Malta Tourism Authority

Ix-Xaghra l-Hamra Golf Course, Mellieha Malta

Technical Appendix 1: Baseline Agricultural Survey

Supporting Document for
Environmental Impact Statement

Prepared by
Joseph A. Buhagiar

On behalf of
Adi Associates

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1. INTRODUCTION

1.1. The Government of Malta intends to seek planning permission for development of a golf course on a tract of land known as Ix-Xaghra L-Hamra and Tal-Qortin in the vicinity of Golden Bay, Ghajn Tuffieha and Manikata. The proposed development is for an 18-hole golf course and ancillary facilities with the possibility of developing part of the land for urban purposes. Malta Tourism Authority (MTA) as the project proponent and the entity submitting an application to MEPA, has been requested by MEPA to prepare an Environmental Impact Statement (EIS) to determine the current state of the environment in the area earmarked for development, and the likely effects thereon of the construction and operation of these facilities. As a result MTA has commissioned a study comprising a number of baseline surveys to be carried out including one for agriculture. The studies are guided by Terms of Reference (ToR) provided by MEPA.

1.2. The consultant was commissioned by Adi Associates Environmental Consultants Ltd acting on behalf of Malta Tourism Authority, to conduct an agricultural survey of the area earmarked for development, delimited in red on **Figure 1** and henceforth collectively referred to as the Ix-Xaghra l-Hamra Golf Course Development Area (XHGCDA).

Terms of Reference

1.3. The draft ToR issued by MEPA require the following:

2.0 DESCRIPTION OF THE SITE AND ITS SURROUNDINGS

This description is identified by the area of influence for each relevant parameter. The area of influence for each parameter shall be determined by the consultant who shall also justify the extent of the chosen sphere of influence. This must be approved by the Malta Environment and Planning Authority prior to commencement of the EIA. This description should include:

2.2 Land cover, agricultural quality and produce

This should include a multi-seasonal study with:

A field-by-field survey with adequate maps, plans, diagrams, photographs;
Details of crops, trees and vegetation in general;

Cropping pattern;
A description of how the land was used over the past years;
A description of the physical quality and productivity of agricultural land;
The agricultural value of the land;
A description of the agricultural potential of the land;
A description of the soil type, depth and texture is also required. This section should also include the drainage potential of the site in line with the soil type and underlying rock;
A classification of the land;
The impact of loss of land on the viability of the holding and the effect on agricultural operations in the locality.

1.4. In meeting the ToR, the Agriculture Baseline Survey is:

- To carry out a field-by-field survey giving details of crops, trees and other relevant vegetation present, over two growing seasons, suitably mapped and quantified;
- To assess and describe the physical quality of the land including a description of the soil type, depth and texture;
- To survey and appraise the productivity of the agricultural land and in particular to ascertain and advise on the agricultural value of the land and its agricultural potential as well as arrive at a land classification as determined by the Agriculture Department and MEPA;
- To determine the agricultural use of the land over the past years;
- To supplement the fieldwork by literature surveys and consultant's previous knowledge of the study areas;
- To analyse the policies (including local and international legislation) relevant to agriculture in the study area. These must be done especially in the light of the Golf Course Development Policy Paper issued by the MEPA; and
- To make recommendations as to any mitigating measures that need to be taken for the conservation/ preservation of areas or agricultural units that are of agricultural heritage importance within the study area and its environs.

1.5. In accordance with the above ToR, the baseline agricultural study is intended to satisfy the specific objectives outlined below.

i) A detailed study of the general physical parameters of the XHGCDA, including:

- An overview of the climatic constraints imposed on the site by aspect, slope, predominant wind direction, underlying substratum, and water availability from direct precipitation, surface run-off and throughflow;
- Soil quality - soil types by texture and total fines, average depth, drainage qualities, water retention, workability and nutritional status;
- Major constraints to agriculture including liability of the land to subsidence and sliding, soil creep, sheet and gully erosion, soil puddling, drainage and workability.

ii) A detailed field-by-field survey of the XHGCDA, including:

- Details of seasonal crops such as fodder or market vegetables and long-term or standing crops such as fruit trees or vines, presently available on the respective allotments. Other plants / trees / shrubs planted for alternative functions other than, or in addition to, cropping will also be noted;
- Details of the current cropping pattern over two growing seasons;
- Changes in land use, if any, over the past years.

iii) The economic aspects of agricultural practice in the XHGCDA, including:

- Classification of the agricultural land based on a set of predetermined criteria of an internationally recognised system such as the USDA or the UK system;
- Current agricultural value of the land in terms of productivity;
- Assessment of the agricultural potential of the land for three different scenarios:

  a) intensive but unprotected vegetable market gardening;

  b) intensive covered cropping (ground cloches or polytunnels); and

c) long-term standing crops (such as vineyards for noble grape production or olives).

iv) An assessment of the impact due to loss of land, including:

- Identification of the likely positive and negative impacts of the Scheme on the agriculture of the XHGCDA and surroundings and an evaluation of the significance of the effects;
- The economic viability of the farmers' remaining holdings, the potential negative effects on agricultural operations in the locality and mitigating measures; and
- A description of mitigation measures designed to:

  a) minimise adverse impacts on agriculture including potential displacement of current activities on the XHGCDA; and

  b) enhance agriculture potential of land not directly involved in the golf course but within the golf course development area.

2. DRY SEASON SURVEY

METHODOLOGY

2.1. The summer fieldwork was carried out from the first week of August to the middle of September 2005 mostly on consecutive days. The dates of the site visit are given on the table below.

Table 1: Dates for site visits

Months	Dates					
August	5/8/05	6/8/05	7/8/05	12/8/05	13/8/05	14/8/05
August	17/8/05	19/8/05	20/8/05	21/8/05	22/8/05	
August	25/8/05	26/8/05	27/8/05	28/8/05		
September	2/9/05	3/9/05	4/9/05	5/9/05		
September	7/9/05	8/9/05	9/9/05	10/9/05	11/9/05	

2.2. The methodology employed to gather the data is outlined in the Method Statement. (See **Appendix 2**) The fields comprising the XHGCDA were mainly characterised by visual assessment for a number of parameters / criteria, primarily intended to assist in mapping field crops on the XHGCDA, where present, and the occurrence of fruit or other standing trees and the presence and condition of field boundaries. However, additional data from each site was obtained, including soil samples and other physical measurements, in order to arrive at an informed decision on a number of other requirements for the baseline agricultural survey. The criteria assessed were as follows:

- For tilled fields, the seasonal crops under cultivation by type and variety and, for fallow fields, traces of previous crops where inference was possible. The area or quantity and stage of maturity, the general growth condition of produce and cropping patterns were also noted;
- The presence of standing crops including the type of fruit trees planted as distinct fruit orchards or vineyards or planted around the field perimeter, their general growth condition, estimated age and productivity;
- Presence of fruit trees by type or variety deemed of conservation importance due to their horticultural value or rarity in the Maltese Islands;

- Presence of other trees intended for wind shelter or other uses; principally Carobs and olives but also including exotics such as Acacias and Eucalyptus;
- Soil type and quality, and a true measurement or an estimate of soil depth where possible;
- Soil tillage practice including ploughing, harrowing and weed control measures such as rotovation, hoeing or herbicide use;
- Cultivation indicators including signs of manuring and the addition of fertilisers, as well as the application of pesticides - as useful parameters to determine quality of produce;
- Presence of field boundary walls as well as soil retention measures for terraced / slopping fields, and their general condition.
- Presence and condition of specialised structures for protected cropping such as greenhouses, ground cloches and mini-tunnels combined with the use of plastic and agrifleece;
- Presence of field rooms or other farmhouse structures and their condition, as well as other structures associated with bird trapping and hunting; the latter are quite numerous on the site; and
- Presence of water storage facilities by type and condition, and the presence and type of pipe works for irrigation of field crops.

2.3. The above details were noted and mapped – a land use map detailing where land is presently cultivated, once cultivated but now neglected, and the presence of primary and secondary garrigue. A physical characteristics map was also compiled to show physical parameters such as soil type, soil depth, wall height and condition, presence of reservoirs, etc.

2.4. Soil samples were gathered from fields at suitably chosen spots for laboratory analysis to assess soil textural characteristics and nutrient status. Where possible the samples were collected from the middle of the field. Two kilogramme samples were taken partly from the top 10 cm and the rest from a depth of 20 - 30 cm where soil depth permitted this. Samples are being analysed at the Soil Analysis Laboratory of the Government Agricultural Experimental Farm at Ghammeri. Soil analysis is being carried for the following parameters:

- Electrical Conductivity;
- Chloride Soluble;
- Sodium Soluble;
- Potassium extractable
- pH (1:5 soil: water at 25 ^{0}C); and
- Textural Analysis was performed using the hydrometer method to establish the percentage clay, silt and sand.

2.5. The results of the soil analysis are reported in the second (wet season) report.

2.6. The fieldwork was carried out over several weeks; the winter/spring produce had long been harvested but the summer crop was fully evident. Evidence of the previous wet-season crop had to be derived from the remains of crops left after harvesting which was possible only for those fields (usually dryland farmed) where only one crop is taken.

2.7. Some of the wet-season crops encountered included cereal fodder crops and winter market garden crops such as onions, garlic, broad beans, and rarely potatoes. It was not possible to determine previous cropping on those fields (and usually irrigated farmland) where more than one crop is sown. Most irrigated fields had a summer crop such as tomatoes, watermelons, cantaloupes and pumpkin, which was still being harvested or approaching the end of its harvest. A number of fields had also been prepared for an autumn crop of brassicas and lettuce, or the crop had already been planted though not well developed. The survey for summer crops was extended to the middle of September since a number of farmers plant out their fields to brassicas after a short fallow period in summer. In this locality, the summer brassica planting period starts towards the beginning of August, the brassicas being ready for harvesting by October to November. The results obtained to date, therefore, have elements of both the winter and summer cropping situation, though the summer or dry-season cropping is more intensely covered by the survey.

2.8. The field survey work was supplemented by additional sources of information, which included interviews with farmers wherever possible. Data from the literature included previous surveys and reports related to the study area, consultation of ordinance survey and geological maps. Aerial survey photographs of the area, supplied by the MEPA included those taken in 1957, 1967 and 2004. Photographic records of the holdings taken from various vantage points were also consulted.

2.9. The wet season fieldwork was carried out from the second week of November 2005 to the second week of January 2006 mostly on consecutive weekends. The dates of the site visit are given in the table below.

Table 2: Dates for site visits

Months	Dates					
November	12/11/05	13/11/05	19/11/05	20/11/05	26/11/05	27/11/05
December	3/12/05	4/12/05	10/12/05	11/12/05	17/12/05	18/12/05
December	26/12/05	27/12/05	28/12/05	30/12/05		
January	2/1/06	3/1/06	6/1/06	14/1/06	15/1/06	

2.10. It should be noted that the months of November 2005 through to January 2006 were characterised by overcast weather with frequent showery periods giving farmers little chance to work their fields and sow/tend their crops; a high proportion of the survey shows ploughed and harrowed fields but without visible signs of crop or sprouting seeds. The short periods of bright dry weather saw a flurry of activity to try to catch up with lost time. It appears that the this season is one of the wettest in many decades though it may not be one of the best in terms of produce given the late start.

2.11. The methodology employed to gather the data during the wet season follows closely on that used for the dry season and is mainly based on visual assessment for a number of parameters/criteria. These are outlined in the method statement and were primarily intended to:

- Record the current state of land use for fields under assessment including major changes from the previous dry season;
- Map out the field crops on tilled fields, the seasonal crops under cultivation by type and variety. The area or quantity and stage of maturity, the general growth condition of produce as well as cropping pattern were also noted;
- Record soil tillage practice including ploughing, harrowing and weed control measures such as rotovation, hoeing or herbicide use;

- Record cultivation indicators including signs of manuring and addition of fertilisers, as well as application of pesticides as useful parameters to determine quality of produce;
- Record the state of the land in the absence of visible signs of a crop - where the soil has been recently ploughed and harrowed, but crop pending a P&H (CP) status was noted; and
- Record any improvements made since the end of the dry season survey such as land reclamation, new tree plantings, etc.

2.12. Other details that were recorded in the dry season survey but are not expected to change substantially, such as the presence of field structures, reservoirs and wells, presence of wind shelters, etc were not reassessed. The data collected were used to compile the wet season land-use and cropping maps.

2.13. The field work was carried out over several weeks when most of the dry season cropping had long been harvested and replaced with the wet season crop. The wet season survey includes the autumn crop of brassicas and lettuce that was started off between the beginning of August and the start of the rainy period in mid-September. The early brassicas would be ready for harvesting by October to November but all depends on a number of factors including maturation rate due to climate. Thus figures for some crops may represent the dry to wet season transition and may actually be noted twice The combined results obtained to date, therefore, cover the dry and wet season cropping as well as the standing crop present.

