The Samothraki Seeding Project 2016-2017

INTRODUCTION

In September 2015, we were invited as consultants of Terraprima Environmental Services to participate in a project on the Greek island of Samothraki, led by Marina Fischer-Kowalski from the Institute of Social Ecology of Vienna. This project aims to:

- establish, in Samothraki, a series of trials with sown biodiverse pastures in various places, using different seed mixtures;
- observe and monitor the establishment and development of these mixtures, species and forage varieties in Samothraki;
- transfer knowledge, involving local technicians and farmers, regarding the practices and methodologies associated with the seeding and management of sown biodiverse pastures;

The island of Samothraki is located in the north-eastern point of the Aegean Sea, close to Turkey. The island's principal economic activities are tourism (resident population <3000 inhabitants, which grows substantially in summer), fishing and agriculture. Following the municipality's territorial plan, we can divide the island in: (1) forests, woods and wooded vegetation, (2) forests with agricultural use, (3) agricultural lands, and (4) rocky surfaces.

Agriculture in Samothraki, mainly subsistence farming dependent on subsidies, consists of monoculture cereal production, traditional olive growing, and livestock farming for meat and milk (both sheep and goat). Farm size is limited and the same proprietary owns various land parcels, which makes resource management difficult. In addition, and due to the island's isolation, production costs are higher as compared to the mainland, which also hinders the flow of goods and reduces competitiveness in the global market.

Cereals (mainly oats, barley and wheat) are predominantly sown in the west/south-west of the island. The deep, clayey soils are highly fertile, and have great productive potential. In some irrigated areas, alfalfa (*Medicago sativa*) and corn are sown.

Between the oak and plane forests, there are olive groves, with large old trees. The oliviculture, more concentrated in the south of the island, is traditional and family-run, giving rise to olives and olive oils of high quality, mostly produced without agrochemicals and via artisanal practices passed down through the generations.

Animal husbandry, whilst distributed throughout the island, is concentrated in the north, where the greatest concentration of animals, particularly goats, are found and where potential silvo-pastoral grounds are considerable. Although these pastures belong to families, herding these areas is done in a communal manner, given that there are practically no fences, stables, shelters or shepherds to accompany the flocks/tribes.

The mountainous areas are remarkably steep, accentuating the erosive processes. They are mainly grazed by goats, which have contributed negatively to erosion, due to their high grazing pressure (consequence of EU incentives). This hampers the establishment and development of shrub or trees, which would otherwise minimize the erosive effect of the seasonal heavy rains.

MATERIAL AND METHODS

To demonstrate the applicability of the concept of sown biodiverse pastures on the island of Samothraki, several farmers and several sites were selected to test different forage mixtures, linked to the concept of biodiversity and supported by the high presence of legumes in the seed mixtures.

In 2016, we assessed the different soil and climatic characteristics of the island, such as annual precipitation, soil pH, % organic matter and soil nutrients (e.g. P, K and Mg), in order to select the appropriate mixtures, species and varieties to be sown.

Two types of mixtures were chosen, annual and permanent mixtures. Within each of these types several compositions were selected:

Annual mixture	Permanent mixture
1. Speedmix AC	1. AC 500
2. Speedmix NEU	2. NEU 550
3. Fertifeno NEU	3. AL 550
4. Avex NEU	

Composition of the annual mixtures:

1. **Speedmix AC:** *Lolium multiflorum*, *Trifolium balansae*, *Trifolium resupinatum* and *Trifolium vesiculosum*;
2. **Speedmix NEU:** *Lolium multiflorum*, *Trifolium balansae*, *Trifolium resupinatum*, *Trifolium vesiculosum* and *Trifolium alexandrinum*;
3. **Fertifeno NEU:** *Lolium multiflorum*, *Vicia villosa*, *Vicia sativa*, *Trifolium resupinatum*, *Trifolium vesiculosum*, *Trifolium squarrosum* and *Trifolium alexandrinum*;
4. **Avex NEU:** *Lolium multiflorum*, *Avena strigosa*, *Vicia villosa*, *Vicia sativa*, *Trifolium resupinatum*, *Trifolium vesiculosum*, *Trifolium squarrosum* and *Trifolium alexandrinum*;

Composition of the permanent mixtures:

1. **AC 500:** *Dactylis glomerata*, *Lolium multiflorum*, *Ornithopus sativus Trifolium subterraneum*, *Trifolium balansae*, *Trifolium resupinatum*, *Trifolium incarnatum*, *Trifolium Isthmocarpum* and *Trifolium vesiculosum*;
2. **NEU 550:** *Dactylis glomerata*, *Lolium multiflorum*, *Trifolium subterraneum*, *Trifolium balansae*, *Trifolium resupinatum*, *Trifolium Isthmocarpum*, *Trifolium vesiculosum*, *Medicago truncantula*, *Onobrychis vicifolia* and *Hedysarum coronarium*;
3. **AL 550:** *Dactylis glomerata*, *Lolium multiflorum*, *Trifolium subterraneum*, *Trifolium balansae*, *Trifolium resupinatum*, *Trifolium Isthmocarpum*, *Trifolium vesiculosum*, *Medicago truncantula*, *Onobrychis vicifolia* and *Hedysarum coronarium*;

Note: the reference AC corresponds to acidic soils, the reference NEU to neutral soils and AL to alkaline soils. The numeric reference corresponds to the annual average precipitation for which the mixture is designed, with its respective error margin.

In December 2016 and May 2017, António Martelo visited the island for visual assessment of the parcels. In addition, in May 2017, a detailed quantitative assessment of the effects of

implementing sown biodiverse pastures on aboveground productivity and species composition took place, with this work being done by Marjan Jongen.

- In each parcel, observations along 200 m line transects were made, using the step-point method (at intervals of 1 m), giving measurements of cover for individual species, total cover, and species composition by cover. Collected data will enable calculation of diversity (species richness, Shannon-Wiener diversity index, Simpson´s diversity index, Evenness) and similarity indexes (comparison of species similarity between sown and natural parcels, through calculation of the Renkonen similarity index).
- In each parcel, aboveground productivity was assessed, by harvesting all plant material in three replicate 40x40 cm quadrats. Harvested plant material was sorted into the individual species. Harvested material will be analysed for crude protein and crude fiber, enabling assessment nutritive value and feeding units.
- In each parcel soil sampling took place, for determination of soil texture, soil organic matter and other relevant components, by taking multiple soil cores to a depth of 20 cm.

Overview parcels:

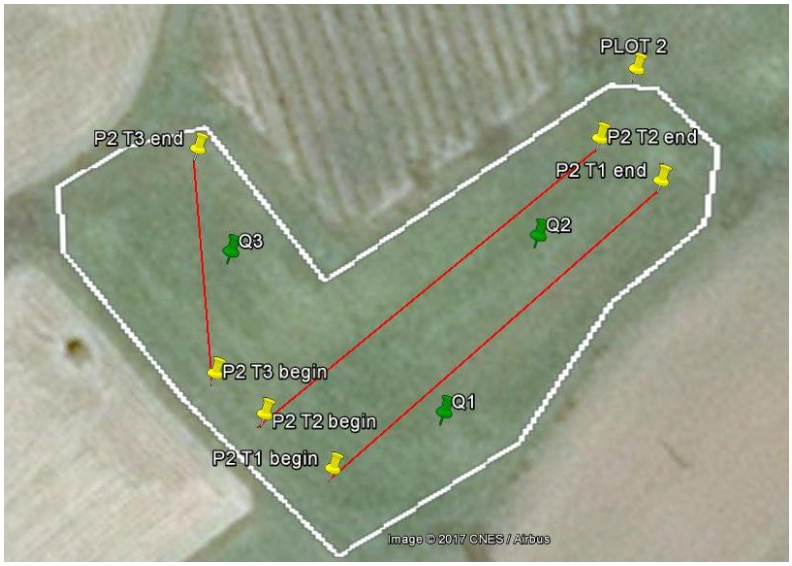
Plot number	Owner	Location	Size (ha)	Annual or permanent pasture
2	K. Chrysostomos	Ag. Georgios	0.7	Annual
4A	V. Panagiotis	1 km W of Makrylies	0.2	Annual
4B	V. Panagiotis	1 km W of Makrylies	0.4	Permanent
4C	V. Panagiotis	1 km W of Makrylies	0.4	Permanent
5	A. Mathios	2 km SE of Kamariotissa	0.5	Annual
6	K. Kostas	1 km SE of Dhaphnes	0.5	Permanent
7	K. Chrysostomos	Megalo Vouni	0.5	Annual
8	G.Nikos	1 km SE of Kamariotissa	1.0	Permanent
9	K. Chrysostomos	Ag. Georgios	0.4	Permanent
10	G. Nikos	1 km W of Makrylies	0.8	Annual
11	C.Panagiotis	Agistros	0.5	Permanent
12	F. Giannis	Ano Meria	1.0	Permanent
13	F. Giannis	1 km E of Kamariotissa	0.4	Annual

SOWN BIODIVERSE ANNUAL PASTURES

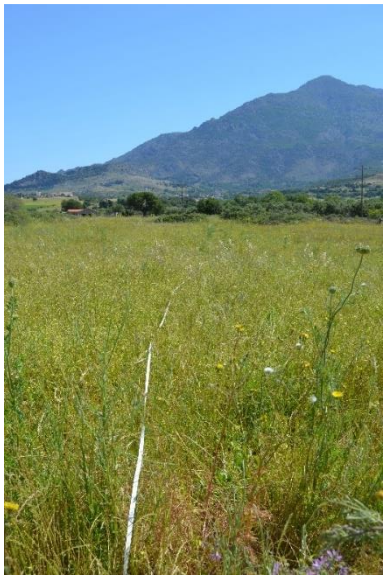
PLOT 2
Annual pasture
Coordinates: N40.451 E25.485

08/12/2016 - In 2015, plot 2 was sown with a permanent mixture. In 2016 the farmer chose to re-seed with the annual mixture ´Speedmix AC´. Some of the species introduced in 2015, such as *Trifolium subterranean* and *Trifolium vesiculosum*, are visible in large quantity, either germinated or as seed. The soil preparation and sowing in 2016 was good, with the soil presenting a good seed bed. However, germination of the new sowing was not yet observed.

30/05/2017 – In this plot, which will be cut for hay, several sown species such as annual ryegrass (*Lolium multiflorum*) and some clovers (*Trifolium* sp.) are visible. The degree of soil cover by the sown species is superior as compared to the nearby plot 7, and therefore the hay will be of superior quality.



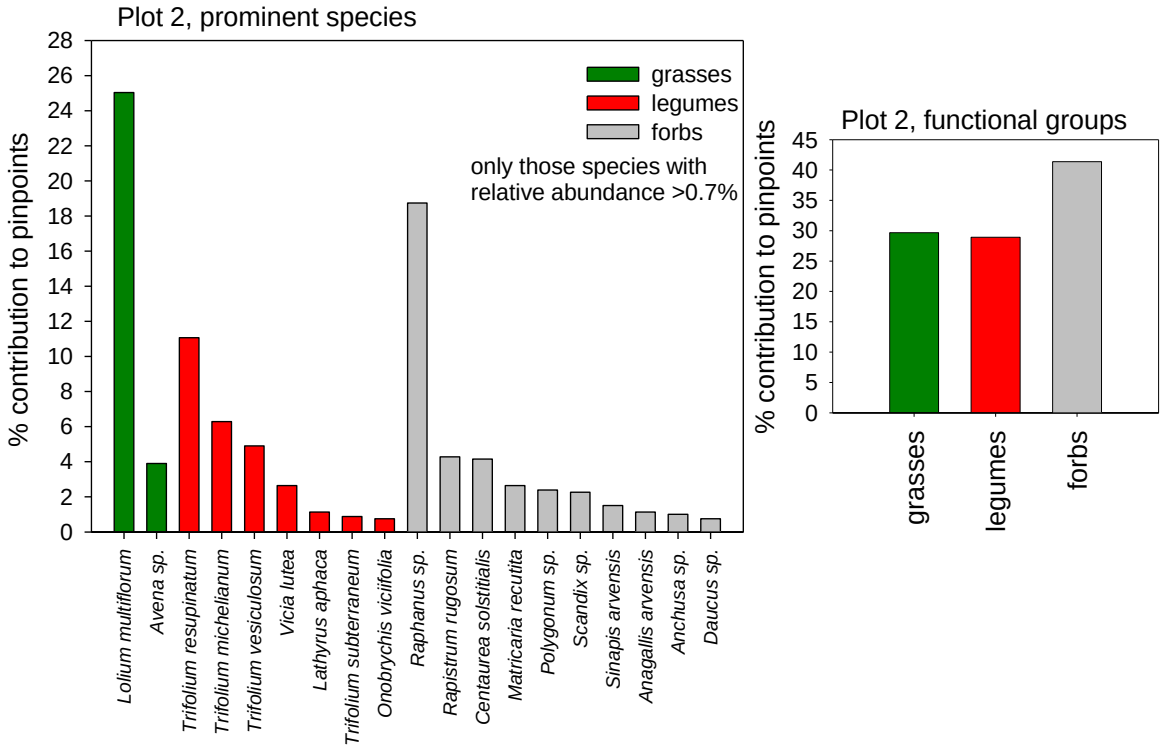
T1: 80 m
T2: 80 m
T3: 40 m



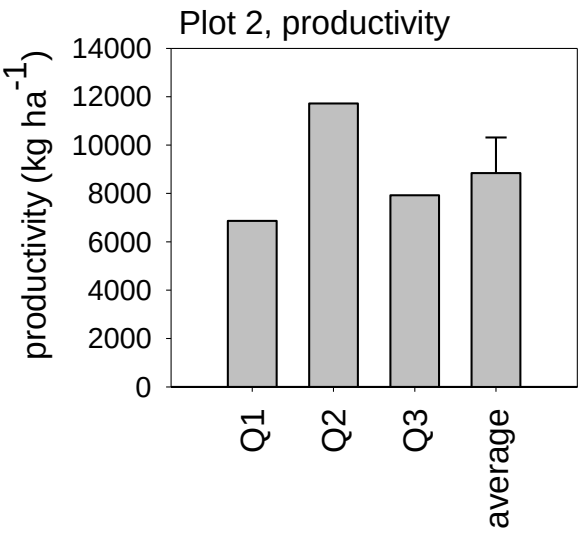
Plot 2, transect 1 (May 2017)

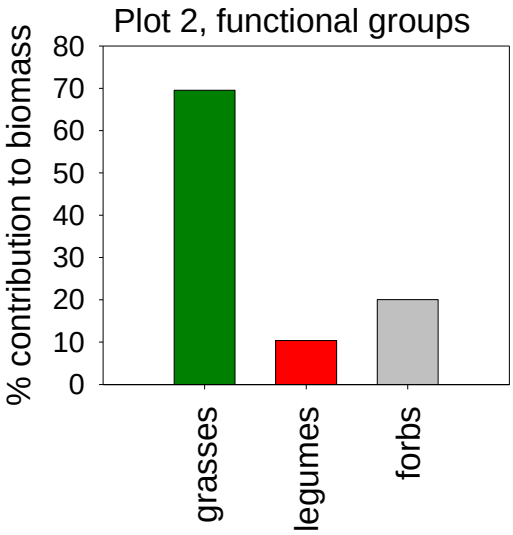
Plot 2, quadrat 1 (May 2017)

Transect data:



Quadrat data:


Plot 2, productivity
productivity (kg ha-1)
14000
12000
10000
8000
6000
4000
2000
0
Q1
Q2
Q3
average


Plot 2, functional groups
% contribution to biomass
80
70
60
50
40
30
20
10
0
grasses
legumes
forbs

PLOT 4A

Annual pasture
Coordinates: N40.437 E25.506

08/12/2016 – This plot was sown with the annual ´Fertifeno NEU´ blend at the beginning of November and germination is more advanced as compared to some of the other plots. The germination is very good, with several species of the mixture clearly visible. Despite the stony terrain the preparatory work was good, as was the sowing operation.

