SOLID participatory research from UK: Mob Grazing for Dairy Farm Productivity

Authors: Konstantinos Zaralis

August 2015

The Organic Research Centre

This work was undertaken as part of the SOLID Project (Agreement no. 266367 (http://www.solidairy.eu/), with financial support from the European Community under the 7th Framework Programme. The publication reflects the views of the author(s) and not those of the European Community, which is not to be held liable for any use that may be made of the information contained.

Summary

The aim of this case study was to determine the effect of mob grazing on soil organic matter under diverse swards and assess the performance of dairy cows in terms of energy utilisation and milk production. Mob grazing is a livestock management grazing strategy that is characterized by high stocking densities of livestock which are moved frequently from paddock to paddock with the aid of electric fences, trampling forage into the soil as they graze. The pasture land is then left, ungrazed until it is fully recovered, allowing the whole host of plant species to establish in the sward. In this respect, mob grazing tries to simulate the grazing behaviour of vast herds of wild herbivores found on the American plains, or in the African savannah. There is a growing notion that trampling of significant quantities of forage onto the soil surface provides a better environment for microorganisms and other soil life and increases the soil organic matter. In addition, as this grazing system allows the plants to grow taller, the formation of large, complex and deep root systems leave high amounts of organic matter in the soil when they die off. Mob grazing is usually applied in diverse swards as these leys are postulated to promote microbial activity resulting in increased soil carbon levels and building humus. The claimed benefits of mob grazing on soil organic matter have not been studied in scientifically robust experiments/studies and this gap in scientific knowledge is reflected in the literature.

A 220 ha mixed dairy / arable farm located at Gloucestershire, UK was used a case study. The farmer introduced a mob grazing approach on diverse swards with the aim of increasing soil organic matter. Preliminary assessments on pasture composition and productivity were carried out in 2013 while systematic data collection on pasture and animal performance in addition to pasture productivity were collected from April to September 2014. In addition soil samples were collected in 2015 from three different fields and compared to earlier results from 2007 or 2012.

This study shows that soil improvement management through rotational high stocking grazing of bio-diverse pastures has a remarkable effect on the build-up of the soil organic matter; while microbial activity in the soil is moderate this can be improved by bio-treatment of slurry or farmyard manure. An average 21-day grazing rotation was applied on the farm during 2014 which is regarded as rather a short period to allow plants to grow to the desired height that fulfils the expectations of mob grazing. Nevertheless the results show that bio-diverse pastures serve as a viable alternative to conventional pastures (i.e. grass / clover pastures) as they can maintain animal productivity at high levels.

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1 Aims and Research question

The aim of this case study was to determine the effects of mob grazing on soil organic matter, and the performance of dairy cows in terms of energy utilisation and milk production.

2 Background

2.1 Farm Background

A UK farmer has been awarded a travel scholarship to study practical aspects of management relevant to the issue of increasing soil carbon and using "Mob grazing" as an approach to address this issue. Mob grazing is a generic term which means that the grass is exposed to "short duration, high-density grazing followed by a long recovery period" (some issues regarding the definition are discussed in section 2.2.1). Because mob grazing involves high stocking density for a short period of time with long recovery times between consequent grazings, there is some uncertainty as to how applicable is this grazing management approach under UK conditions. The farmer believes that longer intervals between grazings are likely to be best suited to swards that are more diverse than those based on ryegrass which are currently typical of UK dairy farms. According to the farmer, mob grazing holds the key to improving and maintaining soil fertility and forage productivity in his organic system. In his study report the farmer notes: "*The best way to rebuild soil carbon levels is by the rotational grazing of bio-diverse pastures. The stable environment under the ley allows the biology to establish in the soil, whilst promoting the plant's ability to exude large amounts of sugars through its roots (up to 70% of what it produces). This provides a ready food source for the microbes, resulting in the ability to increase soil carbon levels by one per cent every three years (20t carbon/ha/yr). From my studies I have determined that the fertility of a soil is its ability to hold and recycle nutrients and water in a plant available form. To do this, a soil needs to be biologically active and fed a range of foodstuffs – a combination of rapidly digestible green plant material/animal slurries and slower digestible crop residues and farm yard manure. The biology in the soil is responsible for breaking down this material, releasing the nutrients from it, and building humus.*"

Manor Farm is a 220 ha mixed dairy /arable farm at approximately 260 m above sea level. It has a long history of arable use in many fields and was converted to organic production in 2005. The herd consists of Friesian-Shorthorn cross dairy cows that are spring calving, with a lactation period of 300 – 310 days. Full-time housing of the cows is limited to two months (i.e. December and January). Kale and fodder beet are grown for additional winter grazing.