2.14. The results of the agricultural survey are presented as an agricultural land use map. **Figures 11** and **12** show the extent and distribution of the different agricultural activities during the wet season in the XHGCDA.

3. SURVEY RESULTS

LOCATION OF SITE

3.1. The area under study, referred to as the Ix-Xaghra l-Hamra Golf Course Development Area (XHGCDA)) in this report, refers to the entire site indicated for assessment, see **Figure 1**. The extent of the site was agreed with MTA, MEPA, and Adi Associates, the remit being to concentrate predominantly on those areas of agricultural importance. The baseline is extended to encompass an Area of Influence (A of I) of 100m beyond the actual development site area as described in **Figure 1**. The 100m cut-off for the A of I has been applied and accepted as a sufficiently wide boundary in similar studies and is justified on the premise that any use of accepted agrochemicals on the proposed golf course should not exert a negative influence on the surroundings beyond this limit. Further details are given in section C of the Agriculture Method Statement in **Appendix 2**.

3.2. The XHGCDA is nestled between two regions with a long agricultural history, and adjacent to a small urban area. Because of its proximity to these agriculture zones and because of its past agricultural history and potential agricultural contribution, the area can still be considered to form part of what the Structure Plan of the Maltese Islands classifies as the Rural Core Agriculture, that is, part of those regions in the Maltese Islands were the impact of urban growth has been the least and where the predominant use of the land is for agricultural practice.

GENERAL DESCRIPTION OF THE STUDY AREA

3.3. For ease of reference, the XHGCDA has been subdivided into a North and South Sector; roughly delimited by the existing major or minor road network or some other defined topographical boundary. The extent of the North Sector, which can be described as a roughly rectangular area, and the South, which can be described as a roughly T-shaped area, are shown in **Figure 2**. The figure also shows the subdivisions of the North and South Sectors into sub-sectors A- V.

3.4. The site covers an area of 114 hectares or 1013 tumoli equivalent. The areas of the individual sectors are approximately:

- North Sector: 640,000 m^2 (64 Ha) or 569 Tumoli equivalent;

- South Sector: 500,000 m^2 (50 Ha) or 444 Tumoli equivalent.

3.5. These two Sectors are separated from each other by a strip of land varying in width from 250m and 40m; the eastern part of this strip being mainly the Manikata urban development and the western part being predominantly garrigue. A narrow corridor of land connects the North and South Sectors.

3.6. The North and South Sectors are quite different from each other and each sector can be said to have its own topographical features and landscape character. The following is a detailed description of these sectors.

North Sector:

3.7. The North Sector is mostly situated on the western end of a major ridge system namely Bajda Ridge and is mainly composed of a mixture of rocky primary (and secondary) low thyme garrigue interspersed with areas that were once productive fields. These are now partly abandoned or under-utilised mostly because of difficulty to till their shallow soils using machinery. However, within the North Sector and adjacent to it, there are agriculturally highly productive tracts of land where the soil is naturally quite deep or its depth has been increased. Furthermore, the low thyme garrigue plays an important agriculture role for honey production which, beside the economic benefit, helps sustain a bee population required for crop pollination. The North Sector incorporates the following areas:

- The north part of Ix-Xaghra l-Hamra adjacent to Ix-Xatba and Il-Mejjiel;
- Il-Qortin adjacent to Il-Ghonq and Ix-Xaghra ta' Ghajn Znuber; and
- The south part of Ix-Xaghra l-Hamra adjacent to Manikata and Il-Moghxa ta' Ghajn Tuffieha.

3.8. For ease of reference, the North Sector has been subdivided into a number of sub-sectors labelled A to G and M to O using major field boundaries to delimit the sub-sectors (See **Figure 2**).

South Sector:

3.9. The South Sector, which has a more varied topography, incorporates the steep-sided southern flanks of Bajda ridge and stretches towards Ghajn Tuffieha where the flatter land forms part of the western extremity of the Pwales Plain - a major valley system important for its agricultural production. The steeper and more rugged part of the South Sector incorporates more extensive terracing dedicated almost exclusively to figs and carobs and occasionally to olives where the soil is shallow or to orchards and vines where the soil is deeper. The flatter tracts of the South Sector also have large areas of irrigated and semi-intensive agricultural production. The T-shaped South Sector incorporates the following localities:

- In-Nahhalija adjacent to the Cliffs known as Il-Minzel tal-Mejjiesa and Il-Kamp ta' Ghajn Tuffieha; and
- Il-Qasam ta' Ghajn Tuffieha adjacent to Il-Fawwara and Il-Ballut ta' Ras Il-Habel limits of Ghajn Tuffieha.

3.10. For ease of reference the South Sector has been subdivided into a number of sub-sectors labelled P to T and U to V, again using major field boundaries to delimit the sub-sectors (see **Figure 2**).

3.11. The sectors can be accessed from a number of secondary roads as well as unpaved country tracks. The North Sector can be accessed from Triq il-Mejjiesa and also through Triq il-Mellieha which runs past Manikata church. From this paved secondary road one can access the northernmost part of this sector through a rough country track running between Ix-Xatba and Ix-Xaghra l-Hamra to the north-western extremity of the site. This same track turns at right angle at this point and thus helps to delimit the northern and western extremities of the site. Another track runs diagonally from the same paved secondary road through the North Sector towards the area known as Ix-Xaghra tal-Qortin. Two minor tracks between sub-sectors D and E and H and J lead to the fields within the North Sector. A third track, paved for about half of its length, delimits the south extremity of the North Ssector. The South Sector can be accessed from two paved roads, namely Triq il-Manikata and Triq-Ghajn Tuffieha which circumscribe the east, south and west extremities of the South Sector. A paved secondary road runs the length of the South Sector dividing it approximately into two halves.

Geology

3.12. The geological considerations are important because very often the underlying parent rock stratum determines the soil type that has formed *in situ* when this stratum is not completely eroded. However, this may not be always the case, since soil can accumulate through alluvial / colluvial action or it could have been imported. The rock strata and the overlying soil have additional roles. The underlying rock stratum may also affect the crop quality and potential for water availability through wells and boreholes, and may determine the rate of water infiltration into the underlying aquifer. The geological subdivisions represented on the XHGCDA are represented in **Figure 3**[1]. They can be described as follows:

a) The XHGCDA is principally located over most of its area on the Upper Coralline Limestone (UCL) rock substratum known as the Tal-Pitkal Member. Another UCL member known as Gebel Imbark Member occurs over a more restricted area, mostly restricted to the hill tops such as in the vicinity of the covered reservoir. The third type of UCL (Mtarfa Member) occurs over a small area immediately to the south of Manikata. The different UCL members show different characteristics which need not be elaborated upon here but which are important in relation to the soil formation, water availability and plant productivity. The Mtarfa Member of the Upper Coralline Limestone (UCL) is a water permeable layer that helps to convey water to the perched aquifer and is indeed tapped in Sub-sector S at three different locations.

b) A yet smaller area is Blue Clay. Though the clay layer is not visible over a large area, it has contributed to the formation of a clayey raw carbonate soil on the terraced southern slopes of the Bajda ridge. The Blue Clay Member, is additionally important since it acts as an aquatard for the formation of the perched aquifer from which a gallery and two deep wells derive water.

3.13. Most of the study area has exposed rocky areas with shallow Terra Rossa soil and protruding blocks of rock with trenches between them, often at right angles to each other. These are typical Karst landscape elements and are most pronounced to the north of Sub-sector I, but also on other sub-sectors such as A, B, C and D. In the Maltese Islands, Karst landscape forms when rain water sinks through the jointed but dense Upper Coralline limestone. It is rarely found on other types of rock strata. The rock would dissolve most rapidly along joints, such that the upper surface of the rock becomes deeply trenched, usually in a rectangular pattern between unweathered stumps. The limestone is not completely soluble and the insoluble residue is usually dark red clay called Terra Rossa that descends into the rock through all available crevices and covers or surrounds the weathered rocky stumps technically known as *lapies*.

[1] According to the Geological Map of the Maltese Islands (Oil Exploration Directorate, 1993)

3.14. Over most of the study area, but especially in the north west part of the North Sector, the rock formation is a type of layered UCL rock from which rubble walls and Girnas are built. Although the soil over most of this area is not very deep, the farmers still manage to get a produce. From interviews with farmers, it appears that the layered rock typical of the area is referred to as *inforra* (which translates as a thin covering layer). This produces spaces for water percolation and root penetration thus helping to sustain a good crop in spite of the shallow soil.

3.15. What is particularly interesting from an agricultural point of view in the XHGCDA, is the type of soil formation to which the various layers contribute. The UCL has contributed to the formation of red and chocolate brown Terra soils. The Clay Member mixed with friable UCL has contributed to the formation of a clay loam classified as a Carbonate Raw Soil. A pale coloured Xerorendzina soil is visible on one extensive area (just outside the area of study but included in the AoI) where the soil appears quite deep and has been reclaimed for small allotments. This soil may be of recent origin and imported since the exposed rock strata do not typically host *in situ* formation or colluvial deposition of this soil type. Historical accounts of extensive carting of pulverised rock for agricultural use from the main globigerina limestone quarry areas exist, but these are not close to this site. The mixing of Terra Rossa with the friable underlying UCL in the process of deep ploughing has produced a type of manufactured soil that is pale red in colour but very coarse grained and porous in contrast to the to fine clayey characteristics of parent Terra Rossa soils.

Topographical Considerations

3.16. The site occurs on a major ridge system and borders on two valley plains. The topography features elements typical of a ridge with land sloping at various gradients from a high point; in this case the western end of Bajda Ridge which is formed from a series of concatenated hills. The southern part of the North Sector, specifically the land on Sub-sectors H, N and O forms part of three hills, the highest with an altitude of 85m ; a covered gravity-feed reservoir is situated on it. From these points, the land falls at various gradients forming rather straight slopes as is typical of UCL formations. The land in the North Sector falls most sharply from the highest point towards the northeast and to southwards towards Manikata. These slope angles are usually in the range of 3 to 6°. Elsewhere in the North Sector the land is not quite as steep and tends to be almost level or retains a slight gradient to the northeast. In the South Sector, the land first falls sharply to the south reaching slope angles in the range of 10° before levelling off almost completely. These topographical considerations are essential for they invariably determine the type and extent of land use and field size. Thus there is more terraced land on about a third of the South Sector and terraces are much higher than in the North Sector.

3.17. Gradients taken along a number of representative transects across the XHGCDA are shown in **Figure 4** as follows: four different transects from hilltop A (coinciding with the reservoir) and another four from hilltop B for the North Sector. A series of four transects (C) are taken for the South Sector from four different points on the steepest slopes to the road and another four (D) from the road towards Il-Qasam ta' Ghajn Tuffieha. These gradients are tabulated in the table below:

Table 3: Gradients

Transect	North Sector A	North Sector B	South Sector C	South Sector D
1	1 in 10	1 in 26.5	1 in 22	1 in13
2	1 in 36.5	1 in 61.5	1 in 9	1 in 19
3	1 in 35	1 in 16.5	1 in 6.5	1 in 15
4	1 in 9	1 in 17	1 in 7	1in 22.5

Terracing and Soil Retention

3.18. As is typical of any area in the Maltese Islands recognised (perhaps since Phoenician times) for its agricultural value, great effort has been employed in designing the fields into the contours of the existing slopes and valleys that run through the site. The same equally applies for the design of fields on the lower lying plain, with great care being taken to ensure that the water shed from sloping and terraced areas drains away without flooding the lowland or sweeping away the precious soil. Where present on the North Sector, terraces are relatively low, rarely exceeding 1 m in height and do not hold much soil behind them. Terraces on the south aspect are much steeper often of a height in excess of 1.5 m sometimes of the order of 2 to 3 m. Even here the height between one terrace and another is highly variable and most often the height of these steps is primarily dictated by the presence of the natural rock outcrops or escarpments. One other obvious difference between the low and high terraces is the height of wall above the soil level. For the high terraces, the terrace walls stop just above the soil level and rarely reach more than a few centimetres above – this presumably to ensure that in case of heavy floods no water accumulates behind the terrace, leading to its collapse. If any trees are planted at these edges, they are invariably deciduous trees to ensure minimal obstruction to water flow during the rainy season.