29/05/2017 – Vegetation in plot 4A is not very dense, with few grasses and some clovers. Nevertheless, grazing was recommended.

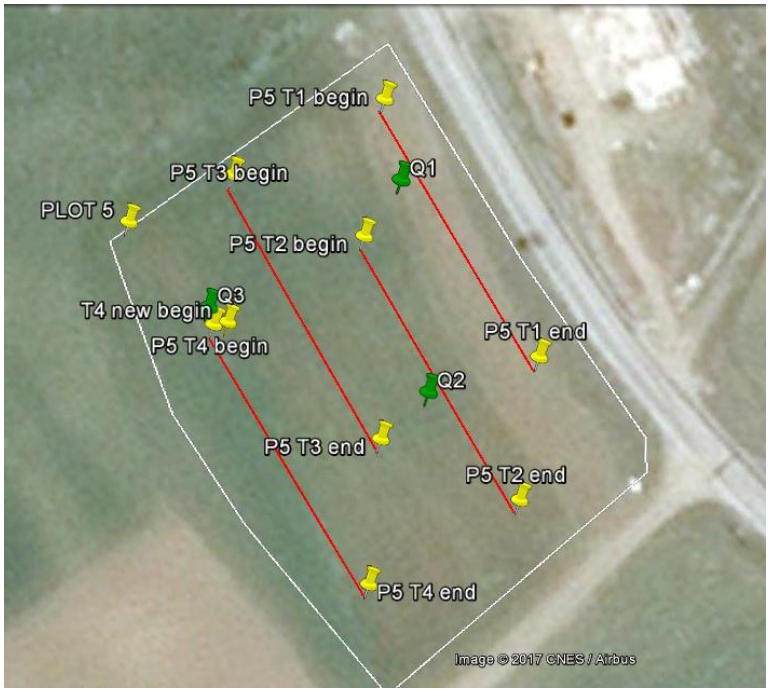
This plot was not monitored in May 2017 by Marjan Jongen as the plot was quite heavily grazed prior to her arrival.

PLOT 5

Annual pasture
Coordinates: N40.459 E25.496

08/12/2016 - This parcel was sown on November 26 with the annual mixture ´Speedmix NEU´. The first rains after sowing occurred on November 30. We have been able to observe some recently germinated leguminous plants, and this parcel may evolve favorably. The soil preparation was quite acceptable, and under favorable climatic conditions we can obtain good production.

30/05/2017 – This annual pasture was cut for hay production. In the regrowth of the crop abundant *Trifolium resupinatum* is visible. The forage productivity was satisfactory, although the plot was very infested with species that were not in the seed mixture.

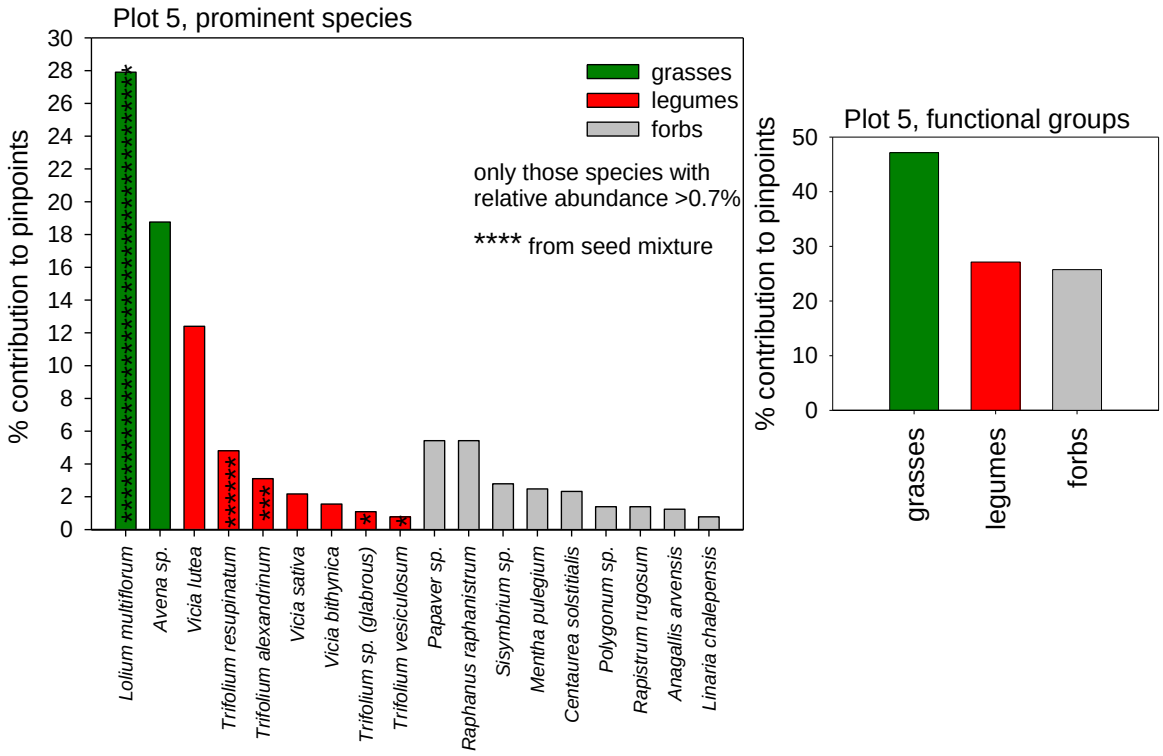


T1: 50 m
T2: 50 m
T3: 50 m
T4: 50 m

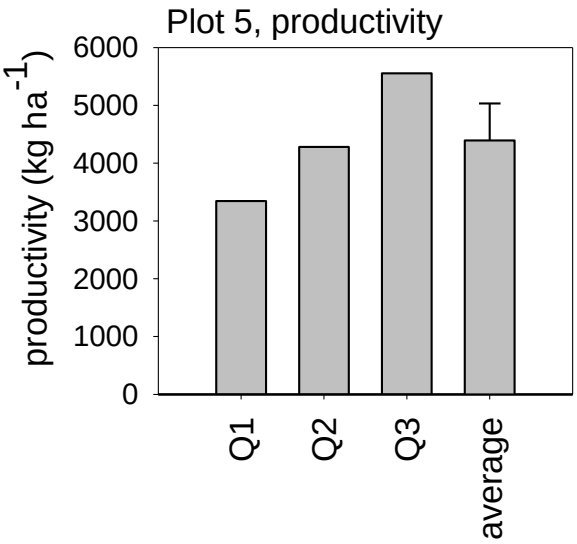
Plot 5 (May 2017)

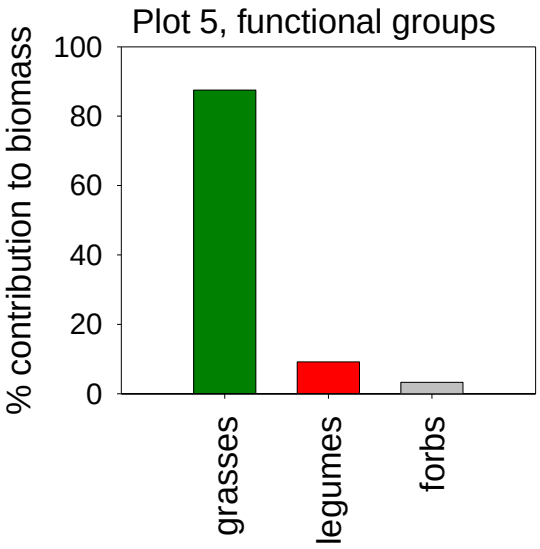
Plot 5, quadrat 2 (May 2017)

Transect data:



Quadrat data:

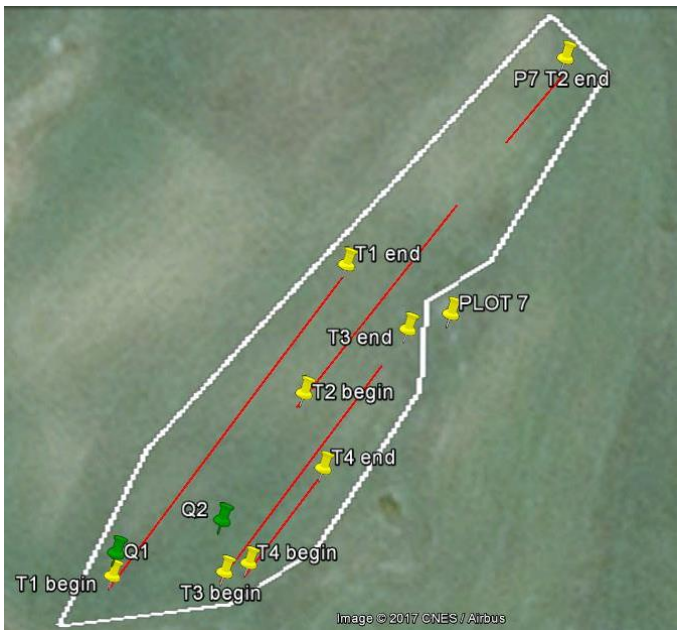




PLOT 7
Annual pasture
Coordinates: N40.449 E25.480

08/12/2016 - This parcel was sown on November 26 with the annual mixture ´Avex NEU´. The first rains after sowing occurred on November 30. Although germination is higher as compared to plot 5, which was also sown on November 26, the preparation of the soil and sowing were apparently less careful. Several germinating species, such as oats, vetches and clovers, are visible.

30/05/2017 - In this annual pasture, which will also be cut for hay, several sown species are visible, for example *Avena strigosa*, *Vicia sativa*, *Vicia villosa* and *Trifolium* sp., especially *Trifolium squarrosum*. However, the degree of soil cover by the sown species is low, and other weeds are clearly dominant.