The farmer introduced a mob grazing approach on diverse swards with the aim of increasing Soil Organic Matter (SOM). Leys were reseeded as part of the rotation every five years with a diverse sward mixture that includes 10 different grass species (i.e. Lolium multiflorum, Lolium perenne, Dactylis glomerata, Phleum pratense, Festuca pratensis, Festuca arundinacea, Poa pratensis, Cynosurus cristatus, Trisetum flavescens, Festuca rubra) six legumes (Trifolium pratense, Trifolium repens, Trifolium hybridum L., Lotus corniculatus, Melilotus, Onobrychis viciifolia) and five herbs (Cichorium intybus, Plantago lanceolata, Sanguisorba minor, Achillea millefolium, Petroselimun sativum). The best method for establishing the long-term diverse ley was found to be sowing under a spring cereal crop.

This case-study aims to gather soil, forage and animal production data from the above-mentioned farm where mob grazing on diverse swards is being used as a method to increase the organic matter of soil in order to evaluate this system and provide information for those considering adopting this approach.

2.2 Research Background

2.2.1 Definitions

It is regarded that "Mob Grazing" as a grazing system has its basis on the grazing patterns of some species of wild herbivores roaming unrestricted over large rangelands: animals spend a short time in a small area before moving on, leaving behind manure concentrated on a small area, and considerable plant residues, above and below ground, both of which contribute to soil organic matter (SOM) and to soil nutrients (Savory and Butterfield, 1999). Mob grazing tries to simulate the grazing behaviour of vast herds of wild herbivores found on the American plains, or in the African savannah. Some authors consider mob grazing to be similar to the holistic grazing approach (Savory, 2013), while McCosker (2000), in an extensive categorisation of grazing methods, uses the term "Cell Grazing" instead of "Mob Grazing" and places these two approaches in different categories. Allen et al., (2010) uses the term "Mob Stocking" instead of "Mob Grazing" and refers to it as "*a method of stocking at a high grazing pressure for a short time to remove forage rapidly as a management strategy*". Amongst farmers another term is frequently used, that of "Tall Grass Grazing". This inconsistency in the terminology and the different perspectives on this grazing system create some confusion and in many cases make it difficult to compare and discuss its claimed benefits. Herein we will regard "Mob grazing" a "short duration, high-density grazing followed by a long recovery period".

Picture 1*. Suckler cows graze tall, mature pasture in Mississippi, USA (source, Tom Chapman, 2012)*

2.2.2 Claimed Benefits

Published work on such grazing systems to date has mainly been carried out in arid areas (Savory and Butterfield, 1999). According to *Savory Institute* (savoryinstitute.com) this management has been shown to provide environmental improvements on previously overgrazed areas in Africa, Australia and America, through the return of organic matter to the soil. Clatworthy, (1984) was the earliest publication which showed that “planned grazing under mob stocking principles” in Rhodesia doubled the number of animals which an arid area could carry, compared with a “government grazing system” (not defined), with no deterioration of the plant community. In another arid region, South Idaho, Weber and Gokhale (2011) demonstrated a statistically significant increase in soil moisture retention under “holistic planned grazing” (i.e. 3 day grazing at high stocking density) compared with both total rest of land and with a 30 day grazing with a lower stocking density.

Farmers are interested in increasing soil organic matter (SOM) because it is well known that it serves as a reservoir of nutrients for crops, provides soil aggregation, increases nutrient exchange, retains moisture, reduces compaction, reduces surface crusting, and increases water infiltration into soil. The build-up of SOM can be influenced by the way in which the sward is managed (e.g. increasing the return of vegetation to the soil), and also by the plant species in the sward. It is considered that leaving higher residuals in the paddock can be a strategy for building up SOM, through the contribution of “liquid carbon” through plant roots. Plants with more above ground canopy are able to grow larger root systems than those that are grazed more severely and the long recovery time between grazing allows plants to establish a healthy root system. The roots grow deeper into the soil, bringing up nutrients and making the plant more drought-hardy. The long recovery time also leads to high volumes of above-ground forage, a mixture of leaf, seed and stem. In addition, it is claimed that the high stocking density results in more than 50% of the plant being trampled into the ground by the animals. Uneaten plant stems are trodden onto the soil surface and these stalks act both as mulch and as a food source for the soil microorganisms, building new soil in the process (Chapman 2012; Richmond 2011). It is also claimed that by turning animals out into a fully mature pasture, animal performance is improved as they can select the most nutritious parts of the plants and benefit from grazing the lush tops of the plants, seed-heads and upper leaves that are high in energy and protein.