3.19. Soil on the terraces cannot always be assigned to a specific group and, in a number of cases, appears to be the result of manufacturing through mixing with friable UCL or has been imported. Most of the Terra Rossa soil resulting from *in situ* formation on the UCL is never very deep, and certainly would be insufficient for terraces even if these were supplemented with rubble infill (as is often the case). By mixing the Terra Rossa previously scrapped off the UCL with friable UCL a light, pale red-coloured and highly grainy soil is formed. Likewise mixing of clay with the same friable UCL creates a light, very pale almost white coloured Carbonate Raw soil.

3.20. Soil creep and soil slumping is not evident on the XHGCDA nor is it expected to be present on the UCL. The exception may be for a small area on the clay surfacing in Sub-sector T though during the course of this survey slumping was not encountered.

3.21. Soil erosion is not greatly evident on the upper or middle reaches of the XHGCDA where terraces are present, although this may not hold for very long. In some areas such as Sub-sector P, field terrace walls have deteriorated or collapsed. Soil erosion from these breaches will eventually result in gully formation. The lack of regular maintenance on these retaining walls on terraced land exacerbates the problem more so than un-terraced land where wall deterioration will result in loss of field demarcation but not soil loss problems. It should be pointed out that repair and especially rebuilding terrace walls requires both the time and expense. Under EU subsidy schemes, farmers should receive around 75% of the current prices for rebuilding or repair but the balance would still amount to considerable sums. There are several parts of the XHGCDA where land has been recently reclaimed or soil depth increased. For instance, soil depth has been very professionally increased and land re-terraced in Sub-sectors A" and S. Conversely, on sub-sector E, the farmers have dumped and levelled rubble and soil without actually building the terrace walls, the reason probably being one of cost since there is no EU subsidy on building of new walls. The overall result, besides being highly unsightly and untidy is an open invitation to disaster since in the event of very heavy rains material will be washed from the sides onto surrounding lowland. An attempt to install a wind barrier has been made through the use of a green belt of Great Reed planted at the terrace margin may indirectly help to stop or reduce soil erosion, though the result is not very effective.

3.22. Whatever the condition of terrace walls on terraced land, it is up to the farmer to apply good farming practice such as contour ploughing perpendicular to the predominant slope to break runoff water flow and reduce gully erosion. This contour ploughing has been observed in most instances on the upper and middle levels of the XHGCDA. The use of strategic planting where the root system helps to bind soil that would otherwise spill over to the terrace below it is also seen; trees planted being quite varied and include figs and vines but rarely prickly pear or carob. Perhaps there is a very good reason for this since evergreens would obstruct water flow over the terrace edge in the event of heavy floods.

3.23. For the lower reaches, most of the land is level plain and, where present, only relatively small terrace steps are present such as in Sub-sector U where the level between adjacent terraced fields rarely exceeds 0.5m. However, there is another reason as to why the terraces in this Sub-sector are low, namely that the fields are not entirely level and slope by around 1 to 2° towards the terrace edge. Elsewhere on the XHGCDA where the land only has a slight slope, the low dry-stone walls present serve more as boundary walls rather than the purpose of soil retention. For those shallow depressions or slopes where terracing has been undertaken, the low gradient present does not require strong and frequent terracing.

Field Boundaries

3.24. Apart from soil retention, the dry-stone terrace and field boundary walls serve additional functions including demarcation of specific holdings, shelter to crops being grown, and some degree of protection against trespassers. In most instances on the XHGCDA it is evident that the holdings were very systematically planned out and demarcated at a very early stage in their development. Indeed, this is very evident in the North Sector where it has been used as a basis of subdividing the XHGCDA into Sub-sectors.

3.25. The perimeter walls on the east, north and west side of the group of Sub-sectors A-G (the southern perimeter wall on the same set of sub-sectors is completely missing) and the main boundaries between these sub-sectors are quite massively built usually in excess of 90 cm in thickness. They show a very professional build from square, layered UCL stone bocks quarried from the site or rough karstic UCL stone depending on the area. The perimeter walls are rather low in the 50 – 75 cm range, sometimes lower especially if the type of crop grown in the fields does not include vines or fruit trees. In those few instances when this is the case, a higher perimeter wall is present as on Sub-sector G where the walls are in the 1.5 m range; intended to give greater privacy and restrict vision as well as reducing access to trespassers. A case where there is another such high perimeter wall though not protecting anything of value, is the entire perimeter of Sub-sector I.

3.26. The boundary walls between the North Sub-sectors are usually over 1.2 – 1.5 m high, sometimes higher. These usually run straight without interruption or opening for hundreds of metres, the longest uninterrupted one is the wall between Sub-sectors C and D, which is 500m long. Within the Sub-sectors walls can be classified as of variable thickness, height (often less than 0.5m) and condition and more often appear to be less professionally built. For the North Sector, the subdivision of fields within each sub-sector is often very erratic and does not seem to follow any systematic plan. However, this does not appear to be the case for the terraced land in the South Sector where the fields appear to be subdivided more systematically usually following the contours of the land. One recurrent occurrence on the North Sector is semi-circular, high walls sheltering fruit-trees and sometimes carobs, from the west, northwest and north winds. These may be as high as 2m and must have entailed considerable effort to build. These protective walls are most evident in Sub-sector C.

3.27. As indicated earlier, the structural condition of terrace and boundary walls is highly variable from one sector or sub-sector to another. The walls in the South Sector are in an overall medium to good state of repair. However, in the North Sector they are in a more variable state of repair ranging from very bad to very good. As regards condition of the perimeter walls, this varies from very bad on the northwest perimeter of the study area to very good on the northeast perimeter. In some sub-sectors, the majority are falling in disrepair or have deteriorated so much as to be non-existent. The most severely affected parts of the Site are the un-terraced fields of the middle levels. A few walls show signs of recent repair or replacement indicating maintenance effort as for instance the fields in Sub-sectors A and S. A number of field walls in fields in Sub-sector A bordering the rough track, are a mixture of stone block and 45 gallon drums rendering this area rather unsightly. They are primarily intended to offer some protection from westerly winds to a number of stone fruit trees rather than to make the wall higher for protection against trespassers.

3.28. In parts of the XHGCDA, especially in the North Sector, trees and shrubs supplement some walls. These are intended for protection and include trees and shrubs such as Carobs, Prickly Pears, olives, and other shrubs. These, when judiciously planted, afford some protection from against destructive winds by deflecting the wind away from crops, and in so doing increase the agricultural potential of the land. Where the Great Reed (*Arundo donax)* has been used as a wall supplement and / or wind shelter, it has not been particularly successful since the presence of an underground water source or constant irrigation is required for it to thrive and form a thick barrier. The use of exotic trees for wind shelter (and other uses including attraction of birds for trapping and hunting) such as Eucalyptus and Acacia is also widely adopted on the XHGCDA. The overall impression is that in the North Sector (but not in the South Sector) there is a general under use of trees (including fruit trees) around the perimeter walls thus losing an important opportunity to increase the agricultural output of the land. However, it must also be stated that the most probable reason for a smaller number of wind shelter belts in the North Sector is that the combination of shallow soil and exposure to the three strongest winds would render their growth slow, stunted and deformed - farmers grow weary of planting trees on which they have very poor returns.

Aspect and Exposure

3.29. Aspect is variable depending on the sector and the gradient of the land in that sector and is especially applicable for terraced land or un-terraced land with a visible slope. The study area produces two major aspects to the north and south of Bajda Ridge, the north aspect being more gently sloping and the south aspect being generally steeper before giving way to a gentler slope. The lowest land consists of an almost level plain in the valleys on either side of the ridge before the land starts to rise gently again. Generally, the majority of the fields in the North Sector have a north to northeast aspect. A few fields on the hill on which the covered reservoir is located have an east and most terraces on the south part facing Manikata have a south aspect. The steeply terraced fields in the South Sector (sub-sectors P-T) have a true south aspect, as do the shallowly terraced fields in the lower areas of this sector (sub-sectors V and U).

3.30. Generally the North Sector (especially land to the north and west of the ridge) is the most exposed and one expects that the unfavourable north (Tramuntana), westerly (Punent) and northwesterly (Majjistral) winds wreak havoc on any crop when they act on the area. The North Sector is also liable to adverse effect from the northeasterly (Grigal). Easterlies (Lvant) and north easterlies (Grigal) are known to be destructive but the number of days per year where these two winds exceed 10 knots and are strong enough to cause damage is relatively small (less than 2% frequency). Additionally they occur during October and March/April when crops grown on the most exposed areas are either just being sown or nearing harvesting.

3.31. Conversely, the South Sector is offered some shelter from these unfavourable winds by the higher landmass of the North Sector itself. Like the North Sector, the South Sector is liable to be adversely effected by winds from the west though this is not as frequent as the other two winds. The south, east to northeast aspect are the most favourable in terms of the heating effect of the sun on the land and generally speaking also in terms of exposure to destructive winds. The favourable aspect of the South Sector is indicated by the land use and indeed this part of the XHGCDA contains the highest concentration of fruit-tree orchards and arable land given to intensive and semi-intensive agriculture. The south aspect tends also to produce a crop that matures rapidly and before other crops with a north aspect. The toponym of an area in the South Sector namely In-Nahhalija (Sub-sector Q) indicates another interesting fact associated with a sheltered aspect. The name translates to "the bee producing area" indicative to its past use for over-wintering during the cold months and for rearing bees for supply to other bee-keepers at the onset of more favourable weather; the warm south aspect would keep them going longer and the hive population would be more advanced compared with hives kept in the open.

3.32. Possibly the greatest problem associated with aspect in an agricultural context is the drying effect of strong winds acting directly on crops, or as a result of deflection from scarps or higher ground, or the result of topographical funnelling. All three situations are known to act on the XHGCDA especially the North Sector. In all cases the result is crop burn, stunted produce, premature drying of the soil and surface crusting as well as reduction of the total moisture content of the soil. This would apply more to the land in the North Sector than that in the South Sector. It seems that, by and large, the land encompassed by the XHGCDA North Sector is particularly liable to the damaging effects of strong wind and this can be seen from the inclined growth of most of the Carobs growing in the North Sector. Carobs are good indicators of wind-burn and will show an inclined top growth, the lowest side being directly opposite to the most adverse wind. There are very a few instances where wind shelter belts have been erected in the form of high walls or a green shelter belt using the traditional Maltese methods such as Prickly Pear (*Opuntia ficus-indica*) and Great Reed as indicated earlier, but these are rather rare on the North Sector. Traditionally, where more protection is required, more robust trees and shrubs such as the Carob (*Ceratonia siliqua*) were used, especially on patches were soil is shallow and the land would be otherwise useless for agriculture. Indeed carobs occur frequently and mostly on the west and northwest holdings of the XHGCDA North Sector. Less distorted carobs also occur on the terraces of the South Sector, often planted on the west side of the terraces and therefore also for wind shelter. The North Sector and the upper reaches of the South Sector have a higher frequency of the exotic Eucalyptus trees - a more recent trend in wind shelter and also to attract birds for hunters to shoot at. These trees not only stand out in the Maltese landscape but adversely affect the soil conditions because of their high demand on water estimated at eight times the water uptake of a similar sized carob. Two fields in the South Sector have a line of mature Cypress trees planted on the west side and acting as a wind barrier to stone fruit orchards and vineyards further east.

Soils

3.33. The soils show three major subdivisions – a dark reddish brown Terra Rossa Soil, a very pale almost white Carbonate Raw soil locally known as Bajjad and a pale red coloured to brown soil that is more typical of Xerorendzinas although it may be a manufactured soil derived from admixture of Terra Rossa and friable UCL. A chocolate coloured Terra Fusca soil and a greenish coloured soil also occur, but these are more restricted in occurrence. Sampling sites are indicated on **Figure 5** and the distribution of soil types and soil depth are illustrated on **Figure 6** and **Figure 7** respectively. Evidence of soil mixing and manufactured soil (with soil mixtures and imported soil occurring especially on reclaimed areas) is also present, this being of variable type generally collected from agricultural areas opened for development from various parts of the island. Soil plays an important part in this Study since differences in soil texture present variation in soil workability during different seasons and dictates to a major extent the types of crops that can be grown. A case in point is the workability of Bajjad Raw Carbonate soil on the terraced slopes of the South Sector. These soils can easily be compacted (*tinqaras*) and its textural and structural characteristics destroyed if worked when very wet and will take years to recondition once compacted. Thus, for those years with very heavy rainfall at the time of ploughing and sowing (as for autumn 2004), farmers refrain from working it. This may explain why, in some years, fields may appear abandoned and overgrown with weeds since working these soils would have been inappropriate, and when sufficiently dry, they would be past the sowing season. One interesting observation is that some of these soils (the Bajjad or Raw Carbonate soils) have an inordinate amount of gravel/sand sized parent particulate matter derived from the friable parent rock material. Though this is too coarse and young to actually integrate into the soil it helps the textural properties of the soil by making it quick draining and therefore workable after a few days of heavy rain.