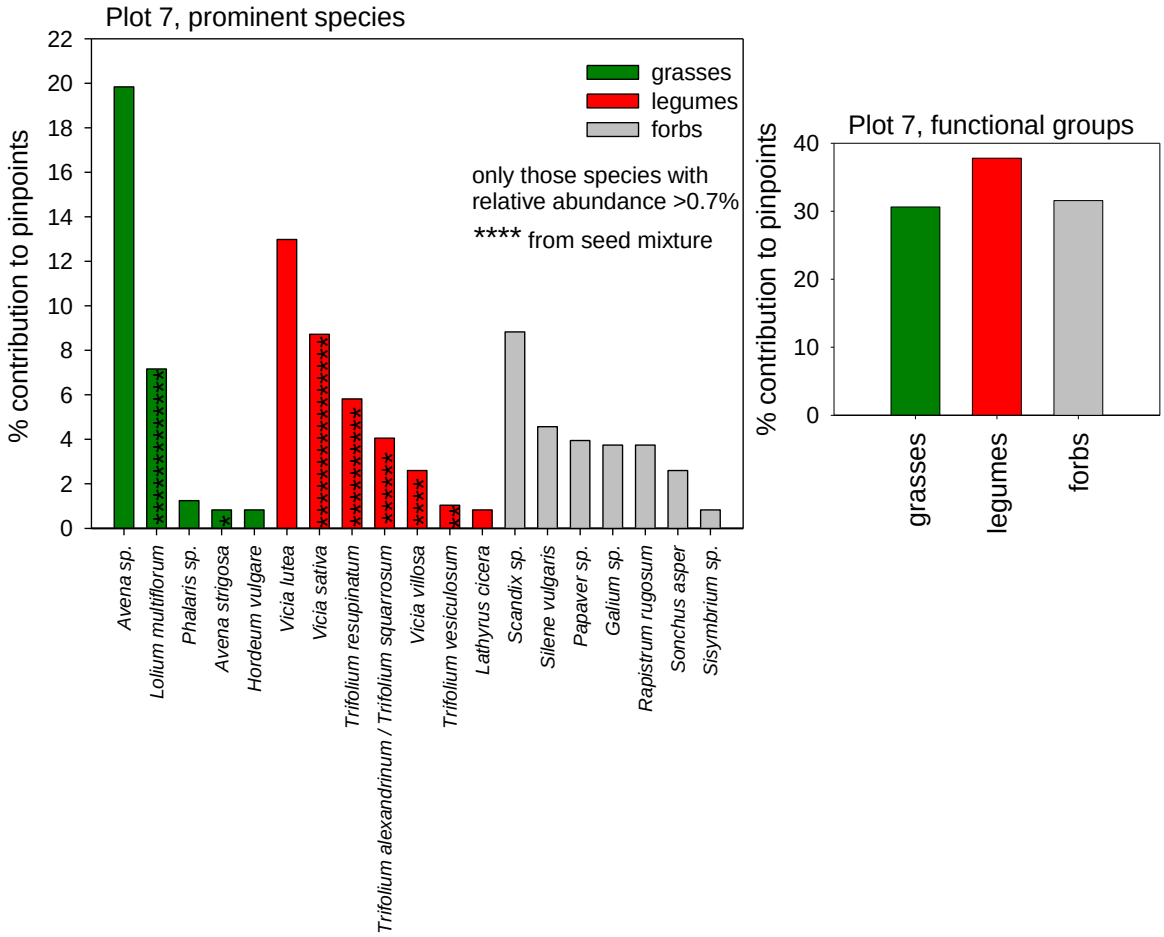


T1: 70 m
T2: 60 m
T3: 49 m
T4: 21 m

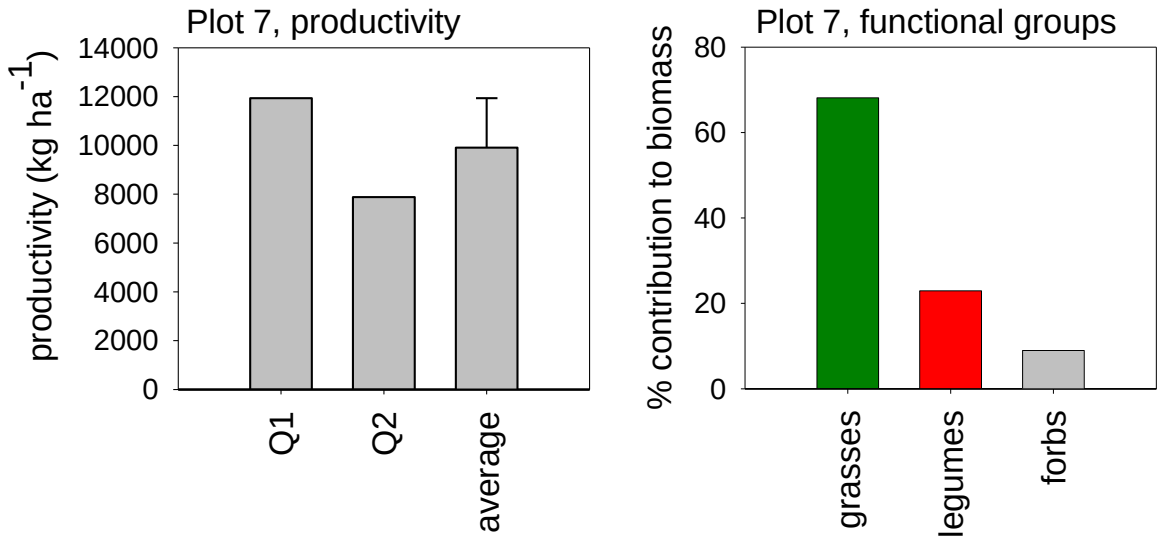
Plot 7 (May 2017)

Plot 7, quadrat 2 (May 2017)

Transect data:



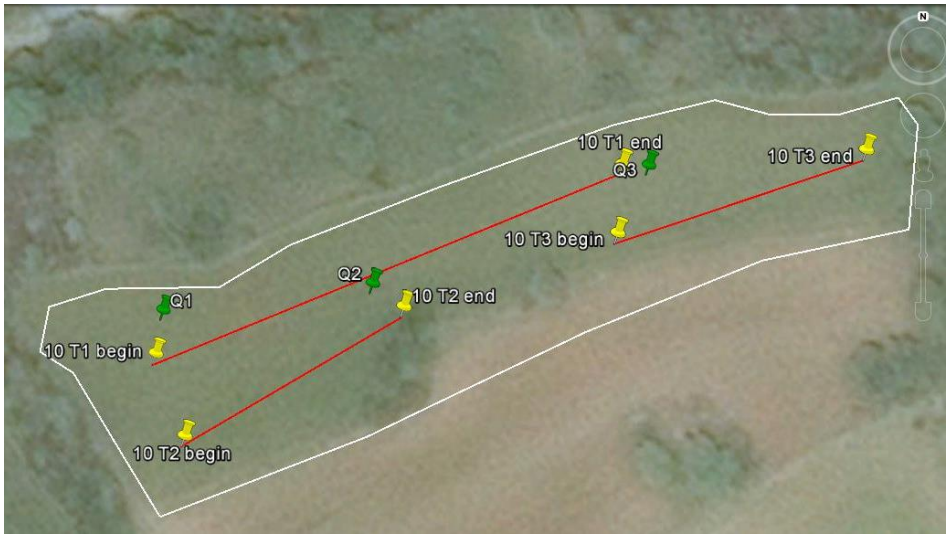
Quadrat data:



PLOT 10

Annual pasture

Coordinates: N40.437 E25.503

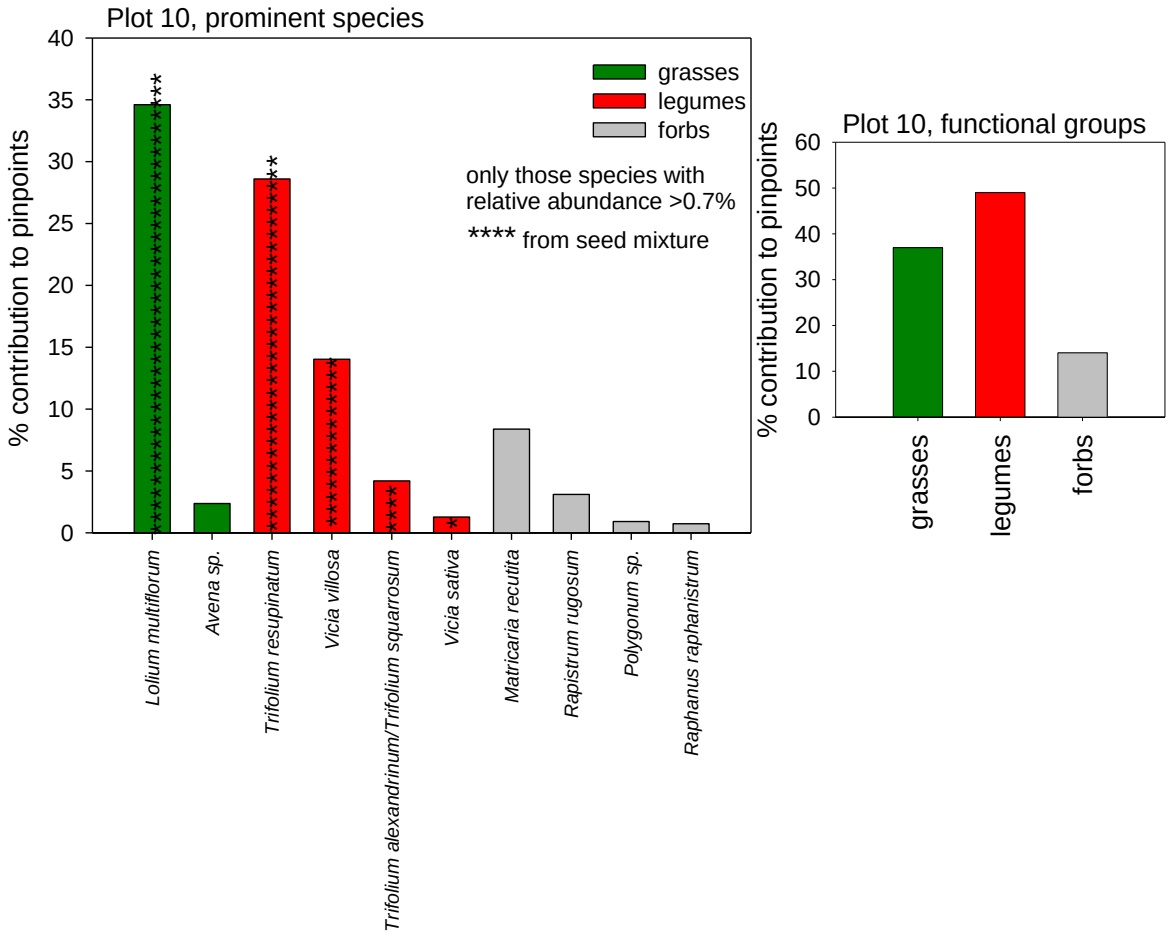


T1: 100 m
T2: 50 m
T3: 50 m

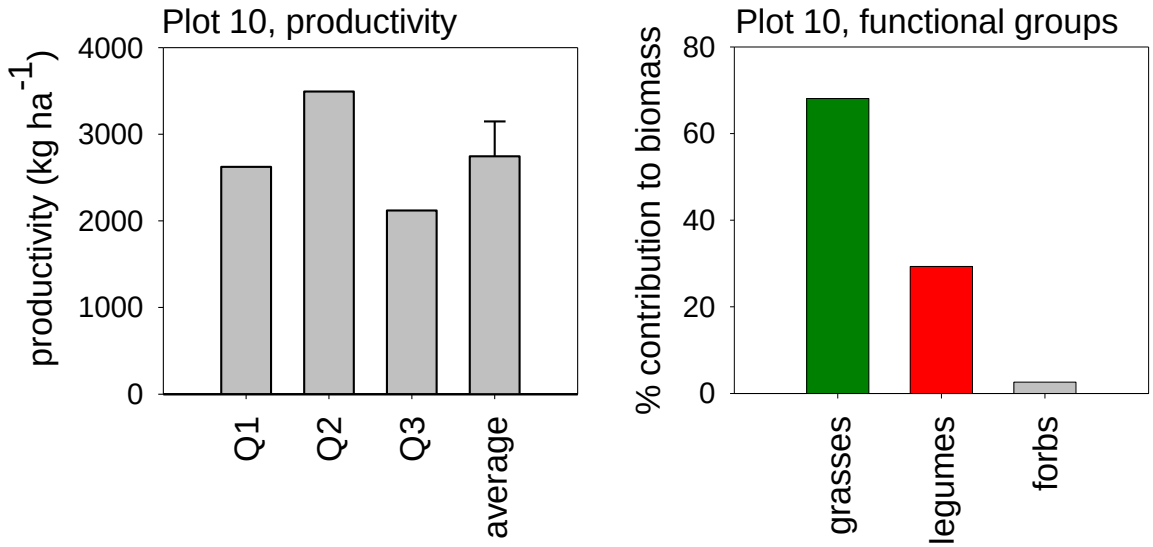
Plot 10 (May 2017)

Plot 10, quadrat 2 (May 2017)

Transect data:

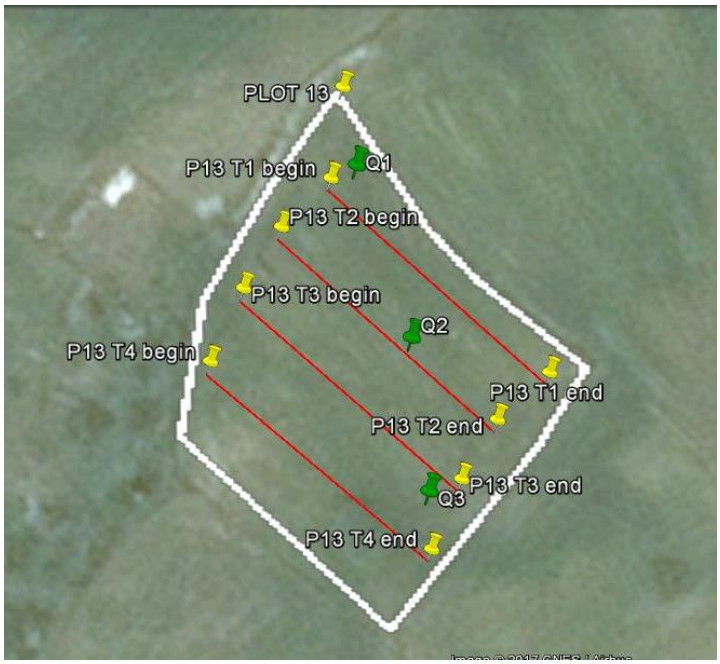


Quadrat data:



PLOT 13
Annual pasture
Coordinates: N40.470 E25.489

30/05/2017 – In this parcel, sown in January with an annual mixture (NEU speedmix), only the annual ryegrass (*Lolium multiflorum*) thrived. The preparatory work for sowing was not optimal, which explains the lack of legumes in the parcel. It was recommended to graze or cut the parcel as soon as possible, since the forage is almost completely senescent, thus losing quality.

