Example of fields in different crop rotation cycles: Different crops on one farm as part of crop rotations. In the front field, the "Norfolk" crop rotation sequence (potatoes, oats, peas, rye) is being applied; in the back field, rye has been grown for 58 years in a row. (Lesław Zimny)

Common Agricultural Policy (CAP) agri-environment-climate measure: Rotation program (Luxembourg)

AUK-Fruchtfolgeprogramm

DESCRIPTION

Rotation program: Diverse rotation of at least five crops on farm level for more biodiversity and less intensive cultivation practice

The Common Agricultural Policy (CAP) agri-environment-climate measure aims to increase diversification of arable crops to overcome negative impacts of monocultures. The technology described here focuses on the benefit of the rotation programme focusing on 5-year rotation cycles (although CAP aid is only paid with at least 5 different crops planted in any given year). The program applies to all arable crops on the farm, with the exception of permanent or temporary meadows and pastures.

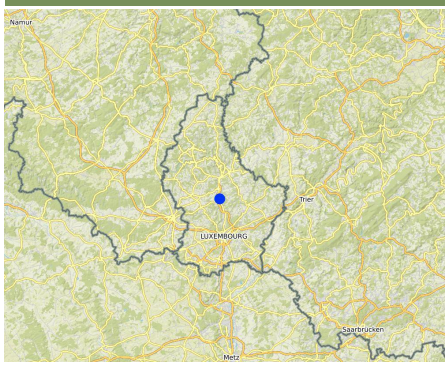
The allocation of the CAP aid is subject to compliance with the following conditions:
At least five different arable crops must be grown during a crop year (as part of the crop rotation programme)
The minimum area per crop shall not be less than 10 per cent of the total area of arable crops on the farm
The share of maize cannot exceed 30 percent
The same crop cannot be grown more than twice on the same field during the commitment period (5 years)
The conversion of permanent pastures and pasture to arable land is forbidden on the whole farm area

The annual aid per hectare is:
- 100€ if total surface of arable land on the farm is less than 50 hectares
- 75€ if total surface of arable land on the farm is between 50 and 100 hectares
- 60€ if total surface of arable land on the farm is above 100 hectares.

Utilised agricultural area (UAA) in Luxembourg is composed to >50% of permanent grassland (due to pedologic and topographic reasons); more than 70% of UAA is used for fodder production. The fodder is used in cattle production (mainly dairy cows). In the past years the arable production concentrated very much on maize (=>easy and reliable fodder plant) and winter wheat (=> good economic results). On many farms, the rotation degrades to a 2 years rotation: maize – wheat, maize – wheat, ... with negative impacts on the soil, problematic weeds, high inputs (fertilisers, pesticides, ...). The aim of the CAP agri-environment-climate measure: Rotation program was to reverse this tendency and to give incentives to bring farmers back to longer rotations (at least 5 years). On a short perspective these are less profitable (and have to be financially compensated) but on a long-term view they have many ecological (and economic) benefits. The EFFO-Project (Effizienz durch Fortbildung = Efficiency by Edification) is a demonstration project, run on three pilot farms showing the advantages and practicability of longer rotations and helping thus to implement these in practice.

Benefits of the CAP rotation program:
- reduced land degradation and increased soil health by reduction of soil erosion
- conservation of ecosystems
- protection of water courses and therewith increasing water availability and quality

LOCATION



Location: Arable land, Entire country, Luxembourg

No. of Technology sites analysed: 100-1000 sites

Geo-reference of selected sites
- 6.10362, 49.76253
- 6.10362, 49.76253

Spread of the Technology: evenly spread over an area (70060000.0 km²)

In a permanently protected area?: No

Date of implementation: 2014; less than 10 years ago (recently)

Type of introduction
- through land users' innovation
- as part of a traditional system (> 50 years)
- during experiments/ research
- through projects/ external interventions
- ☑ CAP

- increased (bio)diversity by increasing plant and associated fauna diversity
- reduced disaster risks (rainstorms, heatwaves, droughts) due to higher plant diversity and thus increased resilience
- increased crop and fodder quality

Strengths of the technology according to the users:
- higher resilience of the cropping system
- advantage of receiving CAP payments
- positive impact on soil structure and (bio) diversity
- positive impact on (drinking) water quantity and quality

Disadvantages of the technology:
- increased administrative burden
- increased planning of crop rotations needed (more complicated to organise)

The compilation of this SLM is a part of the European Interreg project FABulous Farmers which aims to reduce the reliance on external inputs by encouraging the use of methods and interventions that increase the farm's Functional AgroBiodiversity (FAB). Visit www.fabulousfarmers.eu and www.nweurope.eu/Fabulous-Farmers for more information.