3.34. A more detailed analysis of the soil types will now be undertaken. The **Terra Soils** are by far the most common soils on the XHGCDA. They are subdivided into the Terra Rossa proper (red) and Terra Fusca (matt dark brown). According to Kubiena (1953) and Lang (1960), they are the very mature, extensively weathered types of soil; usually completely chalk free with ochre yellow, ochre brown to red coloured. The Terra Rossa is found on Karst landscapes formed on the Upper Coralline Limestone (UCL) and Lower Coralline Limestone (LCL). Two series are identified, namely **Xaghra** and **Tas-Sigra**. The former is associated with Karst landscapes such as the primary garrigue on the XHGCDA and the Tas-Sigra series is associated with deep alluvial deposits on globigerina limestone which is not typical of the XHGCDA. According to Kubiena (1953) and Lang (1960), the **Carbonate Raw Soils** are young soils with very little humus; they are characterised by a dry summer surface climate formed on calcareous parent rocks. In Malta and Gozo four series of carbonate soils have been distinguished on the basis of the variation in the parent material, from which the biological soil differs very little. These are the Nadur, Ramla, Fiddien and San Lawrenz series. The closest classification of the Carbonate Raw soil that occurs on the XHGCDA is for the Nadur series, which has a sandy to sandy loam texture. The **Nadur series** is a carbonate raw soil formed mainly as a narrow belt on the slope of scarps which give way to gently sloping open plains. The soil is usually pale reddish brown, gravely loamy sand, very gritty, loose type of soil. The pale red colour is attributed to an admixture of down washed red sesquioxide clay. Three variants are identified mostly having been produced by physical weathering (or man) from the coarse limestone of the Greensand, the lower part of the UCL and Quaternary conglomerates. Some of the better-weathered highly glauconitic types of very limited extent could be considered Xerorendzinas, but in the main the soils are coarse-textured raw soils with non-intimate admixtures of clay minerals. The **Xerorendzina** is an ash-grey coloured soil, very loose and powdery when dry, with a high chalk content. Xerorendzinas are usually formed on Middle Globigerina Limestone at the foot of scarps and dissected plateaux, rarely on Lower Globigerina Limestone as colluvial deposit, both of which are not present on the XHGCDA and therefore not expected to form naturally in the area. Because of their light colour when dry, these soils are sometimes difficult to distinguish from the carbonate raw soils. There are three series – the San Biagio, Alcol and tal-Barrani, where the San Biagio is formed from UCL, Alcol is formed from alluvial and colluvial quaternary deposits and Tal-Barrani is a transition soil between the San Biagio and Xaghra (Terra Rossa). The Xerorendzina soil formations on the XHGCDA are very limited and were not assignable to one of these series possibly because they are the result of carting and mixing.

Soil Depth

3.35. Soil depth over the XHGCDA is very variable especially where soil has been imported in the process of field and terrace construction. (See **Figure 7**.) The deeper soils usually occur on the outer reaches of man-made terraces. In the course of this survey, the soil depths were established from direct measurement using soil auger. Terraced areas with failing rubble walls were additionally inspected and analysed for soil depth and profile thus getting indirect measurements of soil depth. The depths obtained for most of the areas sampled in the North Sector, is often under 30 cm and rarely exceeds 50 cm but under the soil layer there invariably is a layer of UCL that is not always very hard to penetrate. The outer reaches of the terraces in the South Sector where the walls have fallen apart, indicate that the soil depth though variable is considerably deeper and often exceeds 75 cm. In some of the terraced areas, however, some walls separating fields at different levels and lying on exposed UCL bedrock indicate a shallower soil depth.

Springs and Boreholes

3.36. Fresh water from the Mizieb aquifer is sourced from at least three different sites on Sector S. These were not actually inspected though the information was given first hand by two different framers. One of these sources is a man-made gallery excavated at the Upper Coralline Limestone-Blue Clay interface. These galleries were constructed such that these are gradually and slowly replenished by natural spring water from the aquifer and periodically emptied into a cistern or reservoir. This water used to be a precious commodity especially during the summer months being one of a few sources of water for the community living at In-Nahhalija and their farmstead. From an interview with farmer Joe Galea, water was collected behind a sluice every three days then diverted into a reservoir. The latter was destroyed last November after very heavy rainfall and has not been repaired. The other two sources are shaft wells, some 30 feet deep dug in the friable UCL. Water collects in a clay reservoir at the base of the shaft and is withdrawn as needed, the excess flowing off and eventually lost. Holdings further down on the South Sector have boreholes of undetermined registration status tapping directly into the mean-sea-level aquifer and the farmers abstract water accordingly. Some have registered shaft wells sunk in the 1940's also tapping the mean-sea-level aquifer. Most complain that the quality of the water has deteriorated a lot in the past years and one farmer is using reverse osmosis to polish his water before using in his greenhouses. The sites of these boreholes are indicated on the **Figure 8.** In the North Sector three other boreholes possibly a fourth are present. One is in the holdings of Charles Sciberras, two in the holdings of Joe Sciberras one being completely dry, and a possible fourth in holdings in Sector E where irrigated cropping is undertaken. The fields on Ix-Xatba also have irrigation water and their own boreholes but no interview was held with the farmers here and they would probably have been unwilling to reveal the number of boreholes they have. Water in the North Sector is expected to be tapping the Mizieb aquifer and so it will be better quality than the mean-sea-level one though the quantity would be more limited.

4. AGRICULTURAL LAND CLASSIFICATION

4.1. Land quality or value of agricultural land or what is technically known as an Agricultural Land Capability Assessment (ALCA), can be established using several systems. The most frequent system used is one of limiting values where the land use is ranked according to the limiting values of a number of soil and site properties which restrict or prevent certain activities under consideration. This is in contrast to land suitability assessment where a clearly defined homogenous practice (such as rainfed market gardening) on a particular site is classified on the basis of positive features associated with the success of that particular land use. For the purpose of this part of the study, agricultural land capability assessment is discussed; land suitability is treated at a later stage when considering current and potential cropping strategies for the site.

4.2. An ALCA is ultimately based on the interpretation and evaluation of a range of parameters or criteria agreed upon beforehand or form part of an internationally recognised system of classification. The land can then be rated according to a graded scale for each criterion or sub-criterion. Malta does not have its own land capability classification system and the United States Department of Agriculture (USDA) system, which is internationally recognised, has been adopted with some modifications for our use in past studies with the agreement of MEPA. The USDA includes a range of criteria namely: climate, natural resource information on terrain, geological formations, natural vegetation and socio-economic information. The general agreement with MEPA for past studies has been that in the assessment, factors relating to soil, land and climate should form an important component. In this system, agricultural land is classified using a range of criteria and sub-criteria, each ranked on a multipoint point system, so that eventually the land is given a total score. The criteria that were identified in the system proposed by MEPA were subdivided into two sections – site evaluation and soil properties and included such factors as percentage slope, susceptibility to erosion, severity of erosion, percentage tillable, type of soil containment and their state of repair land size, meteorological intensity (wind exposure) and accessibility. For the soil properties, the following criteria were proposed: average effective depth, texture and workability, permeability, supporting features (relating to water availability or reserves) and cropping intensity.

4.3. For this reason, in previous studies, it was agreed that:

- Criteria suggested by MEPA would be adopted and integrated into the USDA system as long as these are measurable; and that
- The most important criteria that need to be considered in an ALCA adapted for Malta were: the physical characteristics of the soil including soil texture, structure, depth; land characteristics including topography, slope angle, percentage rock outcrops, aspect and degree of exposure to destructive winds; size of holdings, types and size of facilities present, accessibility, water availability and potential for water storage, soil fertility, agricultural quality by crop type or intensity of cultivation and long term sustainability of the agricultural practice.

4.4. The USDA scheme classifies land on the basis of its soil taking into account other features of land - mainly slope angle, climate and frequency of flooding. As mentioned earlier, the main concept is that of limitations, both permanent physical limitations such as slope angle, soil depth, and climate as well as temporary physical limitations such as nutrient status and drainage. Limitations that apply to the cultivation techniques are also incorporated into the system. However, no weighting is given on the type of crops that can be grown since this is usually incorporated in the land suitability classification. The scheme assumes a moderately high level of management. The USDA system assigns four classes for land that is suitable for arable agriculture with increasing limitations from Class 1 - 4. Four other classes 5 - 8 are used for land that is unsuitable for arable agriculture and will not be considered here. The main criteria used and each class characteristic are listed in the table below. The criteria have been grouped for convenience under three subheadings namely: permanent physical limitations, temporary physical limitations and cultivation and crop production limitations. Land allocated to any class has the potential for the use specified in that class and for the class below it. Once again it must be pointed out that this scheme applies for the classification of good quality rainfed agricultural land to rainfed land of agricultural value.

Table 4: Classification of agricultural land according to the USDA system of classification

Criterion	Class I	Class 2	Class 3	Class 4
Permanent Physical Limitations				
Soil textural characteristics	No/Slight	Moderate	Severe	Severe
Soil depth	Deep	Moderate	Moderate	Fairly good
Slope angle	Nearly level	Gentle slope	Moderately steep	Steep slope
Overflow damage & gully erosion	Not subject	Subject	Moderate	Severe
Temporary Physical Limitations				
Nutrient status - fertility erosion	Need manure or fertilisers	Moderate	Low fertility	Severe erosion
Poor drainage - puddle erosion	Subject	Need drainage	N/A	N/A
Cultivation & crop production limitations				
Land quality for agriculture	Good	Good	Restricted	Restricted
Risks of damage in cropland use	No/Slight	Moderate	Severe	Severe
Productivity	Good	Moderate	Low	Low
Cultivation cycle	Rotation beneficial	May need rotation	Need special rotation	Occasional cultivation only
Cultivation method	Ordinary	Ordinary to Specialtillage	Restricted tillage	special handling needed

4.5. Additional levels of classification are present so that each class can be subdivided further into subclasses. Four capability subclasses have been created that may be assigned singly or in combination. These are again identified on the basis of limitations and can also be considered as part of the permanent physical limitations. The four subclass limitations identified, are:

- (e) erosion hazard;
- (w) excess water/wetness and therefore posing problems for land tillage and cultivation;
- (s) soil root zone limitations - depth and stoniness (and texture, is included in the UK system); and
- (c) climatic limitations - may be prone to the action of drying winds and/or leaf burn, amongst others or to drought.

4.6. Using this system cultivated land or parts thereof assigned a 2s classification is good agricultural land subject to soil depth limitations and possibly stoniness. A 3sc class may be applied to moderately steep sloping land with a shallow soil cover and liable to drought. From the characteristics summarised in the table below, it is evident that using the USDA system of classification, the land earmarked for development falls in different class categories with considerable variation between sectors and even within each sector. In order to arrive at a land capability classification, the land in the XHGCDA was subdivided by sector and level as indicated in below and on **Figure 13**. A class and subclass was assigned to each subdivision according to the number of limiting criteria in each category as shown in the table below. As can be seen most of the land in the South Sector has been classified as good agricultural land with optimum to sub-optimum qualities that can be reasonably amended if the required capital and technical investment is made. North Sector has been classified as good to restricted depending on soil depth.

Table 5: Classification of land on the XHGCDA based on the USDA system

	North Sector		**South Sector**
Terraced areas (moderate) Terraced areas (deep)	Class 2 sc Class 1sc	High Terraces (upper) High Terraces (lower)	Class 2sc Class 1wc
Un-terraced areas (deep) Un-terraced areas (shallow)	Class 1 sc Class 3 sc	Low Terraces Un-terraced areas	Class 1 Class 1e

4.7. The justification for the above classification of the XHGCDA is summarised below. In this justification, additional criteria have been included and these are shown in italics. However, it should again be noted that using the USDA classification system, no weighting is given to the limitations imposed by field size and buildings, accessibility, aspect and exposure, water availability and facilities for water storage, investment potential etc. These are, therefore, considered separately and their weighting given due importance at this point as additional justification for the above classification. Some of these factors impose a number of limitations and, therefore, decrease the agricultural value of the land under consideration.