The claimed benefits of mob grazing on SOM and animal performance have not been studied in scientifically robust experiments/studies and this gap in scientific knowledge is reflected in the literature. In the UK, there is a small but growing interest in this grazing method especially in the view that this method contributes to increasing SOM, but there is some uncertainty about the levels of production that may be achieved.

3 Methodology and Data Collection

3.1 Location of the Farm

Manor Farm managed by Nuffield Scholar Rob Richmond was used as a case-study. The farm is located in the Cotswolds, near Gloucestershire, UK.

3.2 Data collection and sampling

Data were collected from April to September in 2014 while preliminary assessments were also carried out in 2013.

3.2.1 Forage samples for pasture productivity, forage composition and feed intake estimation

Herbage yield and composition of the swards were assessed on a monthly basis in the same field (*Big Aero*) which was representative of the type and the age of the swards across the farm.

Picture 2. *Assessing productivity of diverse lays with the quadrat method (i.e. 1, un-grazed plot; 2, grazed plot)*

The square-metre quadrat method was used to determine the productivity of the grazed pasture and thus allowed estimates of dry matter (DM) intake of the grazing cows. Briefly, a one-square-metre quadrat was placed randomly three times across the un-grazed plot (i.e. this was the next plot to be grazed by the animals within the next 12h). All the vegetation within the quadrat area was cut to approximately 5 cm height and the cut herbage from each quadrat was collected in separate bags; fresh weight was recorded. The same procedure was followed also in the residual forage in the grazed plot (i.e. this was the plot the animals had just grazed).

DM content of the herbage both in the un-grazed and grazed plots were determined, allowing the calculation of the total DM productivity of the field while differences in DM productivity between un-grazed and grazed plots were used to estimate forage DM intake of the grazing cows. Sub-samples of the harvested forage were separated into four categories as follows: a) grass, b) clover c) other legumes and broadleaves and d) senescent material allowing for the determination of percentage of grass, clover, and broadleaved species on the grazing plots. Additional herbage samples were analysed by wet chemistry for metabolisable energy (ME) and Crude Protein (CP) content.

3.2.2 Monitoring of farm records and additional calculations

At the end of the monitoring period each year the farmer provided data and information regarding milk production and composition, grazing records (i.e. area and livestock numbers grazed daily) as well as supplementary feeding records regarding forage and concentrate supplementation, amounts and periods fed. These data in addition to chemical analysis data were used to estimate the ME intake of the cows over each season from the given field. Data from the sampled field were extrapolated to provide an estimate for the whole farm for each year.

3.2.3 Soil Samples

Historic data on the organic matter content of soil from three different fields are available from 2007, and 2012. At the end of the two years' monitoring, soil samples were taken again in spring 2015 from these fields to assess the change in soil organic matter (changes in SOM are likely to be slow, so maximising the time will increase the likelihood of detecting a change).

3.3 Time Scale

The project initiated in 2013 with farm visits and preliminary monitoring of the system while systematic data collection lasted from March to September 2014. Final soil samples were collected in spring 2015.

4 Results and Discussion

4.1 Pasture productivity and herbage composition

The productivity of the grazed sward during the monitoring period (i.e. April to September 2014) averaged 10.3 tonnes per hectare. Herbage composition and monthly productivity of the diverse swards grazed by the cows from April to September are shown in Figure 1.

Herbage production increased from April to August while the composition of the herbage in summer months remained relatively constant as shown in Figure 1. Clover production accounted for about 24% while grass production accounted for 71% of the total herbage production. The productivity of other legumes and "broad leaves" represented 6% of the total production and senescent material remained below 3% of the total production. Preliminary data collected in 2013 indicated a similar productivity of the grazed sward but herbage composition fluctuated between months (data not shown).

Five forage samples collected at farm visits during April – September 2014 were analysed for chemical composition. The grazing diverse sward had an average of 19.1% DM, 10.8 MJ of ME, 21.3% of CP and 376 g of NDF indicating a good quality forage. The average ME content was marginal as normal values for this type of forage are 11 to 13 MJ of ME per kg DM, but CP content was high and NDF within the expected levels.