Maize monoculture (Flambo)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose
- ☐ improve production
- ☑ reduce, prevent, restore land degradation
- ☑ conserve ecosystem
- ☑ protect a watershed/ downstream areas – in combination with other Technologies
- ☑ preserve/ improve biodiversity
- ☑ reduce risk of disasters
- ☐ adapt to climate change/ extremes and its impacts
- ☐ mitigate climate change and its impacts
- ☐ create beneficial economic impact
- ☐ create beneficial social impact

Land use

Land use mixed within the same land unit: No

Cropland
- Annual cropping: cereals - barley, cereals - maize, cereals - wheat (winter), fibre crops - flax, hemp, other, legumes and pulses - peas

Number of growing seasons per year: 1
Is intercropping practiced? Yes
Is crop rotation practiced? Yes

Water supply
- ☑ rainfed
- ☐ mixed rainfed-irrigated
- ☐ full irrigation

Purpose related to land degradation
- ☑ prevent land degradation
- ☑ reduce land degradation
- ☐ restore/ rehabilitate severely degraded land
- ☐ adapt to land degradation
- ☐ not applicable

Degradation addressed

soil erosion by water - Wt: loss of topsoil/ surface erosion

biological degradation - Bc: reduction of vegetation cover, Bh: loss of habitats, Bq: quantity/ biomass decline, Bl: loss of soil life, Bp: increase of pests/ diseases, loss of predators

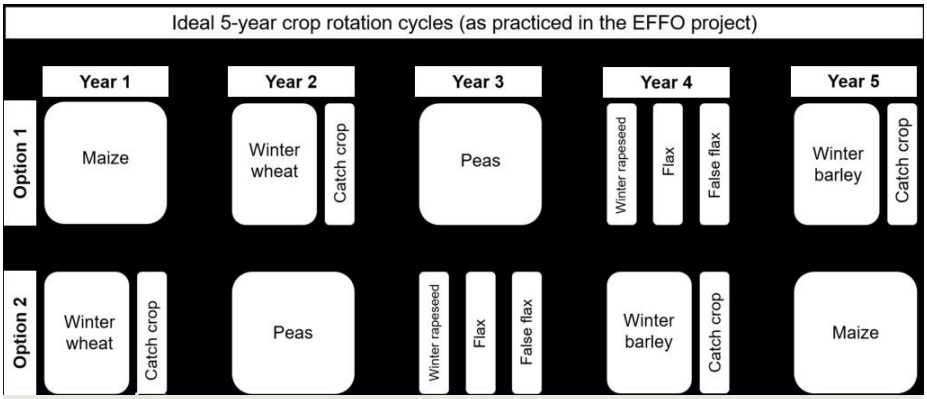
SLM group
- rotational systems (crop rotation, fallows, shifting cultivation)
- ecosystem-based disaster risk reduction

SLM measures

agronomic measures - A1: Vegetation/ soil cover

TECHNICAL DRAWING

Technical specifications
Across Luxembourg, sizes of fields and farms vary. Ideal 5-year crop rotation cycles are suggested as part of the EFFO project to maximise benefits of the crop rotations.



Author: EFFO project

https://www.list.lu/en/research/project/effo

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs
- Costs are calculated: per Technology area (size and area unit: **7006 ha**)
- Currency used for cost calculation: **€**
- Exchange rate (to USD): 1 USD = 0.91 €
- Average wage cost of hired labour per day: n.a

Most important factors affecting the costs
Yields, market prices, logistical difficulties

Establishment activities
1. change from a two years rotation (wheat-maize) to a diverse five years rotation (Timing/ frequency: annually)

Establishment inputs and costs (per 7006 ha)

Specify input	Unit	Quantity	Costs per Unit (€)	Total costs per input (€)	% of costs borne by land users
Labour					
laber total		1.0	69.0	69.0	
Plant material					
seeds		1.0	130.0	130.0	100.0
Fertilizers and biocides					
Fertilizer		1.0	164.0	164.0	
Herbizide		1.0	145.0	145.0	
Other					
additional		1.0	37.0	37.0	
Total costs for establishment of the Technology				**545.0**	
Total costs for establishment of the Technology in USD				*598.9*	

Maintenance activities
n.a.

NATURAL ENVIRONMENT

Average annual rainfall
- ☐ < 250 mm
- ☐ 251-500 mm
- ☑ 501-750 mm
- ☑ 751-1,000 mm
- ☐ 1,001-1,500 mm
- ☐ 1,501-2,000 mm
- ☐ 2,001-3,000 mm
- ☐ 3,001-4,000 mm
- ☐ > 4,000 mm

Agro-climatic zone
- ☑ humid
- ☑ sub-humid
- ☐ semi-arid
- ☐ arid

Specifications on climate
In the last years extreme weather conditions (rainfall, drought, ...) are happening more and more often.
Healthy soils (on the basis of large rotations) are more resilient towards these extreme weather situations.