Table 6: Justification for classification of agricultural land on the XHGCDA North Sector

Criterion	Un-terraced / Terraced Deep (Class 1sc)	Terraced (moderate) (Class 2sc)	Un-terraced Shallow (Class 3)
Permanent Physical Limitations			
Soil textural characteristics	No/Slight (Sandy loam)	Moderate (sandy loam)	Moderate (Clay loam)
Soil depth	Moderate (>1m)	Moderate (>50cm)	Shallow (<40m)
Slope angle	Almost level (1^0)	Almost level (1^0))	Almost level (1^0)
Overflow damage & gully erosion	Sometimes subject	Sometimes subject	Not Subject
(e) puddle erosion hazard	✗	✗	✓
(w) wetness	✗	✗	✗
(s) root zone limitations	✗	✓	✓
(c) climate limitations	✗ / ✓ *(liable to wind exposure)*	✗ / ✓ *(liable to wind exposure and drought)*	✗ / ✓ *(liable to wind exposure and drought)*
Temporary Physical Limitations			
Nutrient status - fertility erosion	Needs manure or fertilisers	Needs manure or fertilisers	Needs manure or fertilisers
Poor drainage - puddle erosion	Not Applicable	Not Applicable	Temporary if applicable
Cultivation & crop production limitations			
Land quality for agriculture	Good	Good to moderate	Very Restricted
Risks of damage in cropland use	No	No	Moderate
Productivity	Good	Good to moderate	Poor
Cultivation cycle	Rotation beneficial	Rotation beneficial	Rotation beneficial
Cultivation method	Ordinary	Ordinary	Restricted tillage

Table 7: Justification for classification of agricultural land on the XHGCDA South Sector

Criterion	High Terraces Lower (Class 1wc)	Low Terraces and Plain (Class 1/1e)	High Terraces Upper (Class 2sc)
Permanent Physical Limitations			
Soil textural characteristics	Moderate (CRS)	Moderate (Sandy loam)	No/Slight (Sandy loam)
Soil depth	Moderate to deep (<1m)	Moderate to deep (>1m)	Moderate to deep (<1m)
Slope angle	Almost level (1^0)	Gentle slope (1.6^0)	Almost level (1^0)
Overflow damage & gully erosion	Sometimes subject	Sometimes subject	Not Subject
(e) puddle erosion hazard	✓	✓	✗
(w) wetness	✓	✓	✗
(s) root zone limitations	✗	✗	✓
(c) climate limitations	✓ *(liable to drought)*	✗	✓ *(liable to drought)*
Temporary Physical Limitations			
Nutrient status - fertility erosion	Needs manure or fertilisers	Needs manure or fertilisers	Needs manure or fertilisers
Poor drainage - puddle erosion	Subject	Subject	Not Subject
Cultivation & crop production limitations			
Land quality for agriculture	Good	Good	Restricted
Risks of damage in cropland use	Slight	No	No
Productivity	Good	Good	Moderate to low
Cultivation cycle	Rotation beneficial	Rotation beneficial	Rotation impractical
Cultivation method	Ordinary to restricted	Ordinary	Ordinary

Limitations Imposed by Water Availability and Irrigation Practices

4.8. The number of holdings on the XHGCDA with water storage facilities is quite low in certain sectors. There are different reasons for this, but most of the areas without storage facilities have shallow soil. Where the soil is very shallow, it is logical that no investment has been made in water holding facilities since the returns for intensive cultivation would still be limited by the soil depth. This is the case over most of the north sector, where only a few farmers have invested in digging boreholes; some have been unlucky in landing dry wells. Over most of the south sector and ix-Xatba, where the soil is deep and therefore intensive cultivation is possible all year round, the farmers tend to opt for a borehole and irrigate directly with water pumped under pressure. Indeed, it seems that wherever the farmer sees sufficient returns, no expense is spared to get the water to his crops. Of course, this applies if no other constraint such as exposure to strong winds is present. On the XHGCDA there are least four holdings where the farmers have laid extensive water lines (63 mm or wider bore, high pressure irrigation lines with above normal PN values, hence highly expensive) with one stretching slightly under two kilometres. In three cases, namely the holdings on AA 4-5, O1 and S6, the water is pumped under pressure from boreholes or from shaft wells tapping the mean sea level aquifer, to higher ground; a highly expensive operation. However, the returns must justify the expense. Sometimes, the holdings lend themselves to the erection of a reservoir on high ground where the water collected is then gravity-fed to irrigate the crops. This has been observed on a few holdings including S5a and K1a.

4.9. The oldest and most intensively farmed areas in the ix-Xatba and fields between Qasam ta' Ghajn Tuffieha and Habel Cillaq have a range of water storage facilities; mostly open surface reservoirs adjacent to shaft wells. The collection and storage of water for use during the dry season is not widespread and irrigated cropping during the dry season is restricted to a relatively small percentage of the holdings to which water can be hauled or pumped. In this case, summer crops such as melon, tomato, and brassicas are grown. In addition there are fruit trees and vines, which, once established need comparatively smaller quantities of water. However, for the larger orchards and vineyards, the total quantity of water needed would still be considerable. For irrigated summer cropping, there are yet two other constraints that are making a greater impact year after year. This is related to the increasing conductivity in irrigation water due to excessive abstraction and consequent infiltration of seawater into the mean sea level aquifer. The Pwales valley, once considered the best kitchen garden location, increasingly produces less in summer due to the problem of salinisation of the soil. The other side effect is that overproduction of irrigated summer crops from all over the island together with importation of produce from other EU states, has depressed value of produce to throwaway prices and could eventually force the farmers out of business.

4.10. As regards irrigation practices, there is considerable variation according to what is being grown, where and when. Where water is freely available, such as for holdings in the south sector and ix-Xatba, then sprinkler irrigation is not uncommon, though this is restricted for tender growth and more for wet season than dry season cropping. Sprinkler irrigation tends to be very wasteful of water and is increasingly not used. For the irrigated tomato or melon crop, drip lines consisting of collapsible drip irrigation pipes are installed under a layer of black plastic mulch and the crop irrigated as necessary from a main delivery pipe connected to a pump; water is delivered into the system under pressure. At least a 1000 gallons of water are needed per week per tumolo (0.1125 ha) for a crop of tomatoes, and almost twice that amount for a melon, cantaloupe or vegetable marrow crop. Crops of tomato and brassicas are also grown that are not truly irrigated in the sense that the seedlings are planted in a shallow basin that is flooded until the seedlings are established. Once the seedlings take hold, irrigation is stopped and the crop left to grow without further irrigation. For the brassicas, this usually works out quite well; these start to mature at the onset of the rainy season in September and therefore their planting is timed to mature under rainfed conditions. For the unirrigated tomato crop, the yield remains rather low (though better tasting than irrigated tomato) since the plants have to thrive on residual soil moisture. Most of the holdings given to vines or other fruit trees have a dedicated irrigation system consisting of 64 mm mains to which are connected 16 or 20 mm bore plastic feeder pipes that deliver water directly to each vine or tree. Water is pumped from cisterns or reservoirs or directly from water tankers.

Field Size and Agricultural Buildings

4.11. In Malta, excessive land fragmentation has produced very small holdings that make mechanised cultivation more time consuming and sometimes less economical. However, in the XHGCDA, it is immediately evident that the field size is highly variable, depending on the sector - the two extremes being present; a number of holdings are quite large and because of their size, these have an increased agricultural value, others are so small that they do not qualify as fields.

4.12. Excluding those at ix-Xatba, the fields are generally small to very small in the north sector. Most have a regular shape but a good few are of an irregular shape. There are some holdings that are terraced but terraces in the north sector are usually wide compared to those in the south sector. In the north sector, the size constraint is probably secondary since the shallowness and exposure problems take precedence over limitation as to what can be grown. Fields in the south sector and ix-Xatba are usually larger especially on land with a low gradient presenting few problems of access. The problem of elevated production cost due to small size of holding is, therefore, not usually present. Conversely, terraced fields on steep sloping land (south aspect of the land between in-Nahhalija and Manikata) are usually quite long but narrow. In addition to the problem of size, these narrow terraced fields usually present a number of other constraints, the most acute is probably the problem of access from one terrace to the next which sometimes requires steep access ramps that are not easily manageable for tractors. Therefore, they have to be worked using small hand machinery (formerly done by mule).

4.13. Field rooms and other structures for shelter and storage are recorded on the survey sheets and must be classified as frequent. Again, there is a wide range of field room type and size. The most remarkable are the Giren; some are quite old if not truly ancient and most have served as places of habitation in addition to storage of produce in the distant past.[2] Yet another unique agricultural holding is the remains of a set of buildings on the northwest extremity of sub-sector S, they are the nascent site of the village of Manikata, well located on a vantage point and with a source of fresh water from a gallery tapping the perched aquifer. [3]

4.14. The number of field room structures is considerably larger than those noted above. Most are of recent construction from square stone blocks, bricks or

[2] These XHGCDA Giren are of high cultural value due to their unique shape and method of construction and need to be preserved at all costs irrespective of what development is to be considered. They represent one of the most unique collections of agricultural heritage in the island.

[3] These buildings make an important contribution to the rural character of the area and every effort should be made so that as far as is possible, the structures present are restored and/or preserved.

discarded rubble. Most of the structures present are small agricultural buildings, which can be classified as field rooms ,but there are also a number of farmhouse complexes, some in a good state of repair other in disrepair. The smaller and recently built buildings are not considered as sufficiently important to affect the agricultural value of the land, but the larger buildings have a contributing role if sufficiently repaired. The most unfortunate situation arises from the large number of structures that serve the purpose of bird hides and mar the otherwise beautiful landscape. Some have been extended into field room complexes exacerbating the problem even further.

Limitations due to Effects of Aspect and Exposure

4.15. The effects of aspect and exposure on agriculture has been treated in section above (see dry season survey) and is considered to be an important limitation for part of the XHGCDA. Exposure to strong and cold winds has a deleterious effect on agriculture. This is especially true for fields occurring on the north sector of the XHGCDA, less so in the south sector since this receives protection from the cold northerly and north-westerly winds by the elevated grounds of Manikata. However, crops in both sectors are liable to limiting effects due to strong winds, cold damage, or heat stress depending on the season. Strong westerly winds laden with sea spray, which has a burning effect on crops and trees, are liable to negatively effect a large number of holdings on the XHGCDA. The absence of large number of trees planted as a wind shelter exacerbates the problem, though there are instances where carobs or prickly pear have been planted in such a way as to afford some protection from prevalent winds. In other instances, rubble walls or makeshift 45 gallon tanks have been raised to disproportionate height (sometimes over 2 m) to afford protection to fruit trees. During the wet season, the problem of exposure to cold winds explains why winter market vegetables are avoided for the north-facing higher reaches of the north sector; this would render the soil quite cold thereby considerably retarding the maturation of produce and affecting the overall quality and market value of such vegetables. However, land on ix-Xatba, which has a slight south aspect, has a wet season crop. The sheltered lie of the land and the predominantly south aspect of the south sector do not produce these problems in winter but the problem is aggravated in summer.

4.16. Fruit trees planted on exposed ground are of the deciduous type such as Figs, Almonds and other stone-fruit trees; these are not adversely affected by strong winds occurring during early autumn/winter. Indeed, soft-stone fruit trees planted in the exposed areas would benefit from a cold aspect or exposure since an important requirement for them to set abundant fruit is a cold spell during their dormancy period. What is interesting in terms of stone fruit production is that stone-fruit trees on terraced land in the south sector (mainly peach and apricot) appear to be productive not withstanding the sheltered and warm aspect that they enjoy. This is possibly due to the cultivars used, which appear to be quite old and possibly developed to withstand this microclimate.

4.17. The overall effects of aspect and soil type on agriculture in the protected south-aspects areas is that there is a tendency towards early maturation of vegetables and fruit, which has the advantage of fetching better market prices. The north-aspect tends to produce winter crops that mature later than in south facing fields since the soil tends to be cooler, thus retarding slightly crop development or as may be the case here where the farmer opts to sow crops late thereby avoiding the very cold spells associated with December/January period. On the other side of the coin, north-aspect locations tend to be at an advantage during summer, since crops growing on this aspect suffer less from heat related stress. This is especially true for crops such as brassicas and melons that tend to prefer a north aspect and a cooler soil. The south sector therefore tends to suffer more in summer.

Utilisation of Field Perimeters

4.18. The utilisation of field boundaries for fruit tree planting is more evident in the north sector than the south sector. Most field boundaries are planted with figs, prickly pear, pomegranates and stone fruit, and rarely vines and other fruit trees. However, most of the trees planted round field boundaries are quite old and, except for figs, past their productive age. Figs, prickly pear, pomegranates, vines, and fruit trees planted along boundary walls usually make a significant agricultural contribution and increase the value of the agricultural land; therefore, it makes little sense to allow these trees fall into decline. Reasons for this situation are most probably related to the lack of full time farmers and the cost of replacing these trees. Since the holdings are not farmer-owned, the farmers do not feel inclined to make the required investment in water storage facilities and irrigation equipment required to establish and maintain these trees. Considering the substantial investment needed to re-plant, lay new irrigation lines and maintain fruit trees it is surprising to find a few enthusiastic farmers willing to dedicate their spare time to such a task. One particular farmer on the north sector has planted several hundred olives, vines, stone fruit, etc both around field boundaries and as fruit tree plantations on disused land, all at his own expense.