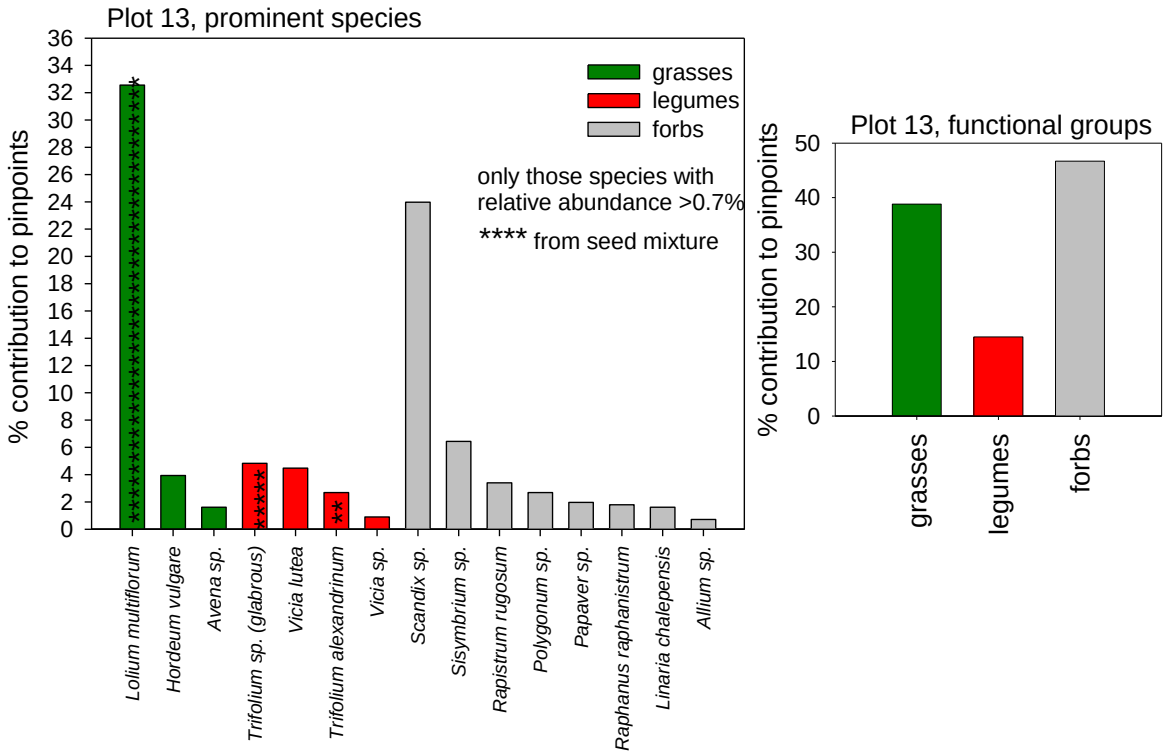


T1: 50 m
T2: 50 m
T3: 50 m
T4: 50 m

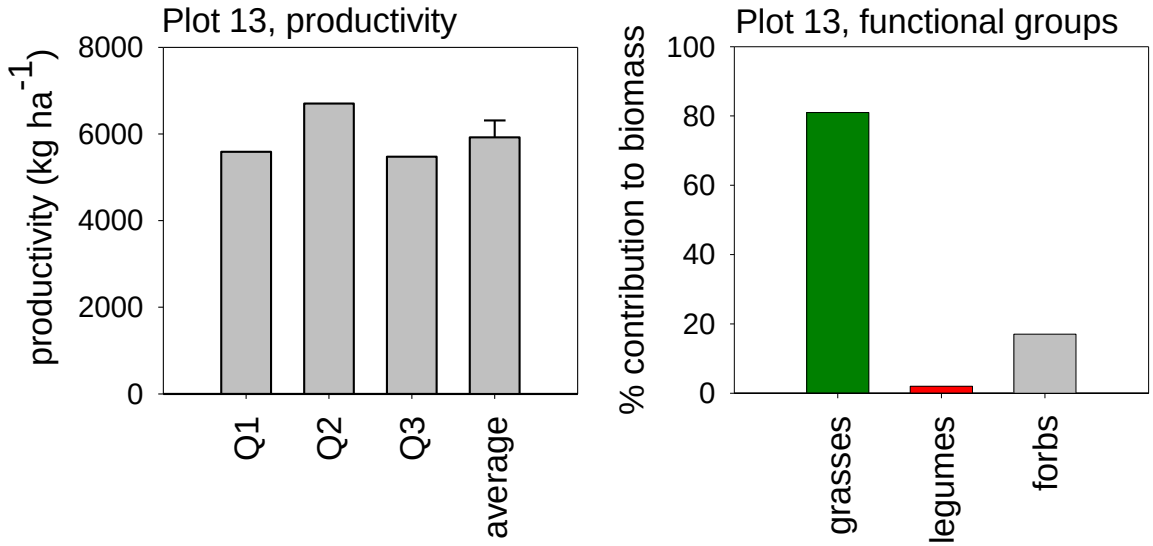

Plot 13 (May 2017)


Plot 13, quadrat 1 (May 2017)

Transect data:



Quadrat data:



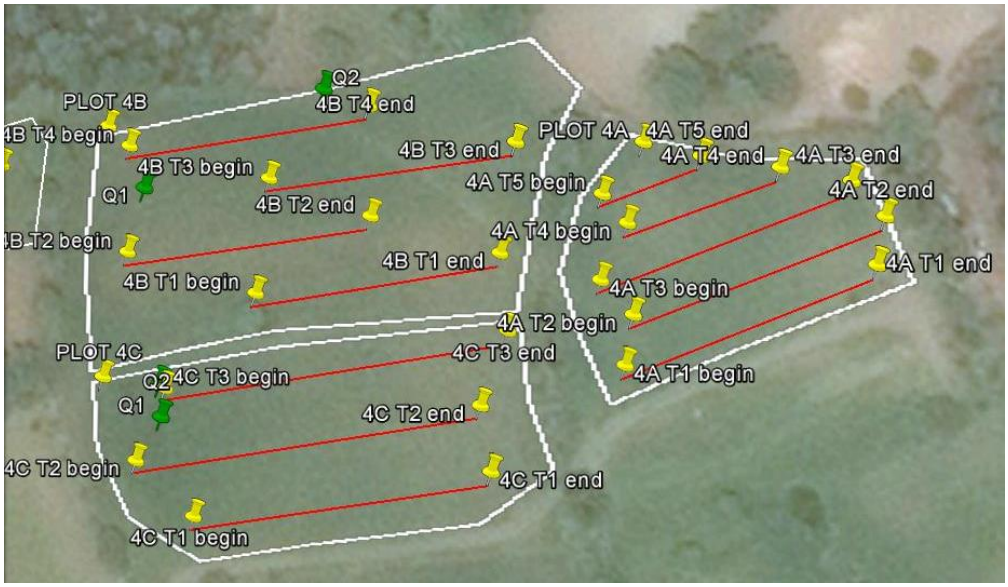
SOWN BIODIVERSE PERMANENT PASTURES

PLOT 4 (B and C)

Permanent pastures
Coordinates: N40.437 E25.505

08/12/2016 - These plots were sown at the beginning of November thus their germination is more advanced as compared to the other plots. The germination is very good, with several species of the mixture clearly visible. Despite the stony terrain the preparatory work was good, as was the sowing operation. Plot 4B was seeded with the permanent mix ´NEU 550´ and plot 4C with the permanent mix ´AL 550´.

29/05/2017 - Plots 4B an 4C, sown with permanent mixtures, are well grazed, with a large seed production from the various seed species being visible. Its future will be guaranteed due to the high seed production and the good management carried out in the plots. In addition, the altered management increased the potential of indigenous leguminous plants. Recommendations encompassed an intensive grazing, to ensure total removal of the pasture produced, and a cover fertilization in autumn with +/- 30 phosphorus units.



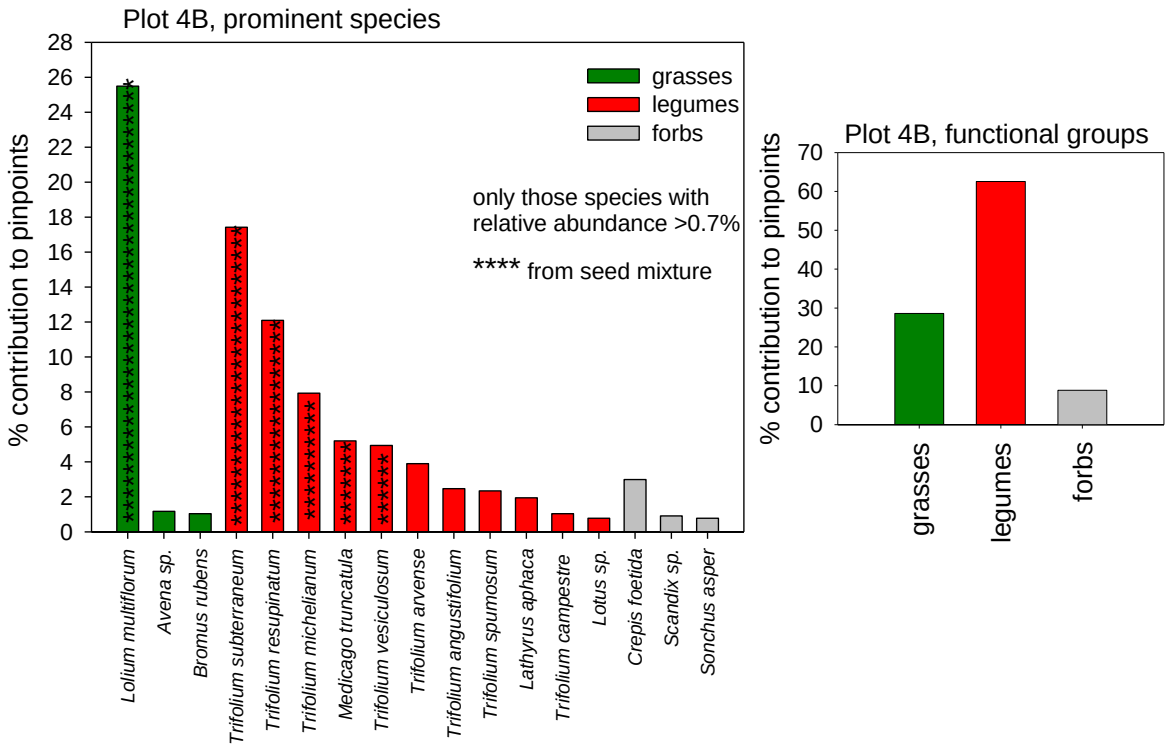
Plot 4B (May 2017)

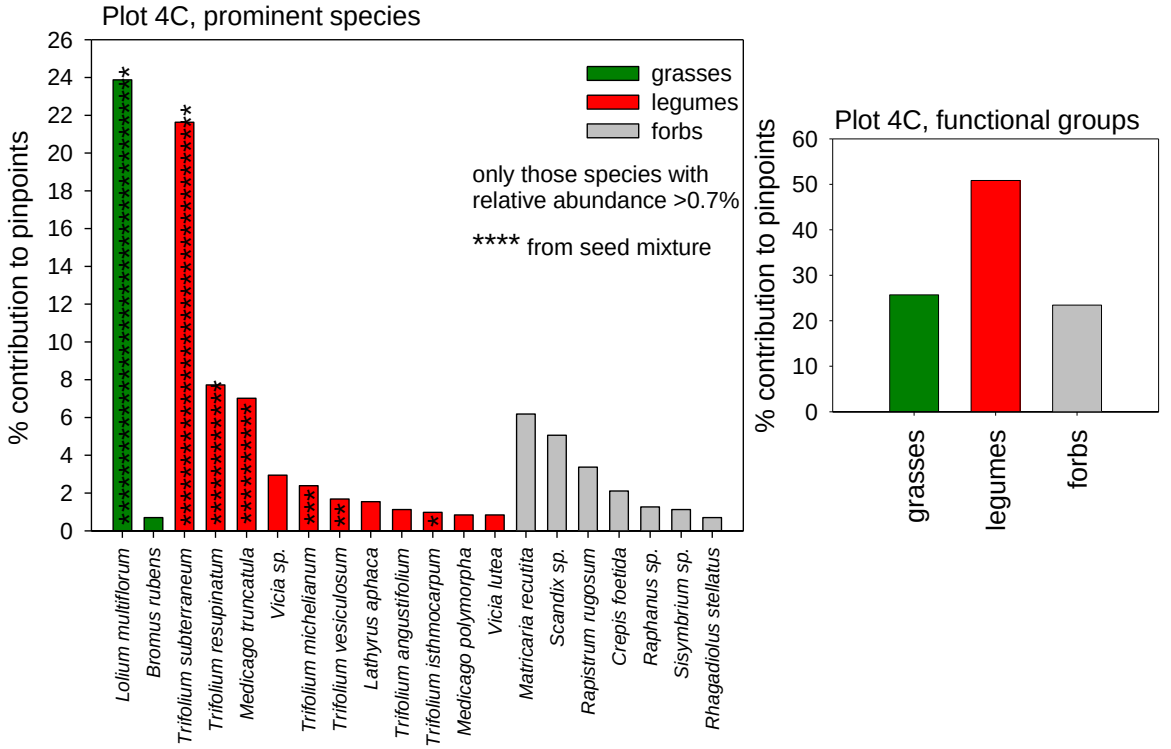
Plot 4B, quadrat 2 (May 2017)

Plot 4C (May 2017)

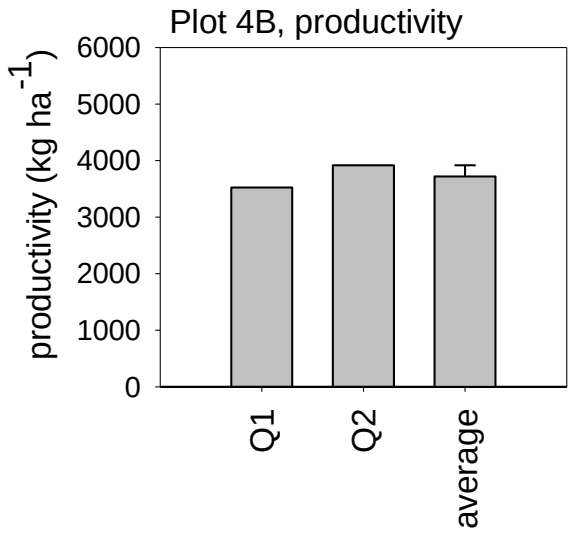
Plot 4C, quadrat 1 (May 2017)

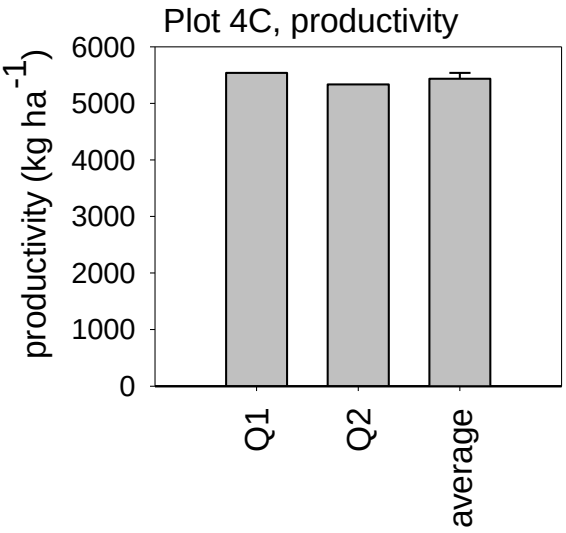
Transect data:





Quadrat data:



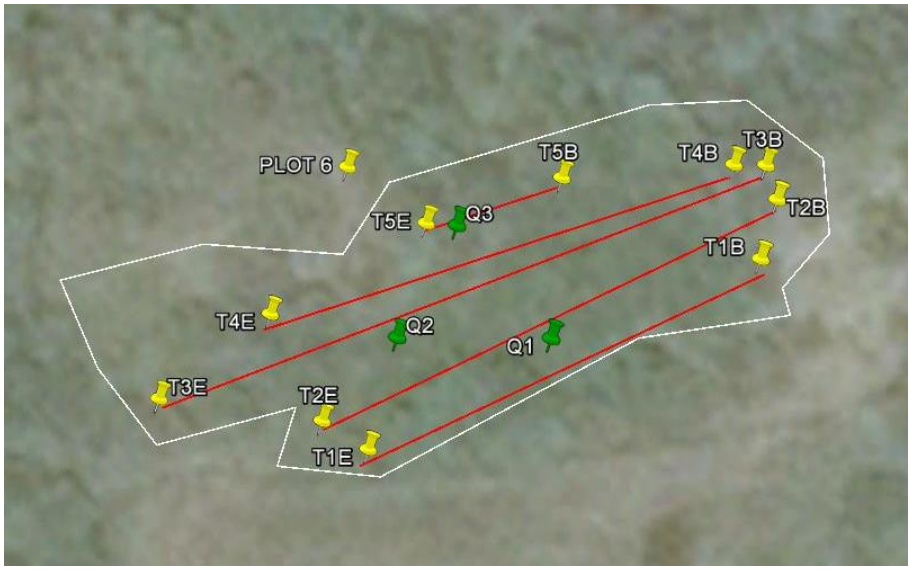


PLOT 6

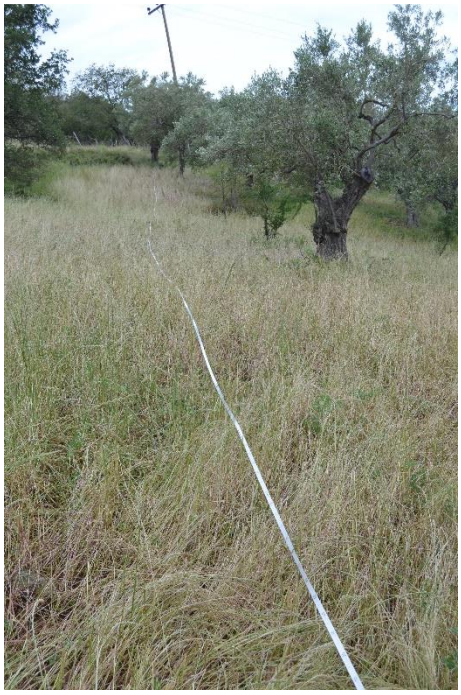
Permanent pasture
Coordinates: N40.414 E25.550

08/12/2016 - This parcel was sown on November 16 with the permanent mixture ´AC 500´, in the undercover of an olive grove with a fairly steep slope. Although soil preparatory work was not optimal, due to slope, the germination is excellent, with high biodiversity and good plant development, especially considering that sowing only took place three weeks previous.