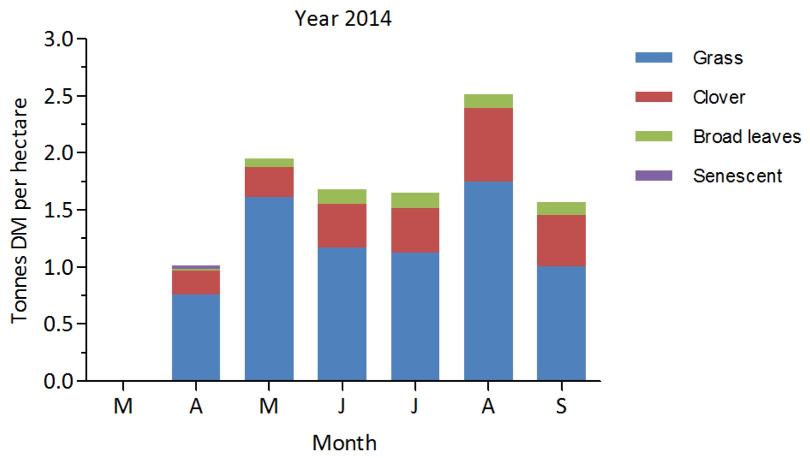

Figure 1. *Monthly pasture productivity (tonnes of DM per hectare) and herbage composition of the diverse swards.*

4.2 Gazing data, feed intake and cow productivity.

Grazing data from the 3rd of April to the 25th of September 2014 are shown in Table 1. On average 181 milking cows grazed a diverse sward field of total area of 12.5 ha for a total of 43 days in monthly rotation intervals. The duration of the grazing varied from 6 to 10 days based on herbage availability. The cows were moved on twice a day after each milking, grazing two adjacent plots of an average size of 0.9 ha delimited by electric fences. The average stocking density over the grazing period was 115 tonnes of livestock per hectare. The resting period of the diverse sward between consecutive grazings averaged about 21 days with 16 and 25 days the shortest and the longest, respectively. These resting periods do not coincide with the principles of "mob grazing" where resting periods are of long duration (i.e. more than 50 days) but the stocking density was relatively high (Table 1). In year 2013 the farmer was applying a 40 to 50 days rotation management allowing the pastures to recover for longer but the total forage productivity was similar to 2014.

Table 1: *Summary of the grazing data during the monitoring period 3rd of April to the 25th of September 2014.*

Grazing Period From	Grazing Period To	Grazing duration (days)	Number of cows	ha grazed per day*	Total LW of grazing cows (t)**	Stocking Density (t LW per ha)
03-Apr	09-Apr	6	150	2.08	82.5	79.2
05-May	12-May	6	180	2.08	99.0	95.0
02-Jun	11-Jun	8	189	1.56	104.0	133.1
05-Jul	23-Jun	10	189	1.25	104.0	166.3
09-Aug	19-Aug	6	189	2.08	104.0	99.8
12-Sep	25-Sep	7	189	1.79	104.0	116.4
On Average		7	181	1.81	99.6	115.0

*The total area was not grazed at once but it was divided into two plots
** Assuming a cow LW of 550 kg

Daily ME requirements were calculated for an average LW of 550 kg and include ME requirements for maintenance (i.e. 65 MJ ME), reproduction (i.e. 26 MJ ME) and monthly milk yield based on monthly average milk fat and milk protein content (see Table 2). The estimated grazed intake per cow per day in each month as well as the calculated ME intake are shown in Table 3. Over the period the average daily grazed intake per cow was 17 ± 1.9 kg DM but it fluctuated from as little as 10.9 kg DM in July up to 23.8 kg DM in August. The average daily concentrate supplementation per cow was 2.9 ± 0.29 kg DM ranging from 4.3 kg DM in April to 2.2 kg DM in September.

Table 2: *Average monthly milk production and composition during April to September 2014 and calculated ME requirements per cow.*

Month	Milk Fat	Milk Protein	Milk Yield	ME Req for Milk
April	3.47	3.15	24	113
May	3.40	3.22	26	122
June	3.53	3.21	25	119
July	3.49	3.19	22	104
August	3.69	3.27	20	97
September	3.98	3.43	17	87

Table 3: *Estimated feed (kg DM) and energy intake (MJ) per cow per day during the grazing period from April to September 2014.*