Limitations in Soil Fertility

4.19. The fertility of the soil in the XHGCDA can be described as being good to medium in the larger proportion of the holdings that are being worked. The holdings that are not being worked show evidence of low fertility. Soil analysis has been carried out on 42 soil samples collected from the north and south sectors to establish the nutrient status of the soil in these fields. All results are based on a 1:5 soil: water extraction. The list below summarises the range of values obtained and associated ratings for chemical properties. The ratings given in round brackets are those applied by the Department of Agriculture, which are sometimes slightly different from those ratings applied by the FAO Soil Bureau.

- Electrical Conductivity : 222 - 2437 μS^{-1} (non-saline to very saline)
- pH (1:5 soil) : 7.3 - 8.18 (slight to moderately alkaline)
- Potassium Extractable : 288-2018 mg/Kg (very high)
- Sodium Soluble : 20- 255 mg/Kg (Very low to very high)
- Chloride Soluble : 98 - 1191 mg/Kg (medium)

4.20. The levels of nitrogen and phosphorous were not measured in the course of these tests since this service is no longer available at the Government soil testing facility. As for the other tests carried out, the following observations can be made. For most of the soil samples coming from both cultivated and uncultivated fields, the potassium levels are above the normal range of fertility expected for these soils, and in samples taken from marginal land close to garrigue, the potassium levels (K^{+}) are also in the very high range. The same trend applies for electrical conductivity which indicates that the fertilizer loading appears to be higher than normal, especially for the intensively cultivated fields. For example, the electrical conductivity for some soil samples (i.e. 2437 μS^{-1}) is extremely high, and certainly much higher than expected, indicating that there is a high level of soluble salts in these soil samples. The higher conductivity values are classified as very saline by the Department of Agriculture, but most of the soils analysed, fall in the non-saline range. Conductivity usually has a good positive correlation with soluble ions such as sodium and potassium, both of which are quite high for the same soil samples. The high levels of potassium are in all probability due to 'blind' addition of fertiliser without performing soil fertility tests prior to a fresh cropping cycle. The pH of most of the soil samples was in the slightly alkaline or moderately alkaline range; this is expected given the calcareous nature of our soils. One may even venture to say that our soils are expected to be more strongly alkaline. The reason that they are only slightly alkaline is becuase the addition of sulphate fertiliser and nitrogen plus sulphur (such as ASN 26 + S) tends to lower the pH and acidify the soil.

4.21. Considering that these soil samples were collected in summer, the high conductivity readings are probably due to the salinity of the water used for irrigation in some part of the XHGCDA. Another reason could be that, for summer crops, fertilisers are applied directly into the watering system to avoid wastage and therefore the can explain the high levels, even on newly prepared or cropping fields. Reference has already been made elsewhere to the pH levels and the high potassium levels in these soils. The latter is an important plant nutrient and contributes to increased flowering but may be overused; this tends to change the quality of the product. It is unfortunate that the full nutrient status of the soil cannot be assessed because of absence of data on nitrogen and phosphorous. However, the probability that the levels of these nutrients are also high cannot be excluded, since potassium is applied either as potassium nitrate or as a compound fertiliser. This automatically suggests that the associated salts are also applied at a higher rate than actually needed. Given the above general considerations, together with the texture, porosity, and overall workability of this soil, most of the cultivated land on the XHGCDA is of good agricultural quality. Apart from potential problems caused by excesses mentioned above on some of the more intensively farmed fields, a persistent limitation to soil fertility on some soils is the low level of organic material which results from the lack of addition either because it is not so readily available or because it is so expensive. The high conductivity and soluble sodium and chloride levels, the low level of organic matter and high pH place some of the XHGCDA soils in the chemically less favoured group of soils.

4.22. The soil structure on most of the cultivated fields of the XHGCDA is satisfactory. The texture also falls into the satisfactory range - falling in the loam (sandy and clay loams included) for most of the cultivated fields. For the strict Terra Rossa group, the texture is mostly clay, which makes them poor draining. These soils do not coincide with the most intensely cultivated areas. Given that the cultivated fields are predominantly loams, water relations are also reasonably good. Tillage is also easy, making them amongst the more easily worked soils. They are universally cultivated and give satisfactory crops. The range of crops grown includes cereals, vines, stone fruit, root crops and market garden crops in general, the latter especially on irrigated land. Observations of deficiencies made on these soils include potassium necrosis of fruit tree leaves and lime-induced, iron chlorosis in stone fruit. In any case, some of these fields show an unique characteristics in being able to support continuous cropping especially if manure is routinely added.

Addition of Farmyard Manure

4.23. The addition of farmyard manure (FYM) to amend the soil organic content has, in recent times, decreased considerably. This is both because of the scarcity of the material and because it's expensive. Application rates of FYM for market gardening and root produce is in the range of 1.25 - 1.5 tons dry weight per tumolo (usually a truckload is around 3 to 3.5 tonnes; this amount is added to two tumoli for a crop of potato). In the past, FYM was routinely applied every three years as part of a three-year crop rotation process involving different crop sequences as outlined below:

- FYM, winter potato, tomato and ploughing; sulla and summer fallow and ploughing; wheat and summer fallow followed by FYM and deep ploughing.
- FYM, sulphate of ammonia or 12-12-17-2 compound fertilizer, winter potato, spring potato, summer fallow and ploughing; two potato crops, onions May-August on watered land; wheat crop, summer fallow and ploughing; Sulla followed by FYM and deep ploughing.
- FYM, winter potato and spring onions, summer fallow and ploughing; beans, spring potatoes, summer fallow and ploughing; wheat, summer vegetables and ploughing; sulla, FYM and ploughing.

4.24. There is clear evidence of the use of FYM on some of the intensively farmed holdings: there are a number of manure clamps close to intensively farmed holdings both on the north and south sector. FYM application is certainly being practised on some of these holdings though not necessarily part of the rotation. Though it makes more sense to use FYM as part of rotation, it may not be necessarily so. Farmers are making more frequent but also a more rational use of it. For instance, the summer vegetable marrow and cantaloupes/sugar melons had FYM added on most of the fields having this crop. FYM may be broadcast uniformly, or added into the basin of each individual plant thereby giving the required conditioning directly where it is needed or applied as a fertigation. In the south sector a type of fertigation using manure slurry is applied; the field is divided into square beds around 2m by 2m, the planting beds are then flooded with manure slurry, this is then allowed to dry and then the soil is rotovated to incorporate the manure into the soil.

4.25. The expense and shortage of supply of FYM has forced farmers to use less organic and more inorganic fertiliser. This may eventually contribute to the gradual depletion of soil fertility as well as a general interference with uptake of nutrients and a decline in the general resistance to disease. These problems are known to increase when the soil humic acids are depleted. For the other soil series, mono-cropping of a wheat fodder crop is extensively practised since this is least demanding in terms of labour, seed and fertiliser input. This practice, which eliminates the need for a rotation requiring the addition of FYM, contributes less to a decline in soil fertility; monocot fodder crops are known to encourage a very healthy soil microbial population, which is good at fixing atmospheric nitrogen. However, over the very long term, wheat mono-cropping may lead to a deficiency of readily available silica in our calcareous soils inherently low on this element.

Fertiliser Loading

4.26. Present day artificial fertiliser loading is perhaps the most difficult part to assess in the absence of sufficient statistical data by locality. Fertiliser application in the Maltese Islands follows no written standards and most often is the result of the farmer's experience or what the suppliers prescribe. The most recent data available are the FAO statistics for the fertiliser application in the Maltese Islands for the agricultural season 1992 -93 on the effective arable surface. This was divided as follows: 125 kg/ha for nitrogen, 20 kg/ha for phosphorus and 20 kg/ha for potassium. In Italy, the corresponding rates of fertiliser application have been reported as 53 kg/ha for nitrogen, 39 kg/ha for phosphorus and 23 kg/ha for potassium. It is immediately evident that our nitrogen application is higher than our neighbouring country. This high use of nitrates can have a direct effect on the ground water table and partly accounts for the high nitrate levels reported in the aquifers. In effect, the nitrogen fertiliser loading given to cereal cropping have an even higher application than given in the official statistics. In Malta, nitrogen fertilisers for cereal are usually applied as a base dressing of ammonium sulphate (21 % nitrogen) at the rate of 50 kg per tumolo (0.1125 ha). This gives a total rate of about 450 kg /ha of ammonium sulphate but the effective nitrogen application rate is only 93 kg/ha. This already brings out a discrepancy from that stated in the FAO statistics for Malta, but yet is still almost twice that used in Italy. The use of compound general fertiliser such as 12-12-17-2 at the rate of 50 kg/tumulo is becoming increasingly popular both for fertigation with drip lines (where the NPK percentages may vary with crop type and stage of maturation) and also with cash crops such as potatoes where the fertiliser is broadcast. However, it is rarely used for low return crops such as wheat for fodder where in this case the cheaper nitrogen fertilisers such as ammonium sulphate, ammonium nitrate, or urea are used.

4.27. Recommendations given by farmers' co-operatives on fertiliser use also contradict the values given in the official statistics. Recommended application rates of Polyfeed compound fertiliser on tomato is 1 kg/tumolo per day for the first 70 days and 2 kg/tumolo per day from day 71 onwards. This brings a total of over 200 kg of compound fertiliser per tumolo per season and a fertiliser bill of around Lm80.00 per tumolo. More modest applications are followed at the rate of 2 - 3 kg/tumolo per week gives a total of 32 - 48 kg per tumolo for a 110 day growth period, but the harvest is proportionally lower. Although this may seem a low amount, there are additional fertilisers added such as manure, and the figure would still exceed those used in the EU.

4.28. The nitrogen application for cereal crops is estimated to be in the region of 50 kg ammonium sulphate base dressing per tumolo. Nitrogen fertiliser assists in decomposition of wheat stubble that, when ploughed into the soil, produces a high C:N ratio. By increasing the nitrate application, the nitrogen tie is reduced and deficiency problems do not result. This is, however, an expensive practice since nitrate fertiliser is costly, and furthermore, problems arise if nitrogen is leached into the aquifer. Although excess nitrogen application is a constant problem on the local scene, it is exacerbated by certain forms of the fertiliser, such as urea. The withdrawal of urea salt fertiliser from the market is in compliance with the Nitrates Directive. The practice of burning the wheat stubble before ploughing helps to reduce nitrogen application, but it also means that precious organic material is converted to carbon dioxide. The practice used abroad of spraying the cereal stubble with a cellulose and lignin digesting enzyme, has never been introduced to Malta.

Use of Plant Protection Products

4.29. Figures for pesticides use from planting through to harvesting are now available by type and locality. Individual farmers adopt different pesticide application regimes that are now regulated by an appropriate board, and usually follow recommendations given by suppliers. Despite the regulations, the absence of formal training leads to widespread pesticide misuse. The gross figures confirm this. For the cultivated land area, in the Maltese Islands, a total of 25 kg of pesticides are applied per hectare as compared with 15 kg/ha for Italy (FAO 1994, pp. 1-22). The problem of pesticide overuse is exacerbated when one considers the greater potential for excessive intake of toxic substances in both food and drinking water due to infiltration into the aquifer. Besides destruction of beneficial organisms, there are the additional ecological problems of pest resistance and hence the need to use even more pesticides. Statistics for pesticide use indicate that the most frequent pesticides used are fungicides - approximately four applications, and the least used are selective herbicides - a single treatment, although some weedkillers are popular with some crops such as onions and wheat. Two treatments of insecticides per crop occupy middle ground between fungicides and herbicide use. Irrigated crops also receive more pesticides than rain fed or dry farmed crops.

5. PRESENT LAND USE: WET AND DRY SEASON

5.1. Unless otherwise specified, the detailed agricultural land use refers to the surveys carried out between August 2005 and January 2006.

5.2. It should be emphasised that although the marginal land may be unsuitable for mechanised cultivation, it does not mean that it is devoid of vegetation or that no agricultural use is made of it. Indeed, in a majority of cases, such marginal land has a vegetation cover that varies according to location from fruit trees to garrigue vegetation. The latter has a limited direct financial contribution to agriculture but is ecologically very important. Indirectly, it may also help to shelter and allow foraging for useful animal species that aid agriculture (see section on apiaries below). Fruit trees occurring on such marginal land tend to be of the types that require little maintenance once rooted and tend to fend off without the need for regular watering, fertilising, pruning, and spraying. They include figs, prickly pear, pomegranate, and olives.