29/05/2017 - Plot shows good vegetative development, although annual ryegrass (*Lolium multiflorum*) is the dominant species. In favourable conditions, there will be abundant seed production of the various species sown. It was recommended that only after completion of flowering and seed production, animals enter to take advantage of all the forage produced.



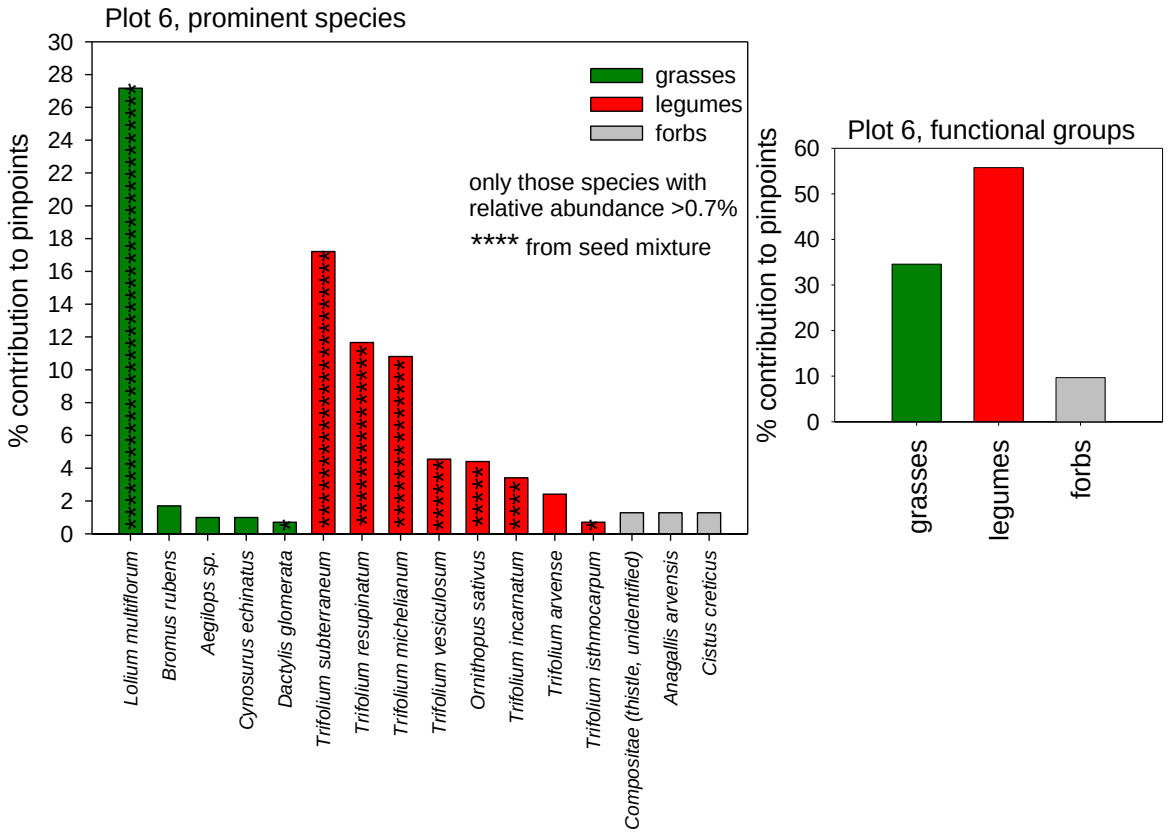
T1: 43 m
T2: 46 m
T3: 49 m
T4: 50 m
T5: 13 m



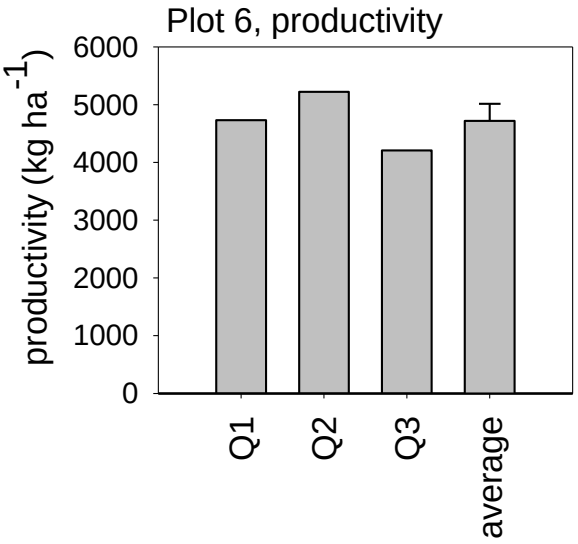
Plot 6 (May 2017)

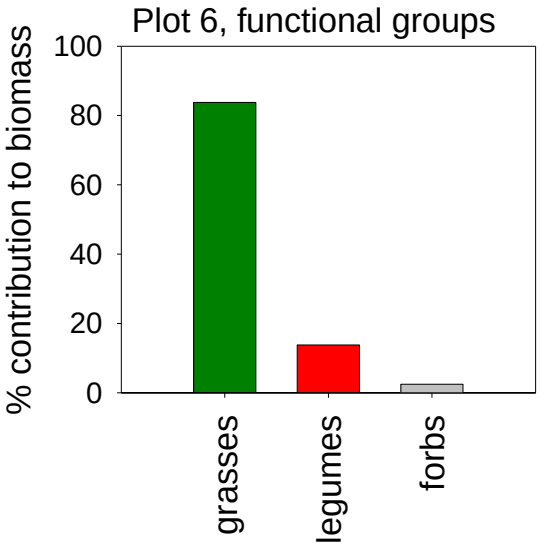
Plot 6, quadrat 2 (May 2017)

Transect data:



Quadrat data:

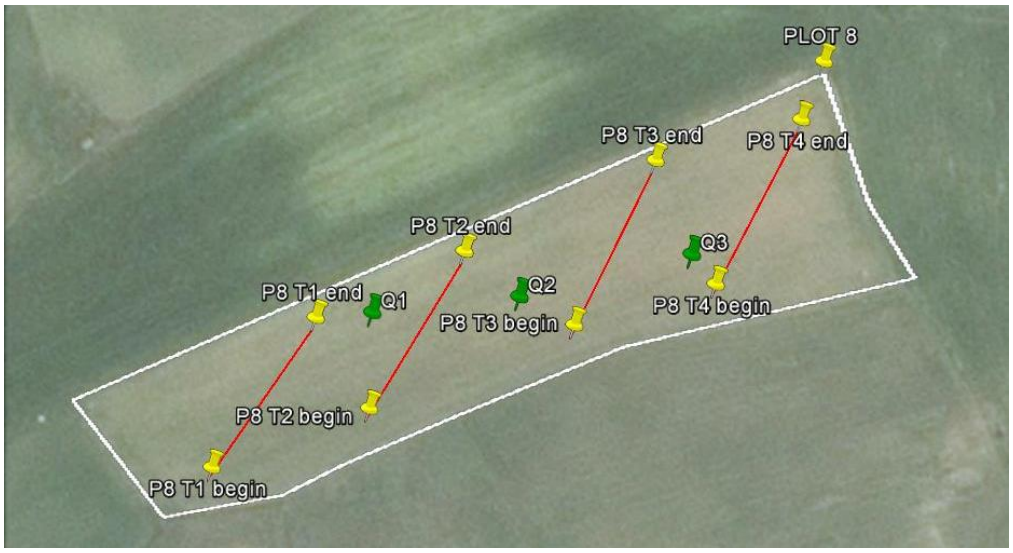

Plot 6, productivity
productivity (kg ha-1)
6000
5000
4000
3000
2000
1000
0
Q1
Q2
Q3
average


Plot 6, functional groups
% contribution to biomass
100
80
60
40
20
0
grasses
legumes
forbs

PLOT 8

Permanent pasture
Coordinates: N40.466 E25.479

30/05/2017 - In this parcel, sown in February 2017 with the permanent mixtures NEU 550 and AL 550, few sown species are present. The vegetation mainly represents weeds, in particular, and in a high percentage, *Papaver rhoeas*, which is well adapted to this type of soils. Two species of *Vicia* (vetches) are also visible but these two species were not in the seed mixture.

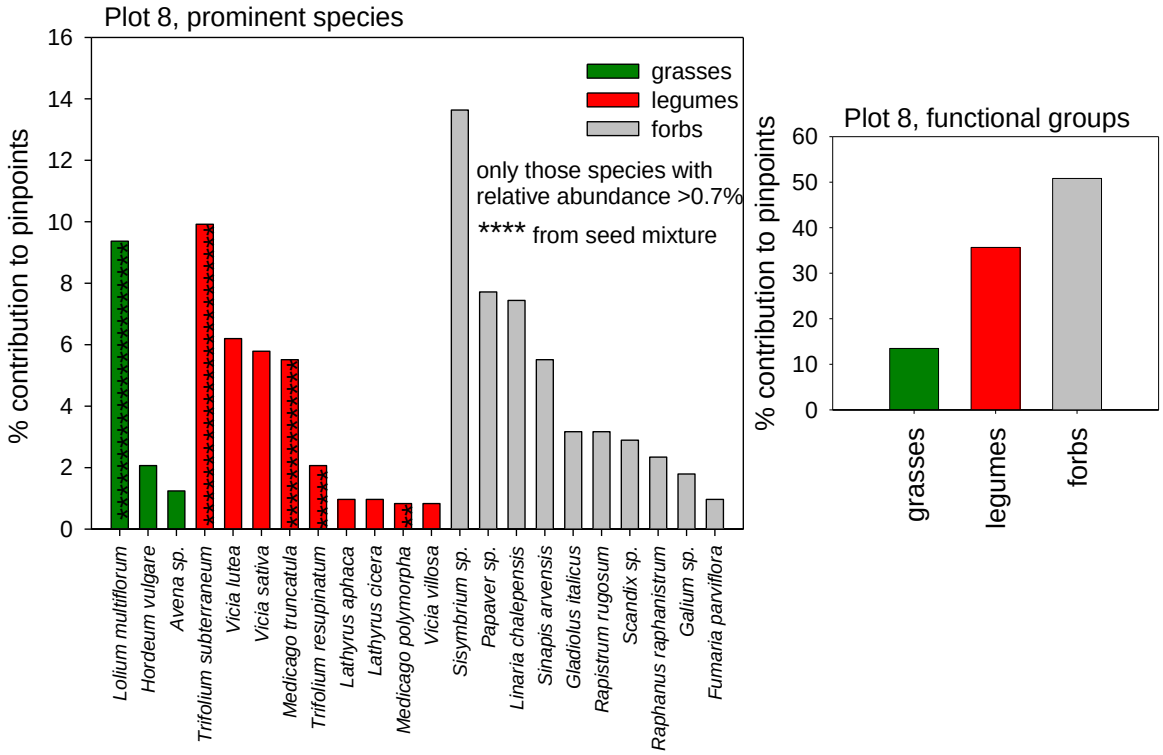


T1: 50 m
T2: 50 m
T3: 50 m
T4: 50 m

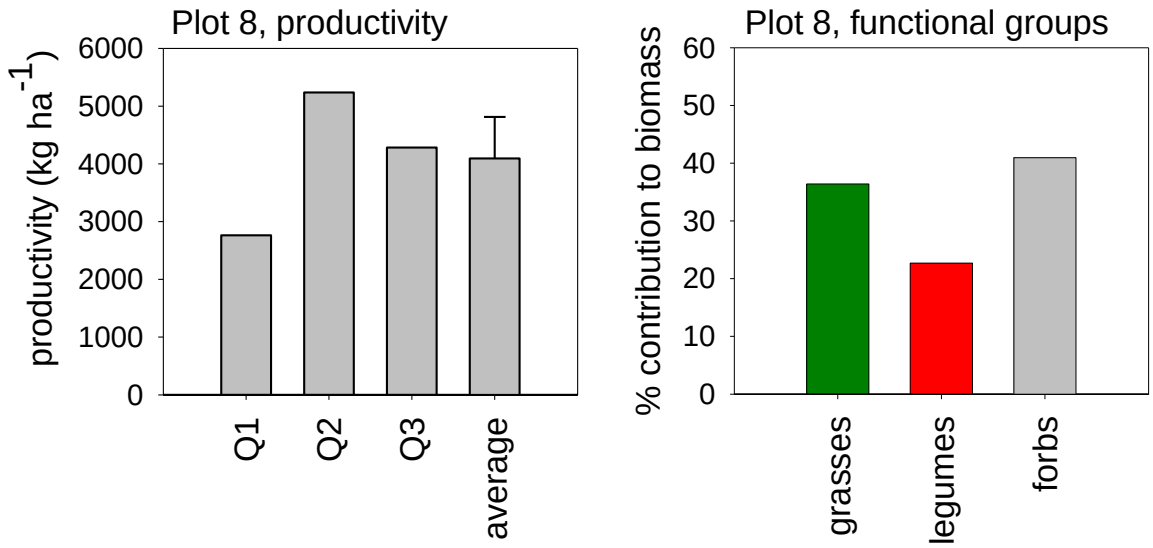
Plot 8 (May 2017)