Slope
- ☐ flat (0-2%)
- ☑ gentle (3-5%)
- ☑ moderate (6-10%)
- ☐ rolling (11-15%)
- ☐ hilly (16-30%)

Landforms
- ☑ plateau/plains
- ☐ ridges
- ☐ mountain slopes
- ☐ hill slopes
- ☐ footslopes

Altitude
- ☐ 0-100 m a.s.l.
- ☑ 101-500 m a.s.l.
- ☐ 501-1,000 m a.s.l.
- ☐ 1,001-1,500 m a.s.l.
- ☐ 1,501-2,000 m a.s.l.

Technology is applied in
- ☐ convex situations
- ☐ concave situations
- ☑ not relevant

- [ ] steep (31-60%)
- [ ] very steep (>60%)

- [ ] valley floors

- [ ] 2,001-2,500 m a.s.l.
- [ ] 2,501-3,000 m a.s.l.
- [ ] 3,001-4,000 m a.s.l.
- [ ] > 4,000 m a.s.l.

Soil depth
- [x] very shallow (0-20 cm)
- [x] shallow (21-50 cm)
- [ ] moderately deep (51-80 cm)
- [ ] deep (81-120 cm)
- [ ] very deep (> 120 cm)

Soil texture (topsoil)
- [x] coarse/ light (sandy)
- [x] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Soil texture (> 20 cm below surface)
- [x] coarse/ light (sandy)
- [x] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Topsoil organic matter content
- [ ] high (>3%)
- [x] medium (1-3%)
- [ ] low (<1%)

Groundwater table
- [ ] on surface
- [ ] < 5 m
- [x] 5-50 m
- [ ] > 50 m

Availability of surface water
- [ ] excess
- [x] good
- [ ] medium
- [ ] poor/ none

Water quality (untreated)
- [x] good drinking water
- [ ] poor drinking water (treatment required)
- [ ] for agricultural use only (irrigation)
- [ ] unusable

Water quality refers to: ground water

Is salinity a problem?
- [ ] Yes
- [x] No

Occurrence of flooding
- [ ] Yes
- [x] No

Species diversity
- [ ] high
- [ ] medium
- [x] low

Habitat diversity
- [ ] high
- [ ] medium
- [x] low

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- [ ] subsistence (self-supply)
- [ ] mixed (subsistence/ commercial)
- [x] commercial/ market

Off-farm income
- [x] less than 10% of all income
- [ ] 10-50% of all income
- [ ] > 50% of all income

Relative level of wealth
- [ ] very poor
- [ ] poor
- [ ] average
- [x] rich
- [x] very rich

Level of mechanization
- [ ] manual work
- [ ] animal traction
- [x] mechanized/ motorized

Sedentary or nomadic
- [x] Sedentary
- [ ] Semi-nomadic
- [ ] Nomadic

Individuals or groups
- [x] individual/ household
- [ ] groups/ community
- [ ] cooperative
- [ ] employee (company, government)

Gender
- [ ] women
- [ ] men

Age
- [ ] children
- [ ] youth
- [x] middle-aged
- [ ] elderly

Area used per household
- [ ] < 0.5 ha
- [ ] 0.5-1 ha
- [ ] 1-2 ha
- [ ] 2-5 ha
- [ ] 5-15 ha
- [ ] 15-50 ha
- [x] 50-100 ha
- [x] 100-500 ha
- [ ] 500-1,000 ha
- [ ] 1,000-10,000 ha
- [ ] > 10,000 ha

Scale
- [ ] small-scale
- [x] medium-scale
- [ ] large-scale

Land ownership
- [ ] state
- [ ] company
- [ ] communal/ village
- [ ] group
- [x] individual, not titled
- [ ] individual, titled

Land use rights
- [ ] open access (unorganized)
- [ ] communal (organized)
- [ ] leased
- [x] individual

Water use rights
- [ ] open access (unorganized)
- [x] communal (organized)
- [ ] leased
- [ ] individual

Access to services and infrastructure

health	poor	✓ good
education	poor	✓ good
technical assistance	poor	✓ good
employment (e.g. off-farm)	poor	✓ good
markets	poor	✓ good
energy	poor	✓ good
roads and transport	poor	✓ good
drinking water and sanitation	poor	✓ good
financial services	poor	✓ good