5.3. The marked differences in topography, aspect, degree of shelter, soil depth and soil quality in the XHGCDA is evident in the huge difference of land use in the different sectors and sub-sectors. See **Figures 9** & **10,** which show agricultural land use and field & standing crops in Summer 2005. Because of its protected location, the South Sector supports by far the highest vegetable market and fruit tree agricultural production, whereas in the North Sector this is restricted to certain sub-sectors only because of soil depth and climate constraints. Indeed, this is confirmed by the extensive agricultural production on land in the A of I of the North Sector (the exception being the western A of I), where a more favourable aspect and deeper soil are present. However, this climate and soil depth disadvantage should not rule out the North Sector for its agricultural contribution. Through its stands of thyme garrigue, the North Sector supports more bee foraging ground for prime quality, thyme-honey production than the South Sector and possibly many other areas in the Maltese Islands. And bee keeping and foraging is also beneficial for other reasons, since bees act as crop and fruit pollinators during the periods when thyme is not in flower. Starting from the un-terraced land to the west and passing to the almost flat plains to the east in the North Sector and from the terraced slopes west to east and the flat plains to the south of the South Sectors, the agricultural activity concentrates on vegetable market gardening, vineyards and orchards, as well as arable land farming in decreasing order of importance. Animal husbandry is very low key though the same cannot be said for bee keeping. There are also tracts of land with shallow soil and / or difficult access that have mature stands of carobs. Their agricultural contribution may not be considered as amounting to much, but in fact carobs contribute pods for fodder and make an indirect agricultural contribution by giving protection and wind shelter without which other crops would be unable to thrive.

5.4. On the negative side, a substantial percentage of the land has been allowed to run to weeds and shows obvious signs of abandonment. However, this also has to be interpreted with caution as there are times when land is left fallow for a number of years because of soil properties, climatic or market constraints before being returned to active production. Additional land use includes the conversion of tracts of abandoned land to bird trapping sites and hides. This tends to lower the status of the land and has detracted from the true agricultural value of the locality.

5.5. There are indications that this land has been used for arable agricultural and fruit production since antiquity; this is shown in the large number of historical artefacts and structures that were never constructed far from the centre of daily activity. These range from modified natural caves, dolmens, Punic tombs, and Girnas to an old farmstead and building complex at In-Nahhalija attributed to be the hamlet that served as the centre of origin of the present village/town of Manikata.

5.6. As mentioned earlier market gardening for the production of seasonal vegetables and herb crops occupies the most extensive area under cultivation and possibly the most important level of agricultural activity for the area in terms of financial returns. The area supports a certain level of protected cropping under plastic or agrifleece on ground cloches and also some greenhouses. In most instances, this market garden production can be classified as semi-intensive both because of the degree of protection it is afforded and because of the considerable expense that has been invested in irrigation equipment and water abstraction. The crops grown include summer and “winter” crops of water melons, cantaloupes, pumpkin and long marrows; multi season crops of lettuce, carrots, cabbage and cauliflower; summer open crops of tomatoes, aubergines and peppers and winter protected cropping of same in greenhouses; herbs including basil, mint, parsley and celery; onions, garlic and broad beans form another category.

Vineyards and stone fruit and fig orchards are also present on the XHGCDA, these occupying the second largest area of the three categories mentioned. The area under vines and fruit is significant and gives an important financial contribution for the agriculture in the area. Another contribution comes from cultivated trees and shrubs surrounding field margins or planted against scarp faces for terraced areas. These include a number of summer-fruiting trees such as vines, figs, pomegranate, almonds and other stone fruit as well as prickly pear.

5.7. At present only part of the land is given to the production of wheat and barley and mixed cereal / legume (locally and technically called mahlut) are mainly used as a fodder crop for dairy farming locally. Though not always the case, arable land farming now constitutes a minor agricultural activity in the XHGCDA but from interviews with farmers it has been established that not a square metre of land was left unutilised as recently as the 60's and 70's. The crops grown on even the most marginal parts of this land included high value fodder crops such as *silla*, *zofsfa* and *gilbiena*, the use of which went into decline with the advent of mechanisation since they were primarily used as fodder for beast of burden including mules and horses.

5.8. All sectors show some limitations as to what can be cultivated. The greatest limitation for summer crop cultivation on most fields in the two sectors is water availability in terms of volume and/or water quality. Where water is scarce on the surface, it invariably affects the type of agriculture practised and land quality. Fields that do not have access to water for irrigation during summer, have to be left fallow or be used more for those crops that can be started off on a limited amount of water and then left to fend for themselves. Other limitations have to do with soil workability during winter because of the nature of the soil – predominantly for clay soil, which presents limitations due to soil workability in winter, thus restricting what can be grown on them.

APIARIES

5.9. Thyme garrigue is integral to the maintenance of beehives on the XHGCDM where the contribution of bees to pollination and fruit set must not be underplayed. This is in addition to the direct contribution of apiaries to agricultural income through production of honey, wax, and propolis. There is strong evidence to the long association of the XHGCDA with beekeeping. Several holdings have been identified where beehives were kept in the past. Those identified were both the traditional terracotta cylindrical hives (qolla, now considered obsolete) placed in east or south facing rubble wall recesses and the modern method using box and vertical combs type that is now the only acceptable method for bee keeping. The standards require beehives to be inspected regularly for the presence of pests including Varroa (brood mites *Varroa jacobsoni* and *Varroa destructor*) and other problems that devastated the Maltese apiaries some years back. More than five holdings, having remains of the old system, were identified. At present there are three holdings using several boxes of beehives, two holdings in the north sector and one holding in the south sector. The persons who own these hives have indicated that they are not willing to rush and invest heavily for fear of loosing all with another outbreak of the infestation.

SURVEY FINDINGS

Land Use by Area and Percentages

5.10. The area and percentage of land used by different land use categories is given below whilst the subsequent table shows the area given to different vegetable crops, but not area given to fruit trees (vineyards, orchards and trees around field margins). The total area originally earmarked for assessment was a total of 114 hectares or 1013 tumoli. The total area given in the table below is actually larger than this (116.5 hectares or 1040 tumoli) accounted for by a wider area of assessment in the buffer zone or slight differences in measurements of areas.

5.11. The inferences that can be made from these figures are that:

- The percentage of the land actually put to some form of agricultural use is between 37% and 40% with the remaining 60 to 63% being unused either because it is not workable (around 32% or 37 hectares) due to insufficient soil as for garrigue, or because there is no one working it even though there is sufficient soil and it can be worked (around 29% or 34 hectares);

- One tends to treat the 32% (37 hectares) of garrigue as wasteland with no net contribution to agriculture. However, this is not the case since it offers a source of food for foraging bees, which is essential for honey production both on site and off site as well. Additionally, bees help agriculture and fruit tree cultivation indirectly since without them fruit set would be much lower. This output from the XHGCDA is, therefore, not quantifiable but must be taken as a substantial contribution;

- There is a slight increase in the worked area between the dry and wet season survey with a 3% decrease (equivalent to 20 tumoli) in workable formerly unused land area and corresponding increase in used land area;

- The usable land percentages and hectarage reaches a maximum of 43 to 46 hectares for summer and winter cropping respectively, of which not all is covered at any one time with a crop since a worked field can be awaiting cropping or is resting (winter or summer fallow); and

- There are almost 7 hectares of land exclusively dedicated to fruit tree production and an additional 13 hectares of cultivated land has a part usually a sheltered part or field margin, dedicated to fruit trees.

Table 8: Land use

Classification	Summer / Dry Season m²	Winter / Wet Season m²	Summer / Dry Season Tumoli	Winter / Wet Season Tumoli
A1 Recently abandoned Weedy	202,338	192,293	180.66	171.69
A2 Long abandoned Weedy	106,164	93,370	94.79	83.37
A3 Highly Degraded/Rubble	46,784	40,808	41.77	36.44
A4 Land Given to Afforestation	2,428	2,429	2.17	2.17
Or Planted to Ornamentals	7,449	7,449	6.65	6.65
G1 Primary Garrigue	361,431	361,036	322.71	322.35
G2 Secondary Garrigue	8,880	8,880	7.93	7.93
P1 Protected Ground Cloche	2,951	12,540	2.63	11.20
P2 Protected Greenhouse	2,581	2,581	2.30	2.30
W1 Worked Currently in Crop	123,000	211,741	109.82	189.05
W2 Worked Ploughed but No Crop	209,932	160,445	187.44	143.25
W3 Worked Fallow	68,480	53,095	61.14	47.41
W4 Worked but Weedy	21,970	18,516	19.62	16.53
Total	1,164,388	1,165,183	1039.63	1040.34
Total Workable but Unused	357,714	328,900	319.39	293.66
Total Garrigue	370,311	369,916	330.63	330.28
Total Used	428,914	458,918	382.96	409.75
Total Protected	5,532	15,121	4.94	13.50
Total Ornamental	7,449	7,449	6.65	6.65
Percentage Workable but Unused	30.7	28.2		
Percentage Garrigue	31.8	31.7		
Percentage Used	36.8	39.4		
Percentage Protected	0.5	1.3		
Percentage Ornamental	0.6	0.6		

CROPPING

5.12. The types of crop grown on the holdings depend on a number of variables including the local conditions of soil depth, water supply and shelter as well as seasonal variations. In the north sector, the crops grown are mainly rainfed or dry cultivated ('baghli') farmland but some seasonal irrigation is also being practised on those holdings that can pump or haul water by water carrier. The quantity and variety of vegetable crops produced in the north secto,r excluding ix-Xatba, would be classified as more limited than the south sector given the land area involved. However, the soil depth and exposure limitations for this sector have to be kept in mind. A summary of the land area cultivated to the various crops by season and type of produce is given below.

Table 9: Land area given to various crops: wet and dry seasons

Crop	Summer / Dry Season m²	Winter / Wet Season m²	Summer / Dry Season Tumoli	Winter / Wet Season Tumoli
Fodder Cereal	28,095	66,532	25.08	59.40
Fodder Cereal Mixed (Mahlut)		12,629		11.28
Aubergines	4,169	946	3.72	0.84
Pepper	946	2,188	0.84	1.95
Tomatoes	9,420		8.41	
Potatoes	1,767	12,070	1.58	10.78
Vegetable Marrow	26,454	17,737	23.62	15.84
Cantaloupes	17,595	1,342	15.71	1.20
Melons	3,001		2.68	
Carrots	2,935	2,289	2.62	2.04
Garlic	900	8,162	0.80	7.29
Onions	21,294	32,511	19.01	29.03
Brassicas	32,925	45,755	29.40	40.85
Globe Artichoke	6,865	9,102	6.13	8.13
Lettuce	5,993	4,287	5.35	3.83
Broad Beans	8,675	9,687	7.75	8.65
Herbs	4,136	3,168	3.69	2.83
Strawberry	2,893	2,110	2.58	1.88
Mixed Vegetable Gardening	12,079	21,935	10.78	19.58
P & H (CP)	NA	111,998	NA	100.00
Fields Entirely to Vines	40,942	40,942	36.56	36.56
Fields Pred. Stone Fruit	7,246	7,246	6.47	6.47
Fields Pred. Figs	2,013	2,013	1.80	1.80
Fields Pred. Olives	4,978	4,978	4.44	4.44
Mixed V SF F Po	14,803	14,803	13.22	13.22
Total	260,124	434,430	232.25	387.88

NB. Apart from the fields that are sown entirely to fruit, the area of cropped land that has fruit trees recorded on some part of it amounts to 13.62 Ha. The aggregate area that this would occupy is not easy to estimate but a conservative estimate would put it at 1-2 % of this area, which equates with an additional 0.136- 0.272 hectares given to fruit production.

5.13. The greatest crop area for the winter/wet season crop consists of fodder planting, mainly wheat and some barley, as well as a mixed type planting consisting of a mixture of wheat, oats (*Avena*) and other fodder grass species, in total amounting to almost 7.9 hectares or 70 tumoli. A smaller area is actually recorded for this crop from the previous dry season. Since this is a wet season crop that is harvested around June one has to consider situations where the fields are ploughed, obliterating all traces of the previous crop. Another point to note is that a total field area of 11 hectares or 100 tumoli of ploughed and harrowed land with crop pending was recorded to which the crop status has not been assigned because, at the time of surveying, no crop had been sown or planted. Therefore, the fodder crop could actually be much higher than the value given in the table. The next most common winter crop grown on the XHGCDA is brassicas, which includes the following: various cultivars of cabbage, cauliflower, broccoli, brussel sprouts and kohlrabi, giving a combined area of 4.6 hectares or 41 tumoli. The corresponding values for brassicas for the dry season survey is 3.3 hectares or 29 tumoli, which figure could also include part of the wet season hectarage due to overlap of wet and dry season growth. This follows because brassicas can technically be grown all year round if there is a plentiful supply of water, so the dry season value will include crops ready for harvesting as well as newly planted brassica seedlings that will be approaching harvesting time during the time when the wet season survey was carried out.

