 5**	**Period 6**
winter soft wheat	potatoes ware	spring soft wheat			
winter soft wheat	potatoes seed	spring soft wheat			
winter soft wheat	potatoes ware	sugar beet	spring soft wheat	onion	fodder maize
winter soft wheat	potatoes seed	sugar beet	spring soft wheat	onion	fodder maize
winter soft wheat	potatoes seed	sugar beet	spring soft wheat		
winter soft wheat	potatoes seed	spring soft wheat	sugar beet		
winter soft wheat	potatoes ware	spring soft wheat	sugar beet		
winter soft wheat	potatoes ware	sugar beet	spring soft wheat		
winter soft wheat	potatoes ware	sugar beet	fodder maize		
winter soft wheat	potatoes seed	sugar beet	fodder maize		
winter soft wheat	potatoes ware	sugar beet	spring soft wheat	onion	sugar beet
winter soft wheat	potatoes seed	sugar beet	spring soft wheat	onion	sugar beet
winter soft wheat	sugar beet	potatoes ware	spring soft wheat	onion	potatoes ware
winter soft wheat	sugar beet	potatoes seed	spring soft wheat	onion	potatoes seed
winter soft wheat	sugar beet	potatoes seed	spring soft wheat	onion	potatoes ware
winter soft wheat	sugar beet	potatoes ware	spring soft wheat	onion	potatoes seed
winter soft wheat	potatoes ware	winter soft wheat	sugar beet		
winter soft wheat	potatoes seed	winter soft wheat	sugar beet		
winter soft wheat	potatoes ware	sugar beet	fodder maize	onion	sugar beet
winter soft wheat	potatoes seed	sugar beet	fodder maize	onion	sugar beet
winter soft wheat	sugar beet	potatoes ware	fodder maize	onion	potatoes ware
winter soft wheat	sugar beet	potatoes seed	fodder maize	onion	potatoes seed
winter soft wheat	sugar beet	potatoes seed	fodder maize	onion	potatoes ware
winter soft wheat	sugar beet	potatoes ware	fodder maize	onion	potatoes seed