Month	Estimated grazed intake		Supplementary feed Intake*		Total ME Intake	Total ME requirements	Energy Balance
	DM intake (kg)	ME intake (MJ)	Kg DM	ME intake (MJ)			
03 – 09 April	14.0	152	4.3	56	208	204	4
05 – 12 May	22.6	244	3.0	39	283	213	70
02 – 11 June	13.9	150	3.0	39	189	210	-21
05 – 23 July	10.9	118	3.0	39	157	195	-37
09 – 19 August	23.8	257	2.2	28	285	188	96
12 – 25 September	14.8	160	2.2	28	188	178	11

*Natural Organic Green HDF 18 Nuts (BOCM PAUL LTD), 862g DM, 18% CP, 13 MJ ME.
** Assuming a cow LW of 550 kg

The estimated ME intake from the forage in addition to the ME Intake from the supplementary feed (i.e. Natural Organic Green HDF 18 Nuts (BOCM PAUL LTD), 862g DM, 18% CP, 13 MJ ME) covered the daily ME requirements of the cows in most months, but there was a nutritional shortfall in ME intake during the grazing periods in June and July as shown in Figure 2a. This is explained by the relatively low forage DM intake that is estimated for these periods (Table 3). The low DM intake is likely attributed to the low forage availability (see Figure 1) which in turn is attributed to the fact that the farmer applied a relatively short grazing rotation scheme and the pasture was not allowed to recover fully. Nevertheless milk yield did not seem to have been compromised (Table 2) by the relatively low intakes estimated for these days which suggests that subsequent grazing in the next field in rotation allowed for good DM intakes. It is well established that milk production has a linear positive relationship with DM intake as cows produce more milk at higher intakes (see Figure 2b). Over the monitoring period the daily DM intake per cow averaged 19.6 kg DM while the daily milk yield averaged 22.3 kg. These intake and productivity data are consistent with each other and are in accordance with the predictions postulated by the literature and illustrated in Figure 2b.

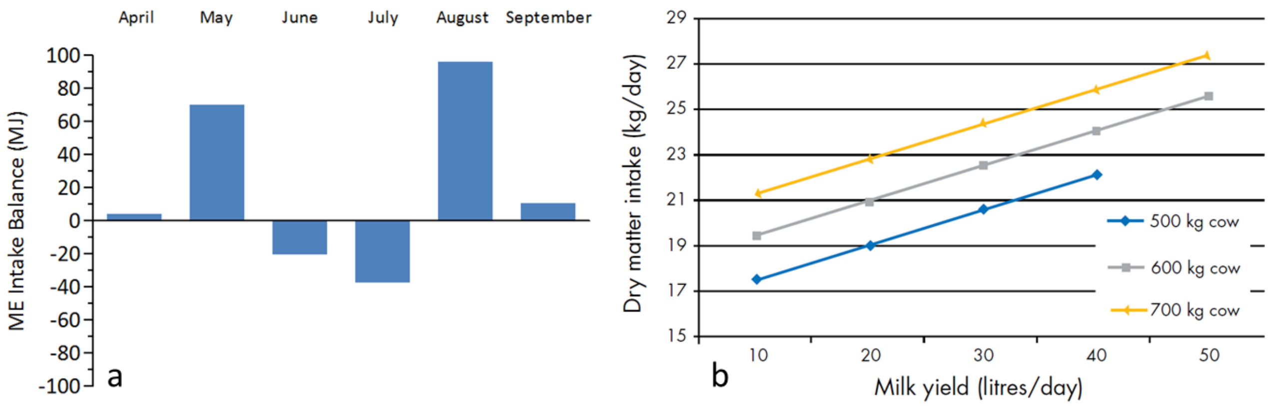

Figure 2. *Monthly estimated ME intake balance of the cows from April to September 2014 (Panel a); relationship between dry matter intake and daily milk yield (Panel b; Source: DairyCo Feed into Milk, 2005)*

4.3 Effects of mob grazing on soil organic matter.

It is well recognized that grassland soils with low organic matter content are characterised by poor fertility, are prone to compaction and flooding and are droughty and lacking soil microorganisms. As the organic matter rises and the soil becomes more fertile, the land grows more forage and the capacity of the land to carry higher stocking rates increases. It has been suggested that rotational grazing of bio-diverse pastures has the potential to build up carbon levels in the soil. The underling hypothesis is that the stable environment under a diverse ley promotes the plant's ability to exude large amounts of sugars through its roots which in turn provides a food source for microbial activity resulting in increased soil carbon levels and building humus. The advocates of mob grazing suggest that this grazing system, by allowing plants to grow taller, results in the formation of large, complex and deep root systems and when they die off, they leave high amounts of organic matter in the soil. It is also advocated that trampling of significant quantities of forage onto the soil surface, provides a better environment for the microorganisms and other soil life and increasing the soil organic matter.