Plot 8, quadrat 1 (May 2017)

Transect data:



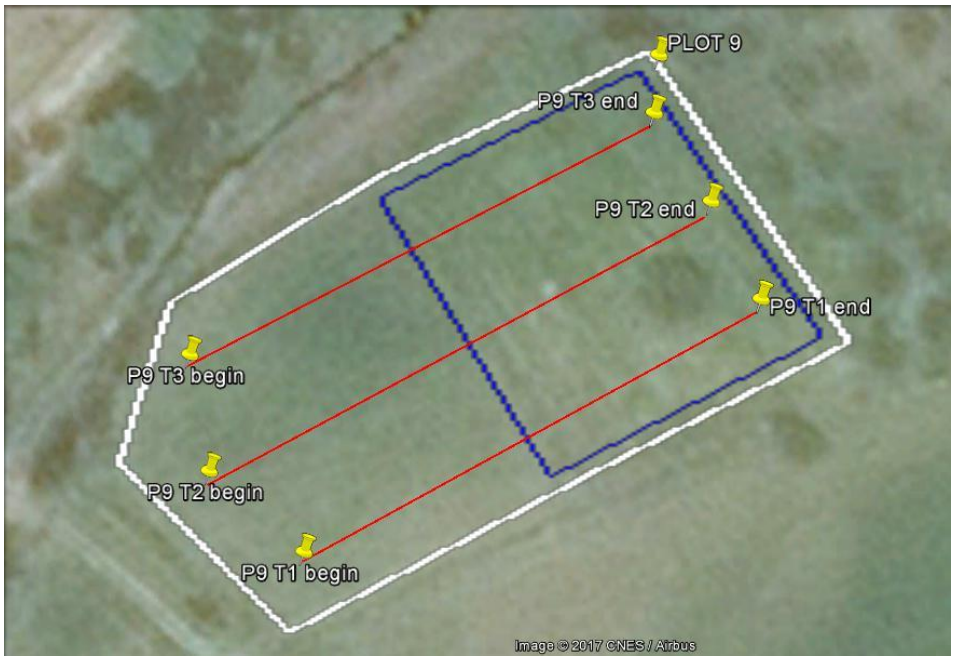
Quadrat data:



PLOT 9
Permanent pasture
Coordinates: N40.450 E25.487

08/12/2016 – This parcel was sown on November 26 with the permanent mixture ´NEU 500´. The soil preparation and sowing work was quite satisfactory, and some germination is visible.

30/05/2017 – The parcel shows little trace of the sown species, with the exception of annual ryegrass (*Lolium multiflorum*). This species has a strong vigor, which will have prevented the other species from thriving. Intensive grazing was recommended to ensure the removal of the forage produced.



This parcel was not monitored May 2017 by Marjan Jongen. Only part of the parcel was sown (a small area of approx. 30 by 40 m, indicated by blue line), and it had been grazed quite heavily previous to her arrival.

PLOT 11

Permanent pasture
Coordinates: N40.464 E25.695

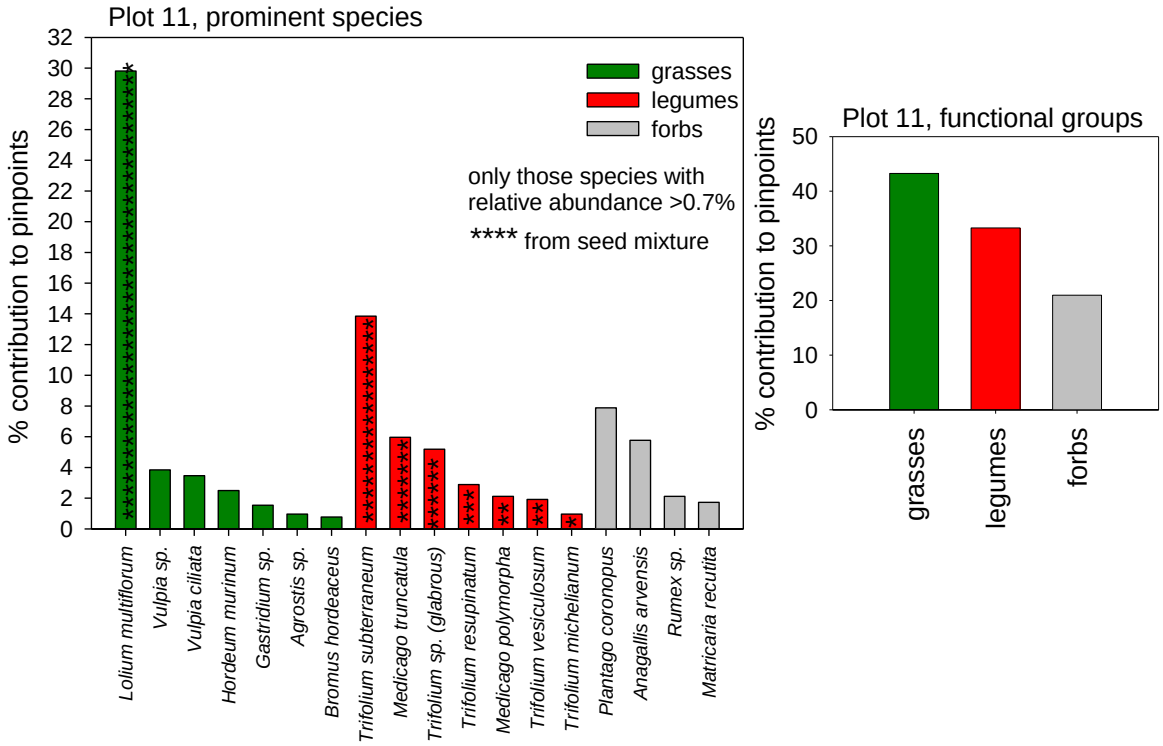
30/05/2017 - In this parcel, sown with the permanent mixture NEU 550, several of the sown species are visible. However, the sowing only occurred in March, and the vegetation is less advanced, although some plants have started flowering. They will need optimum climatic conditions for seed production. Nevertheless, this parcel presents the greatest potential for the establishment of sown biodiverse pastures.

T1: 50 m
T2: 50 m
T3: 50 m
T4: 20 m
T5: 30 m

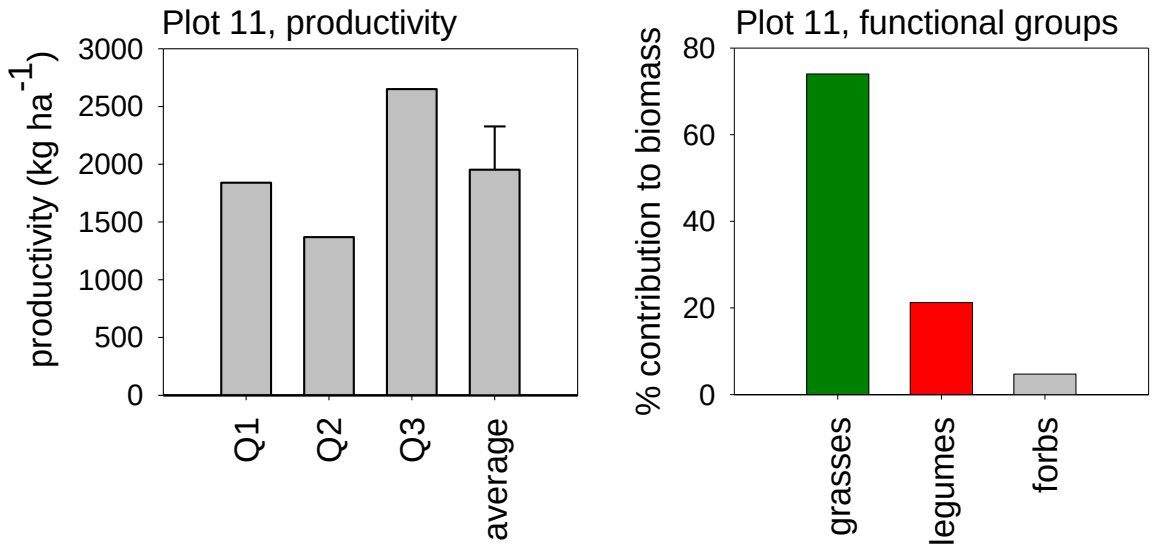
Plot 11 (May 2017)

Plot 11, quadrat 1 (May 2017)

Transect data:

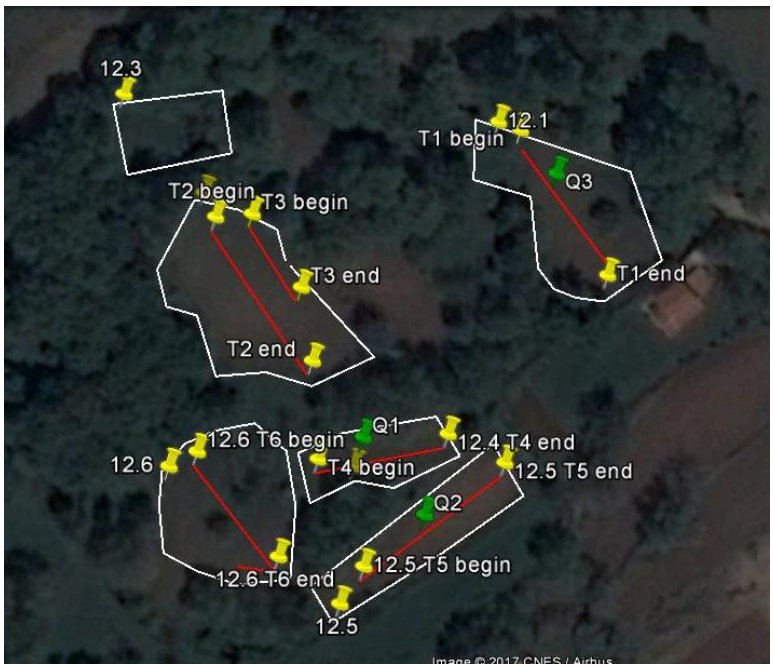


Quadrat data:



PLOT 12
Permanent pasture
Coordinates: N40.465 E25.668

29/05/2017 - Plot 12 is located in the north of the island of Samothraki, and sown in March 2017 with a permanent mixture (NEU 550 and AL 550). The pasture has an excellent vegetative development, and the various species from the seed mixture are clearly visible. Although stones are abundant in some areas (indicative of the degree of soil degradation), the biodiverse pasture shows it full potential and thrived among the rocks. At the time of the field visit, vegetation began to flower (some flowers were visible). However, considering this was at the end of May, there is a risk of limited seed production if weather conditions in June are unfavourable.

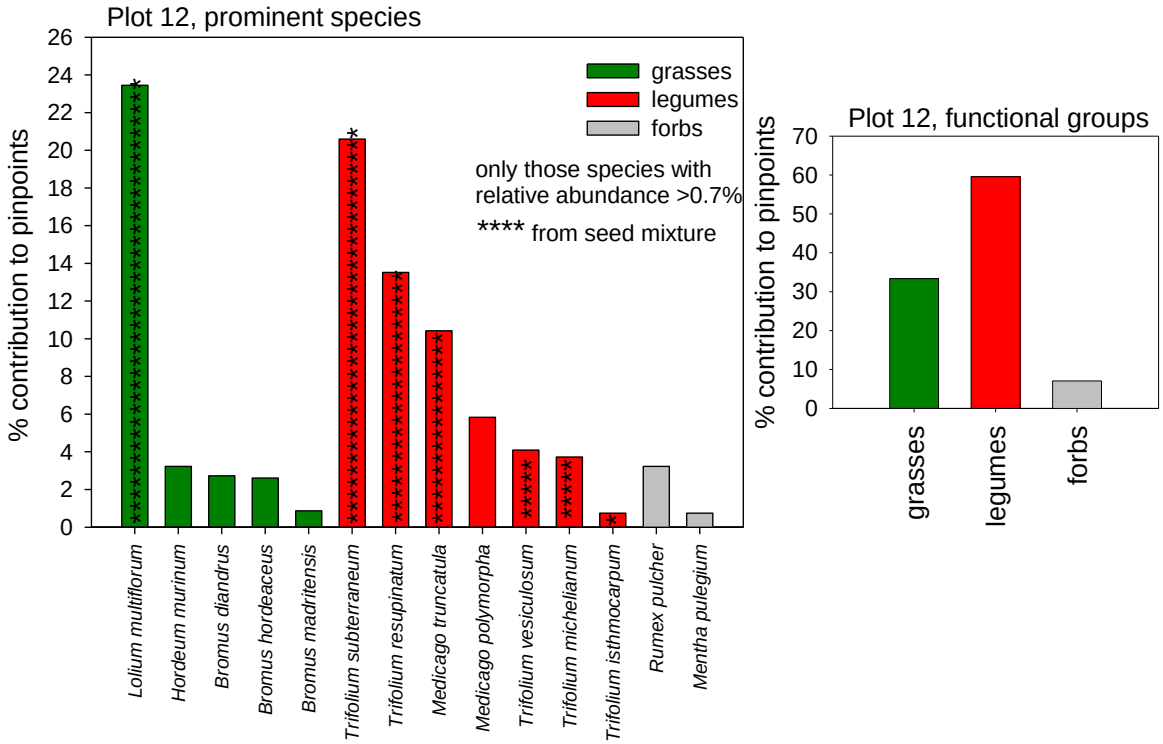


T1: 40 m
T2: 40 m
T3: 20 m
T4: 30 m
T5: 40 m
T6: 40 m

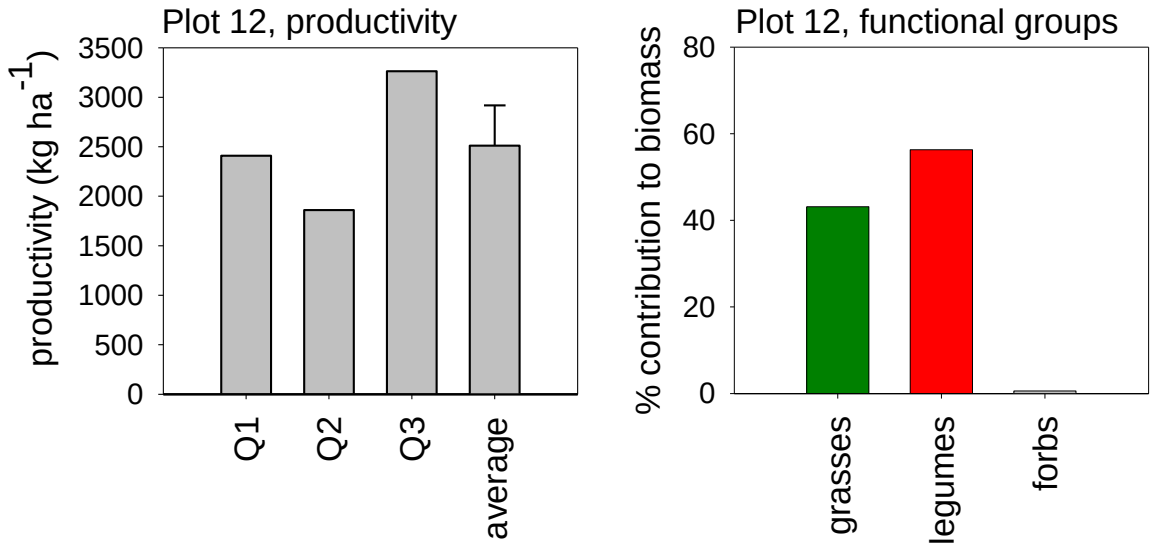

Plot 12 (May 2017)