IMPACTS

Socio-economic impacts

crop quality	decreased	✓ increased
fodder quality	decreased	✓ increased
risk of production failure	increased	✓ decreased
product diversity	decreased	✓ increased
drinking water availability	decreased	✓ increased
drinking water quality	decreased	✓ increased
water availability for livestock	decreased	✓ increased
water quality for livestock	decreased	✓ increased
expenses on agricultural	increased	✓ decreased

inputs			also through CAP subsidies
farm income	decreased	increased	
workload	increased	decreased	also through CAP subsidies

Socio-cultural impacts

food security/ self-sufficiency	reduced	improved
health situation	worsened	improved
cultural opportunities (eg spiritual, aesthetic, others)	reduced	improved
recreational opportunities	reduced	improved
SLM/ land degradation knowledge	reduced	improved

Ecological impacts

water quantity	decreased	increased
water quality	decreased	increased
harvesting/ collection of water (runoff, dew, snow, etc)	reduced	improved
surface runoff	increased	decreased
excess water drainage	reduced	improved
groundwater table/ aquifer	lowered	recharge
evaporation	increased	decreased
soil moisture	decreased	increased
soil loss	increased	decreased
soil compaction	increased	reduced
nutrient cycling/ recharge	decreased	increased
soil organic matter/ below ground C	decreased	increased
plant diversity	decreased	increased
beneficial species (predators, earthworms, pollinators)	decreased	increased
habitat diversity	decreased	increased
pest/ disease control	decreased	increased
flood impacts	increased	decreased
drought impacts	increased	decreased
emission of carbon and greenhouse gases	increased	decreased
micro-climate	worsened	improved

Off-site impacts

water availability (groundwater, springs)	decreased	increased
reliable and stable stream flows in dry season (incl. low flows)	reduced	increased
groundwater/ river pollution	increased	reduced
buffering/ filtering capacity (by soil, vegetation, wetlands)	reduced	improved
damage on public/ private infrastructure	increased	reduced

COST-BENEFIT ANALYSIS

Benefits compared with establishment costs

Short-term returns	very negative	very positive
Long-term returns	very negative	very positive

Benefits compared with maintenance costs

Short-term returns	very negative	very positive
Long-term returns	very negative	very positive

CLIMATE CHANGE

Gradual climate change

annual temperature increase	not well at all	very well	
seasonal temperature increase	not well at all	very well	Season: winter
seasonal temperature increase	not well at all	very well	Season: spring
seasonal temperature increase	not well at all	very well	Season: summer
seasonal temperature increase	not well at all	very well	Season: autumn
seasonal rainfall decrease	not well at all	very well	Season: winter
seasonal rainfall decrease	not well at all	very well	Season: spring
seasonal rainfall decrease	not well at all	very well	Season: summer
seasonal rainfall decrease	not well at all	very well	Season: autumn

Climate-related extremes (disasters)

local rainstorm	not well at all	✓ very well
heatwave	not well at all	✓ very well
drought	not well at all	✓ very well
general (river) flood	not well at all	✓ very well

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- single cases/ experimental
- 1-10%
- ✓ 11-50%
- > 50%

Of all those who have adopted the Technology, how many have done so without receiving material incentives?

- ✓ 0-10%
- 11-50%
- 51-90%
- 91-100%

Has the Technology been modified recently to adapt to changing conditions?

- Yes
- ✓ No

To which changing conditions?

- climatic change/ extremes
- changing markets
- labour availability (e.g. due to migration)

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- More resilient cropping system
- Possibility to receive CAP-payments
- Positive impact on soil structure + life

Strengths: compiler's or other key resource person's view

- More resilient cropping system
- Positive impacts on (drinking) water production + quality

Weaknesses/ disadvantages/ risks: land user's view → how to overcome

- administrative burden → unknown
- more complicated to organise because more crops need to be handled → unknown/more practice with time

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's view → how to overcome

- higher percentage of participating farmers → unknown

REFERENCES

Compiler
Sabine Reinsch

Reviewer
Rima Mekdaschi Studer

Date of documentation: Oct. 8, 2019

Last update: Feb. 10, 2020

Resource persons
Gérard Conter - co-compiler
Frank Richarz - SLM specialist
Gilles Altmann - SLM specialist

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_5617/

Linked SLM data
n.a.

Documentation was faciliated by
Institution

- UK Centre for Ecology & Hydrology (CEH) - United Kingdom

Project

- European Interreg project FABulous Farmers

Links to relevant information which is available online

- Homepage Chamber of agriculture: https://www.lwk.lu/pflanzenbauberatung/effo-effiziente-fruchtfolgen-und-wasserschutz
- Homepage LTA: https://www.lta.lu/effo.html
- Homepage LIST: https://www.list.lu/en/research/project/effo/
- Homepage Ministry of agriculture: https://agriculture.public.lu/de/beihilfen/agrar-klima-umwelt/agrar-umwelt-klimamassnahmen/fruchtfolgeprogramm.html