In the case-study farm, the mob grazing approach on diverse swards was introduced with the aim of increasing soil organic matter. Despite the fact that monitoring of the performance of the diverse swards was conducted only in one field (i.e. Big Aero) soil samples were collected in 2015 from three different fields (i.e. Big Aero, Lanes Estate, Pinchins) and compared with earlier results from 2007 or 2012. The results of the soil analyses in these fields are shown in Table 4.

Table 4: *Soil analysis results in three different fields (i.e. Big Aero, Lanes Estate, Pinchins)*

Analysis Factor* Field	Big Aero		Lanes Estate		Pinchins	
Year	2007	2015	2012	2015	2012	2015
Standard Soil Analysis						
Soil PH	7.2	6.9	7.9	7.9	7.7	7.8
Phosphate (mg/l)	13	7	16	15	6	10
Potash (mg/l)	123	131	247	180	107	154
Magnesium (mg/l)	107	138	106	101	123	124
Physical Soil Structure (%)						
Sand (%)	7	15	21	17	15	20
Silt (%)	55	39	46	41	43	36
Clay (%)	38	46	33	42	42	44
Macro Nutrients						
Organic Matter %	**4.4**	**9.8**	**5.3**	**7.8**	**5.7**	**8**
Microbial Activity	13	25	33	22	27	23
Sulphate (mg/l)	35	56	37	29	49	58
Total Phosphorus	906	901	1025	1244	841	1069
Chemical						
CEC (meq/100)	41.2	36.0	28	30.5	32.9	30.7
Calcium (%)	84.7	78.9	88.1	88.2	87.7	86.1
Magnesium (%)	1.6	3.8	3.6	4	3.1	4.9
Ca:Mg ratio	53	21	24	22	28	18
Potassium (%)	0.8	1.2	1.8	1.9	1.1	1.6
Sodium (%)	0.2	0.4	0.5	0.3	0.4	0.7
Hydrogen (%)	0.0	0.0				
Others (%)	11.5	15.7	8.1	5.6	8.7	6.7
Trace elements (mg/l)						
Iron	33	64	40	57	49	65
Molybdenum	0.4	0.40	0.10	0.3	0.3	0.4
Copper	1.2	1.90	1.7	2.3	1.6	1.6
Selenium	0.68	0.68	0.39	0.38	0.53	0.46
Zinc	1.9	2.0	2.3	2.7	1.4	1.7
Manganese	11.5	22.8	11.8	14.1	16.6	24.6
Cobalt	0.3	0.3	0.2	0.2	0.3	0.4
Boron	1.10	1.60	1.5	1.4	1.3	1.3
Conductivity	2029	1913	2099	1977	2046	2056

*Samples were analysed by Kingshay Analysis Services, Kingshay, Bridge Farm, West Bradley, Glastonbury, Somerset BA6 8LU.

Soil organic matter increased by 122.7%, 47.2% and 40.4% in Big Aero, Lanes Estate and Pinchins fields, respectively. The relative higher increase in soil organic matter in the Big Aero is attributed to the fact that samples collected in 2015 are compared with those collected in 2007 (i.e. 8 years earlier) and not in 2012, which is the case in the other fields (i.e. 3 years earlier). Yet, this is a marked improvement with more than double the levels of organic matter reserve. The build-up of the soil organic matter is also remarkable in the other fields as well. The overall soil analysis data suggest that soil improvement management through rotational high stocking grazing of bio-diverse pastures appears to have a beneficial impact on soil organic matter. Microbial activity in the soil does not seem to have been improved considerably over the years but it can be accelerated by bio-treatment of slurry or farmyard manure in short-term. In all fields tested soil trace element status is generally low which may indicate a potential need for zinc and copper supplementation in the ration of the herd.

5 Conclusions/Recommendations

The results of this case-study show that bio-diverse pastures are sufficiently productive to serve as a viable alternative to conventional pastures (i.e. grass / clover pastures) as they can maintain animal productivity at high levels. Although the farmer claims that the grazing system he applies in his farm falls within the principles of “mob grazing”, the average 21-day rotation he applied in his farm during 2015 is regarded as rather short to allow plants to grow to a desired height that fulfils the expectations of mob grazing. However, it should be acknowledged that grazing rotations were longer in the previous years while stocking density always remains high. This study shows that the build-up of the soil organic matter is remarkable and suggests that soil improvement can be achieved through high stocking rotational grazing of bio-diverse pastures

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