Plot 12, quadrat 1 (May 2017)

Transect data:

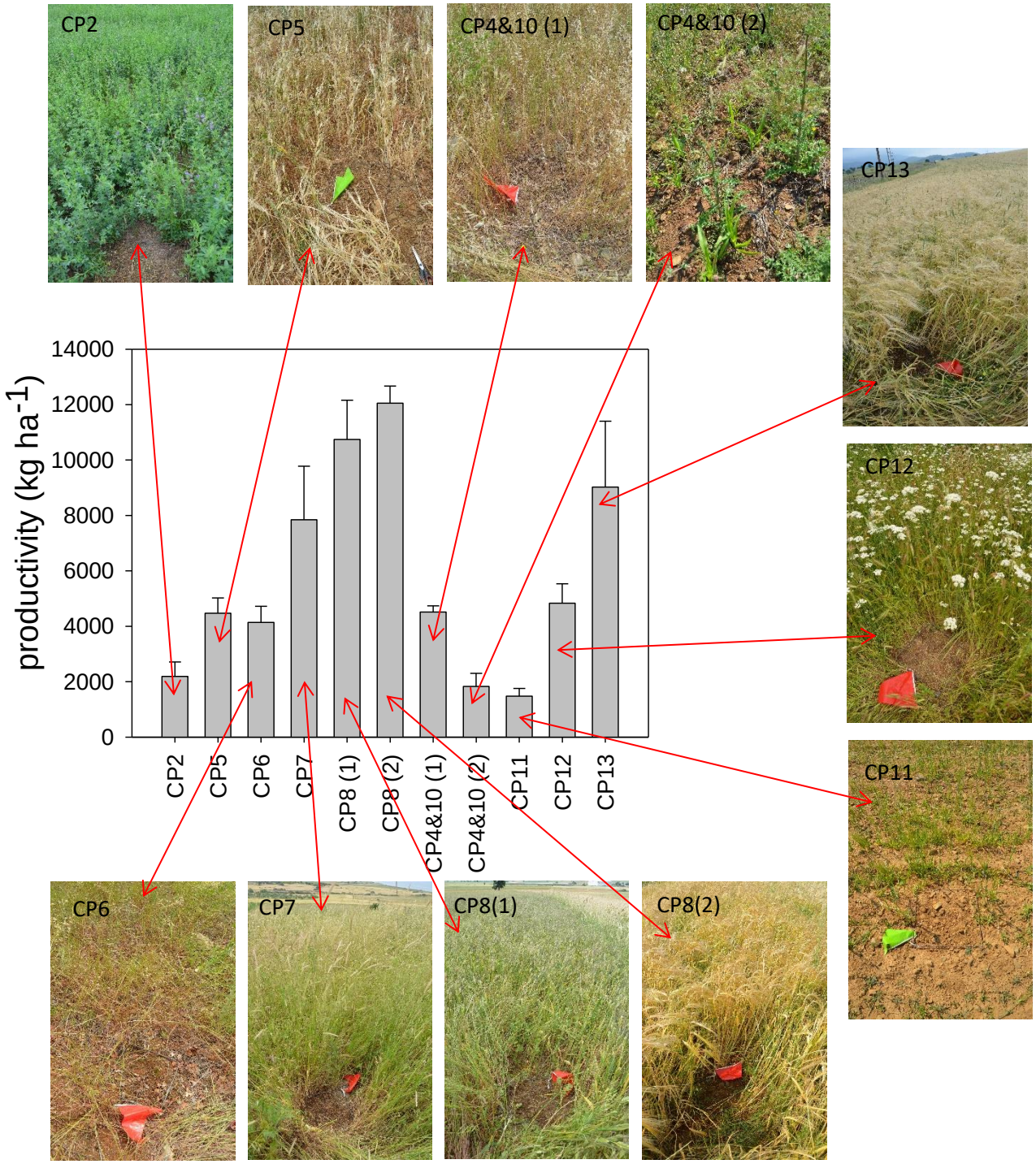


Quadrat data:



CONTROL PLOTS

In addition to the monitoring work in the sown pastures, measurements for productivity (40x40 cm quadrats) were done in several so-called control plots. These control plots are parcels that were sown with traditional species (for example barley, lucerne, oats). The collected material will be analysed for fibre and protein, for comparison with the sown pastures.

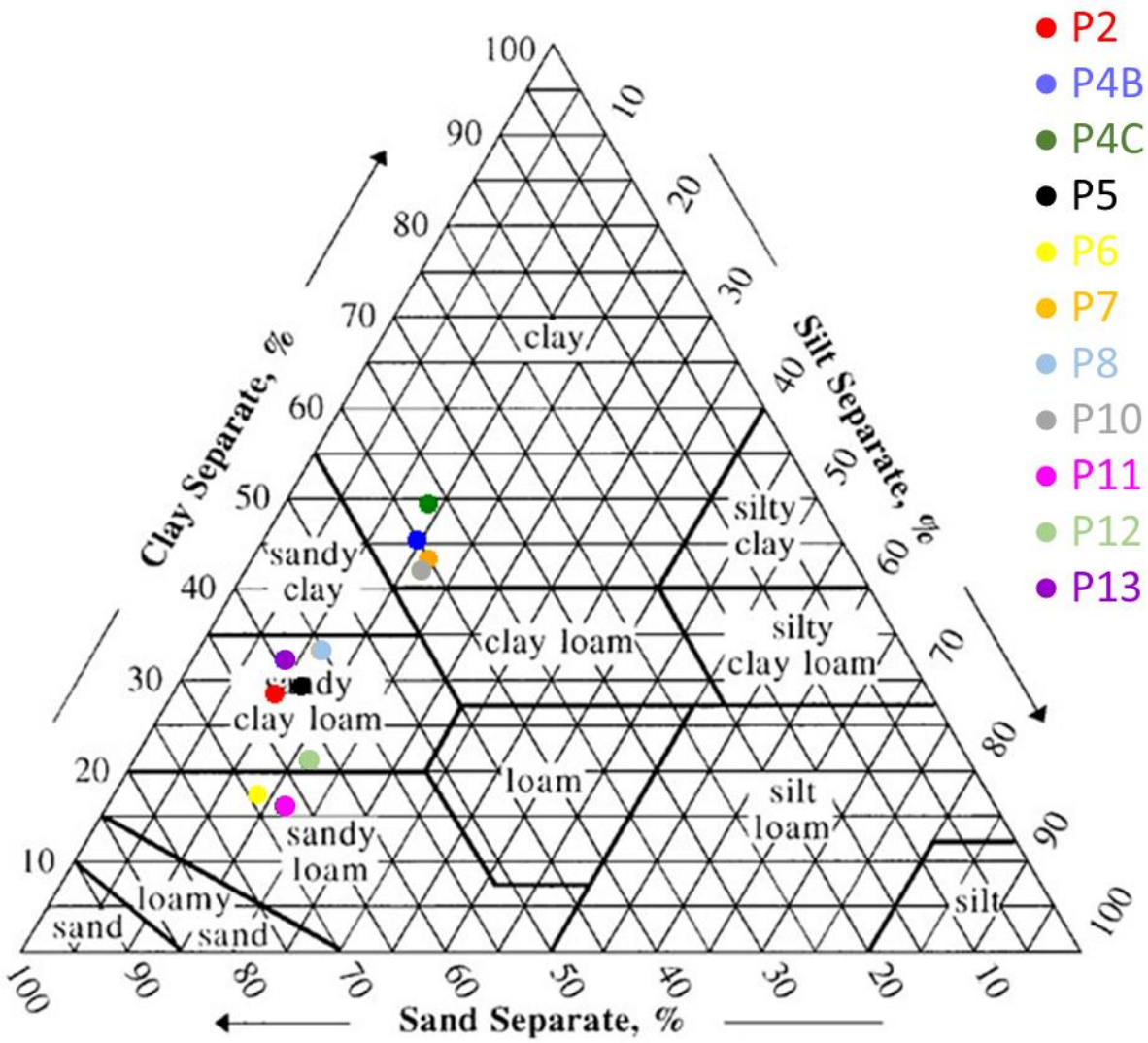


SOIL ANALYSIS

May 2017	P2	P4B	P4C	P5	P6	P7	P8	P10	P11	P12	P13
Phosphorus (P) P_2O_5 mg/kg	150	63	94	122	114	289	76	77	29	100	135
Potassium (K) K_2O mg/kg	204	158	202	151	168	283	235	133	127	120	216
Magnesium (Mg) mg/kg	>220	>220	>220	>220	>220	>220	>220	>220	116	118	160
Calcium need, $CaCO_3$ (t/ha)	0	0	0	0	0	0	0	0	0	0	0
Calcium (Ca) mg/kg	2162	3572	2764	4129	1943	5712	2351	2505	782	1094	4408
Nitrogen (mineral-N) mg/kg	3.5	4.2	3.9	4.2	4.6	5.3	4.2	4.9	6.3	3.9	3.5
pH (H_2O)	7.2	7.0	6.1	7.6	6.2	8.4	7.3	6.2	5.5	5.9	8.1
Organic matter (%)	0.95	1.2	1.65	0.9	1.85	1.4	0.75	1.18	1.30	1.7	0.75
Texture: sand (%)	63.1	41.1	38.1	60.1	70.1	41.1	56.3	42.3	68.3	63.3	60.3
silt (%)	8.9	13.9	12.9	10.9	12.9	15.9	11.0	16.0	16.0	16.0	8.0
clay (%)	27.9	44.9	48.9	28.9	16.9	42.9	32.7	41.7	15.7	20.7	31.7
Classification:											
Soil texture triangle	FGA	G	G	FGA	FA	G	FGA	G	FA	F	FGA
Recommendation of fertilization for a production of 5 t/ha:											
Organic concealer t/ha	0	0	0	0	0	0	0	0	0	0	0
Nitrogen (N) kg/ha	0	0	0	0	0	0	0	0	0	0	0
Phosphorus (P_2O_5) kg/ha	0	50	30	0	30	0	50	50	75	30	0
Potassium (K_2O) kg/há	40	40	40	40	40	0	40	40	40	60	40
Magnesium (Mg) kg/ha	0	0	0	0	0	0	0	0	0	0	0
Boron (B) kg/ha	1	1	1	1	1	1	1	1	1	1	1

Análise Granulométrica: FA (franco-arenoso) = sandy loam
FGA (franco-argilo-arenoso) and F (franco) = sandy clay loam
G (argiloso) = clay

Soil texture triangle:

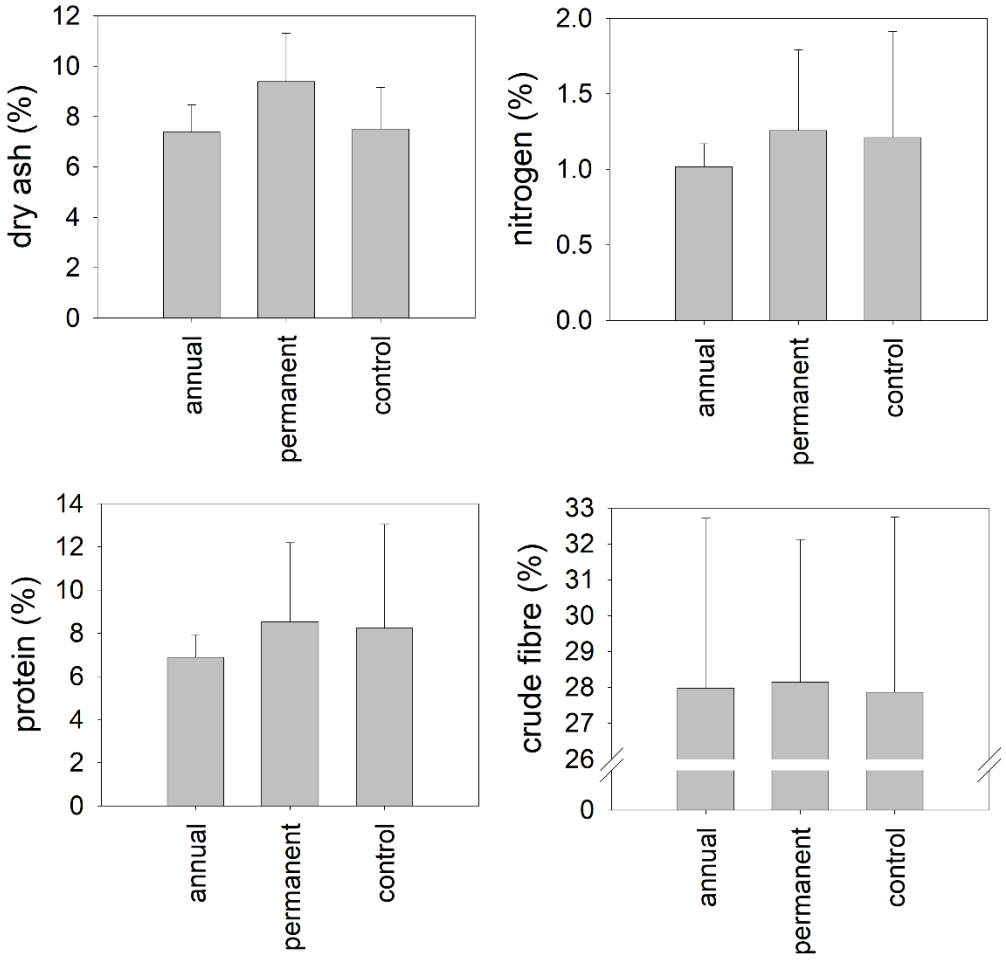


DATA COMPILED

PLOT		TRANSECT DATA								
	annual or permanent	number of species	Shannon index	Simpson	evenness	Hmax	grasses (%)	legumes (%)	forbs (%)	species seed mixture (%)
2	annual	37	2.578	8.008	0.714	3.611	29.69	28.93	41.38	47.3 (49.9)*
5	annual	28	2.452	7.080	0.736	3.332	47.13	27.13	25.74	38.60
7	annual	38	2.787	11.072	0.766	3.638	30.63	37.80	31.57	50.1 (30.2)**
10	annual	17	1.778	4.313	0.628	2.833	36.98	49.00	14.03	83.06
13	annual	38	2.338	5.629	0.643	3.638	38.82	14.49	46.69	42.04
4B	permanent	45	2.602	7.926	0.683	3.807	28.61	62.55	8.84	73.86
4C	permanent	48	2.657	7.963	0.686	3.871	25.70	50.84	23.46	65.73
6	permanent	47	2.558	7.354	0.664	3.850	34.57	55.76	9.67	80.94
8	permanent	40	2.995	14.856	0.812	3.689	13.50	35.67	50.83	29.48
11	permanent	29	2.529	7.303	0.751	3.367	43.27	33.27	20.96	62.13
12	permanent	36	2.379	7.309	0.664	3.584	33.37	59.55	7.07	77.17

PLOT		QUADRAT DATA				
	annual or permanent	productivity (kg ha-1)	grasses (%)	legumes (%)	forbs (%)	species seed mixture (%)
2	annual	8839±1473.8	69.6±4.66	10.4±3.45	20.0±1.24	78.4±1.69
5	annual	4393±639.6	87.5±2.51	9.2±2.00	3.3±0.62	69.4±5.74
7	annual	9908±2025.3	68.1±17.55	22.9±8.89	9.0±8.66	84.3 (30.7)**
10	annual	2746±401.3	68.1±6.97	29.3±5.38	2.6±1.87	96.5±1.69
13	annual	5921±391.1	81.0±4.85	2.0±1.18	17.0±5.94	72.3±6.96
4B	permanent	3721±197.5	–	–	–	–
4C	permanent	5436±102.5	–	–	–	–
6	permanent	4719±293.5	83.8±2.83	13.8±1.49	2.4±2.35	97.1±2.19
8	permanent	4094±720.0	36.4±12.01	22.7±2.03	40.9±10.08	41.7±8.66
11	permanent	1953±373.8	74.0±12.37	21.2±14.23	4.8±4.20	90.1±7.85
12	permanent	2510±408.3	43.1±5.20	56.3±5.07	0.6±0.27	93.5±2.30

Tissue analysis



Tissue analysis, detailed results per plot

PLOT	pasture type	TISSUE ANALYSIS			
		dry ash (mineral content) (%)	total nitrogen (%)	protein content (%)	crude fiber content (%)
2	annual	6.9	0.89	6	30.6
5	annual	6.9	0.95	6.4	29.4
7	annual	7.7	1	6.8	31
10	annual	9.1	1.28	8.7	19.6
13	annual	6.3	0.96	6.5	29.3
4B	permanent	9.7	1.19	8.1	29.6
4C	permanent	8.8	0.93	6.3	31.5
6	permanent	6.9	0.83	5.6	31.2
8	permanent	8.3	1.29	8.8	29.9
11	permanent	10	1.01	6.8	25.2
12	permanent	12.6	2.29	15.6	21.5
CP2 (Medicago sativa)	control	9.1	3.18	21.7	26.5
CP5 (Hordeum)	control	5.1	1.25	8.5	23.1
CP6 (other)	control	5.5	0.57	3.8	32.5
CP7 (other)	control	7.7	0.81	5.5	33.2
CP8W (Hordeum)	control	6.3	1.04	7.1	26.4
CP8E (Hordeum)	control	6.7	1.02	6.9	23.7
CP10 ROAD (other)	control	8.8	0.6	4.1	34.3
CP10 FIELD (other)	control	10.2	1.36	9.3	31
CP11 (Hordeum)	control	9	1.16	7.9	22.5
CP12 (Hordeum)	control	7.9	1.2	8.1	32.2
CP13 (Hordeum)	control	6.3	1.12	7.7	21.1

CONCLUSIONS OF OBSERVATIONS

Taking into account the field observations made during two years, we can confer the following conclusions:

1. Sown biodiverse permanent pastures present great potential and great importance for those areas which are similar to plots 4, 6, 11, 12 and 1 (in plot 1 of Stergiou Vasilis, despite mobilizing the soil, several sown species are still visible in the second year). The results obtained with these mixtures were quite satisfactory, displaying possibilities for future work on the island of Samothraki regarding the spread of these sown pastures.

2. Sown biodiverse annual pastures did not thrive very well in the trials. First of all, because soil preparation and sowing operations were not always as indicated. Secondly, because they were sown in fertile fields traditionally dedicated to cereal production. The sown species could not compete with local floral species, the latter being quite resistant due to successive years of cereal monocultures. This resulted in dominance of native plants, which suppressed the sown species.

3. The existing machinery and equipment on the island, although not the most suitable for soil preparation and sowing of this type of mixtures (some of the sown species have a very small seed size, with 1 million seeds kg^{-1}), do allow for successful operations if care is taken when soil is prepared and mixtures are sown.

4. The sowing dates were not always the most correct, with some plots sown in January, February and March, while it is recommended to sow in the autumn, preferably before the first rains and before the soil temperatures decrease. When sowing in autumn, the sown species only compete with local species.

5. The lack of fences or other methods of animal exclusion, coupled with the small size of each plot, does not allow for a correct management of the sown biodiverse pastures. In some plots there is no control of entry and exit of the animals and due to the small production area, all existing pasture is quickly consumed. Subsequently, it is not possible to correctly assess the results achieved.

6. We observed that two of the species used in the mixtures did not show any adaptation to the soils where they were tested - Sanfeno (*Onobrychis vicifolia*) and Sula (*Hedysarum coronarium*).

7. Some soils in the trial plots, due to their high fertility, benefited the grasses present in the mixtures at the expense of the legumes, which causes irreversible quantitative and qualitative imbalances in the fodder produced.

RECOMMENDATIONS

Taking into account the obtained results, we consider that the sown biodiverse **annual** pastures should, at this moment, not be the focus of action, although they may gain importance in the future. We should currently concentrate our efforts on the implementation of sown biodiverse **permanent** pastures, rich in legumes.

The island of Samothraki provides excellent conditions for the installation of sown biodiverse permanent pastures. They may be of crucial importance, not only for farmers' economic performance, but also for their role in biodiversity conservation, and their high ecological, cultural and aesthetic value.

As one of the most important traditional agricultural land use system, biodiverse permanent pastures present a valuable tool to mitigate the negative effects of those factors not controlled by man. These pastures provide a better use of water resources, by conserving soil moisture and by reducing thermal fluctuations at ground level. In addition, the organic matter produced is not degraded and thus the active ingredients in the soil are increasingly metabolized by the enhanced microbial activity in the soil. Furthermore, the biodiverse permanent pastures play an important role in soil protection against erosive processes and they reduce the fire risk.

In Samothaki, sown biodiverse permanent pastures can contribute to the maintenance and conservation of the biodiversity and its associated landscape, minimizing the fast advancing erosive processes, the latter not only due to adverse climatic conditions, but also to the observed high animal pressure, which increasingly determines the landscape. In addition, the sowing of these pastures will increase the island's forage production, thus allowing a reduction of grazing pressure in the most sensitive areas, such as mountain areas, and enabling a retreat of sheep and goats to less susceptible areas. These pastures can provide a two- to five-fold increase in production, as compared to natural pastures, without introducing new species, but rather cultivars of existing species, selected for their productive capacity, as we observed several native species that entered into the seed mixtures used.

Thus, the concept of SUSTAINABILITY, associated with sown permanent pastures, can be used for livestock products, such as meat, milk, cheese, wool, etc., which may be labelled as 'Sustainable Products', as a result of the good agricultural practices associated with this type of pasture. Also, other local agricultural products provided by the sown biodiverse permanent pastures may be associated with this concept of sustainability.

The agricultural activity which is directly associated with several excellent products of the island of Samothraki (for example the Samotracian goat, the lambs that provide several traditional dishes, the cheeses Mizithra, Kaskavali and other hard cheeses) made by local shepherds from sheep and goat milk take advantage of the natural pastures of the island. These products may be in the front line to be considered sustainable products, due to the good agricultural practices that are applied.

Olive groves, as well as vineyards and other orchards on the island, can also benefit from this concept of sustainability, if associated with good agricultural practices (e.g. integrated protection or biological production) regarding the understorey vegetation. The maintenance of an herbaceous cover, provided by the sown biodiverse permanent pastures, in the understorey of these permanent cultures is fundamental to minimize the erosive processes.

Providing a vegetal cover in olive groves, vineyards and/or orchards will be essential to avoid the soil loss that occurs in those areas with inclination.
This cover will not only protect the soil against erosion and improve its physical and chemical properties, but it will also lead to a gradual improvement of the soil organic matter. This will result in an increase in fertility, infiltration and water retention capacity. The produced vegetal cover should be left on the ground in order to protect the soil, not only reducing the impact of erosion (rain, wind, etc.), but also avoiding water loss through evaporation.

The establishment of sown biodiverse permanent pastures in the understorey of olive groves, vineyards or orchards, would mean that several locally produced products (e.g. olive oils, currently produced in a biological way, according to Greek ancestral methods) could benefit from the concept of sustainability. Another example is the autochthonous species of plum, called ‘Pragouoti’ by the locals, used to make traditional jams and liqueurs, much appreciated by the tourists. These products could, if associated with the agricultural practices mentioned, obtain the sustainable classification.

Another example is the honey. In conjunction with the local flora, the sown biodiverse permanent pastures, with their great variety of flowers during several months, could contribute to a differentiated product, of great quality and at the same time environment friendly. It is already common to sow the mixtures in the vicinity of the hives, to guarantee the quantity and quality of honey and its related products, taken into account that many of the species used in these mixtures are considered as melliferous species.

The Samothraki craft beer ‘Fonias’, produced in a family microbrewery, may also be associated with the concept of sustainability, through the establishment of sown biodiverse permanent pastures, provided that rotation of the cereal, in this case barley, allows for the sowing of these pastures. The sown pastures will subsequently provide nitrogen for the cereal crop, and simultaneously contribute to an improvement of the physical and chemical properties of the soil. In addition, the gradual increase in soil organic matter, will translate into an increase of its fertility, later to be utilized by the cereal culture.

We know that the individual farmers of Samothraki will not be able to develop a process that leads to the certification ‘Sustainable Products’, due to the size of their exploitation and their reduced financial resources. However, public or private entities, national or international, can play a key role in a project with this ambition.

We believe that a project that aims at the sustainability of the island of Samothraki, from its main tourist activity to the fisheries and its agriculture/livestock, will be beneficial. It will privilege the conservation and preservation of its biodiversity and emphasize the great ecological, cultural and landscape values that these activities represent on the island.

The certification of several local products as "Sustainable Samothraki" could be a factor of differentiation with third parties. Also, it will be a tourist attraction for the island to behave ‘environment friendly’, preserving increasingly rare values in the world’s economy, which is often more concerned with financial ratios than with the sustainability of the planet.

The initiative to implement this environmental tool (‘Sustainable Products’) to Samothraki, such as the sowing of biodiverse permanent pastures, will be associated with the higher values that the island represents. It can make Samothraki a world reference in the green

economy, as a result of a policy directed towards the preservation of the ecosystem, simultaneously promoting sustainable economic growth.

Parallel to the establishment of sown biodiverse permanent pastures, a change of those procedures inherent to the agricultural activities on the island, should be considered, in particular, regarding the preparation of the soil:

- Soil mobilizations are carried out favourably to the slope, that is, perpendicular to the contour lines. This provides a superficial water runoff, which will carry a high amount of soil, especially in those plots with a marked slope. These mobilizations should be carried out following the elevation contour lines, so-called ‘contour plowing’, which will reduce the surface water runoff.

- An excessive soil mobilization system is observed, often using plows, with two and three irons (planters), which leads to a greater risk of soil loss due to erosion. In addition, this contributes to the appearance of so-called "callus", which creates a layer impermeable to the subsoil level. Therefore, these plows should only be used in specific cases, and, if possible, alternative ways of soil mobilization should be considered;

- The cereal monoculture system (oats, barley and/or wheat) should be kept to a minimum, especially in steep areas. Here, the permanent pastures with or without agroforestry systems will unequivocally contribute to soil protection. Sowing annual crops (cereals or other crops) should take place as early as possible, using early species and varieties. This will allow for rapid soil cover, before the onset of the period of heavy rains. In addition, using consociations, such as legumes with grasses, will contribute to the maintenance and conservation of the soil, as well as to species biodiversity (note that a fairly poor flora was observed in the lowlands, as a result of successive soil mobilizations and herbicide applications);

- Placing protectors for the natural regeneration of existing forest species will be fundamental to ensure their development and the creation of a stable arboreal cover. This as opposed to the current situation, with goats grazing disorderly, and the young trees are no more than shrub. The erosion risk, due to rains and intense winds, can be minimized if we create a forest, where the broad canopy of trees provides a protective soil cover, a situation observed in the recent past.

To conclude, we hope that the work undertaken meets the expectations, and that it contributes to Samothraki's acquisition of sustainable development parameters. We hope that these parameters will contribute to the preservation / the recognition of the supreme scenic beauty and also contribute to the satisfaction of all those who live in Samothraki.