5.14. Most of the holdings' summer produce consists of the following vegetable crops in decreasing order of frequency: brassicas (mainly cabbages and cauliflowers), vegetable, sugar melons/cantaloupes, tomatoes, lettuce, herbs (mint family, eruca/salad rocket, parsley and celery), aubergines, water melon, carrots, strawberries and pepper. Winter vegetable produce includes brassicas, onions, vegetable marrows, winter potatoes, broad beans, globe artichokes, garlic, lettuce, herbs, strawberry, carrots, peppers and aubergines. The winter market gardening and root crops usually replace crops of tomato, brassica (mainly cabbage), watermelon and sugar melon planted in summer. All summer crops require some form of irrigation, some more than others such as the sugar melons and watermelons. However, farmers opt for the dry farming method or 'baghli' (rainfed) not solely because of water shortage but because it is the least labour intensive. This is especially so if they are working the land on a part-time basis. Where an unlimited supply of water is available to the farmer on demand (via boreholes or reservoirs), considerable effort is employed in getting as much crops as possible per annual cycle - usually three. This would amount to the highest intensity of cultivation on the south XHGCDA. The area under plastic can be considered as the most intensive in terms of financial returns per unit area though only two crops are grown per annual cycle. This amounts to a total of 2,600 m^2 of greenhouses and over 12,500 m^2 of ground cloches.

5.15. Fruit trees are present at intervals along the boundary walls of some of the holdings but there are also fields given entirely to fruit trees or vineyards with little or no interplanting. Olive plantations and vineyards are increasing being established. As regards fruit trees, stone fruits such as bitter almonds, peaches, plums, apricots and other soft fruits such as pear, apple, pomegranate and figs predominate, and occasionally some citrus too. Very few trees are present for the purpose of wind shelter and for protection from trespassers. The most frequently used for the purpose of stopping trespassing are the prickly pear and the reed *Arundo donax*. The occurrence of carobs is common on most holdings, and more common on the north sector of the XHGCDA. There are a few non-native trees such as acacia and eucalyptus planted on the holdings predominately used for hunting and tapping, but again these are few in number.

5.16. The area under cultivation for the main fruit tree crops namely vines, stone fruit, figs, olives and mixed fruit is 7 hectares, subdivided as 4.1, 0.72, 0.2, 0.5 and 1.5 hectares respectively. However, a note of caution is needed here since the total amount of fruit trees in various states of production is in effect much larger than these figures. The total fruit tree area on arable land is not easy to calculate but a very conservative estimate could amount to an additional 1.0 hectare. This is because of at least two reasons, namely:

- Fruit trees are also present on land that is cropped for vegetables, usually at a sheltered corner or along the field margins. The total area of fields growing vegetable crops on which fruit trees are grown amounts to 13.6 hectares; and

- Fruit trees have been recorded growing on garrigue or disused land, these can make a significant contribution to the total area of fruit tress if taken in combination.

Fodder Production

5.17. The land is given mainly to fodder production. Out of a total of 43.4 hectares usable cropping approximately 7.9 hectares (70.6 tumoli) are given to fodder production, amounting to around 18.2 % of the land surveyed. The total area given to wheat fodder production may actually be more than 6.7 hectares, since an additional 11.2 hectares of P & H (CP) worked land are not assigned to a particular crop. Assuming that half of the winter ploughed and harrowed (crop pending) fields receive a cereal crop, then the cereal crop value (mostly wheat) should be increased accordingly to 13.5 hectares or 120.5 tumoli

5.18. The fields sown to barley (Xghir) *Hordeum vulgare* were few and far apart and did not merit a separate area consideration; their area is in the total fodder production.

5.19. The next most important fodder crop is listed as mixed fodder. A number of fields, which appear to be more on the abandoned rather than the cultivated side, are given to a mixed planting of wheat and vetches/sulla interspersed with wild oats *Avena sterilis*. A possible explanation for this type of planting is that the fields are purposely sown to a mixture of seeds that produce a mixed fodder locally known as 'mahlut'. This type of mixed planting is not very productive, but is also less labour intensive and requires almost no fertiliser input; fields given to such planting are more or less self-sustaining. As a fodder, it is more nutritionally balanced than single crops of barley or wheat, and finds a ready market with dairy farmers since it is usually cut still green and sold as hay. The fields are allowed to self-sow after the first hay harvest and will provide a new cycle during the next growing season with minimum or no land tillage. The percentage listed under mixed fodder is 1.26 hectares (11 tumoli) or almost 3 % of the total worked area.

5.20. The high level of wheat cereal is an indication that the farmers choose crops that require low labour input. The fodder cereal crop is followed by summer fallow and September ploughing. Seeding is usually done in October or November as the weather permits, and the crop is not touched before the following May, when harvesting and baling is carried out. The estimated net returns from this type of cultivation follows in the next section.

6. ESTIMATED CROP RETURNS

WINTER CROPS

Wheat for fodder

6.1. This is usually harvested when dry as straw. Grain is usually not harvested separately but as part of the straw. The straw is packed into 20 kg bales and used as dry fodder and bedding straw for dairy animals and the mushroom industry. Fields given to cereal farming have a total area between 70.6 and 120.5 tumoli. A good harvest will produce between 40 and 45 bales of straw per tumolo, each selling between Lm1.20 and Lm1.40 depending on supply and demand. Rarely does the bale fetch a price of Lm1.60. Therefore, gross gain per tumolo of fodder wheat grown is in the range given in the tables below. Note that returns for the mixed planting are expected to be lower than for wheat or barley. However, here the same gains are being applied.

Table 10: Range of expected returns per tumolo of fodder cereal

Cost per bale	Lm1.20	Lm1.40	Lm1.60
40 bales/tumolo	Lm48.0	Lm56.00	Lm64.00
45 bales/tumolo	Lm54.00	Lm63.00	Lm72.00

6.2. Fertiliser input is one 50 Kg bag of ammonium sulphate per tumolo at Lm5.00 and seed another Lm3.00. The labour input in terms of ploughing, harvesting, and baling will amount to around Lm20.00 per tumolo. Therefore, the total cost is Lm28.00 per tumolo, net profit will stand at Lm20.00 minimum and Lm44.00 per tumolo maximum. Profit is usually in between these two figures at Lm32 per tumolo. Present agricultural contribution of this land area is in the range shown in the table below.

Table 11: Net profit from fodder wheat production

	Lm	Lm	Lm
Net profit	1.20	1.40	1.60
40 bales/tm x 70.6 – 120.5 tn	1412 - 2410	1976.8 - 3374	2541.6 - 4338
45 bales/tm x 70.6 – 120.5 tn	1835.6 - 3133	2471 - 4217.5	3106.4 - 5302

Vegetable market produce

6.3. Assuming that half ploughed and harrowed (crop pending) fields receive a vegetable crop, around 52.5 % of the cultivated fields or approximately 204 tumoli (22.85 hectares) are given to winter vegetable market produce (brassicas, onions, vegetable marrows, winter potatoes, broad beans, globe artichokes, garlic, lettuce, herbs, strawberry, carrots, peppers and aubergines, mixed vegetable gardening would include similar proportions of the above vegetables). The larger production values account for around 12 hectares of winter brassicas, onions, and vegetable marrow production not including half of the P & H (CP) area of 5.6 hectares. This amounts to 40.5 % of the total cultivated land area. Summer vegetable market produce shifts to summer brassicas, vegetable marrows, sugar melons and tomatoes in terms of the most cultivated types and stands at 8.39 hectares or 32 % of the total cultivated land area. The area planted to each crop is considered in detail below in the order of decreasing production.

Brassicas

6.4. The percentage given to wet season brassicas is estimated to be around 10.5% of the winter land area or 4.57 hectares, equivalent to 40.8 tumoli. The summer figures are slightly lower at 3.29 hectares or 29.4 tumoli (actually, 12.6 % of the summer cultivated land area). This figure is lower since brassicas continue to be planted up to October weather permitting to get a late crop. Yield is about 200 boxes per tumolo at 25 Kg per box. Prices fetched are highly variable – the average wholesale values as obtained from the NSO statistics for 2005 are Lm1.37 to Lm2.18 per box of cabbage in October/December 2005 and Lm1.73 to Lm2.1 per box cauliflower for October/December 2005 with cauliflower values reaching as much as Lm2.7 to 2.9 per box as for same periods in 2004. On average range of values for brassicas are around Lm2.00 – Lm2.50 per box depending on the month, the colder months usually fetching higher prices. The price of this product is subject to wide fluctuation variation depending on availability, which is in turn dictated by weather conditions. During times of adverse weather (late rain or floods), cauliflower fetches very good prices, though net income may still be low if there excessive plant damage. Gross income per tumolo is being taken as falling between Lm400 – 500. Seed, fertiliser, pesticide, and irrigation costs to establishment are around Lm60 per tumolo.

6.5. The land given to brassica cultivation (wet season figures) should give a return of between Lm13,872 and Lm17,952 taking the net of Lm340 - 440 per tumolo.

Onions and garlic

6.6. Winter onion cultivation takes 7.48 % of the winter cultivated land area equivalent to 3.25 hectares or 29 tumoli. Summer onions, usually grown as shallots, takes 8.19 % of the summer cultivated land area equivalent to 2.13 hectares or 19 tumoli. The cultivation of garlic follows very closely to onion cultivation and will be treated together. Garlic production takes up 1.8 % of the winter cultivated land area, equivalent to 0.8612 hectares or 7.28 tumoli. The capital input for onions are estimated at Lm35 per tumolo, and for garlic estimated at Lm50 per tumolo. Sprinkler irrigation of shallots in summer represents an additional cost, mostly in electricity costs for water pumped from the aquifer. The most time consuming part of onion production is planting and weeding. The use of selective weed killers helps to reduce weeding input. Seedbed and seedling preparation for onions has not been estimated, but will involve both labour as well as fungicide. Onion seed is usually not purchased but retained from the previous harvest. Chinese garlic variety is usually purchased, whereas Maltese varieties are retained from the previous season. Mechanical, hand or chemical weeding is employed, giving a variable costing to growing this crop. Full timers now opt for chemical mechanical or weeding since this is the most cost efficient. The yield is in a range of 1200 – 1500 kg/tm with gross income and profits strongly dictate by the volume of produce on the market; when there is a high production and the market is flooded, the prices are quite low. NSO statistics for 2004-5 dry and green onions average monthly values are in the range 8c to 20c per kg (two-year average). Green garlic commands better prices, around 12c to 30c per kg, and dry garlic commands very good prices in the range of 15c to 50c per kg (two-year average). Average yield per tumolo is1350 kg giving a gross profit range per tumolo for onion of Lm108 - Lm270 and gross profit range per tumolo garlic of Lm162 – Lm675. After deduction of the direct expenses the expected gross and net profit, excluding labour, in a good year would be in the range as indicated in below. For onions, the estimated upper limit that can be worked full time per farmer is 15 tumoli, there is sufficient area for three full time farmers. Even if the maximum returns are obtained, the returns will be just sufficient to support them. However, this is a very ideal situation, since market prices are more often on the low side.

Table 12: Gross and net returns from onion and garlic production

Produce	Low Gross Returns	Lm	High Gross Returns	Lm
Summer Onion	19 tm x 1350 x 8c	2052	19 tm x 1350 x20c	5130
Winter Onion	29 tm x 1350 x 8c	3132	29 tm x 1350 x20c	7830
Winter Garlic	7.3 tm x 1350 x 12c	1183	7.28 x 1350 x 50c	4914

Produce	Low Net Returns	Lm	High Net Returns	Lm
Summer Onion	2052 - 665	1387	5130 - 665	4465
Winter Onion	3132 - 1015	2117	7830 - 1015	6815
Winter Garlic	1183 - 365	818	4914 - 365	4549

Vegetable marrows

6.7. Winter vegetable marrow cultivation takes 4.1% of the winter cultivated land area, equivalent to 1.77 hectares or 15.8 tumoli. Summer vegetable marrow usually grown takes 10.2% of the summer cultivated land area, equivalent to 2.64 hectares or 23.6 tumoli. Although vegetable marrow is technically suitable for dry land farming, the growing season is greatly extended if irrigation is available. Returns per tumolo are highly variable and depend on availability on the market; rainfall and fungus disease are major determinants of yield. There are times when it fetches a good price and others when it is literally thrown away. The average yields are of 2,500 – 3,000 Kg per tumolo on unprotected fields, and as much as 3,500 – 4,000 kg per tumolo for protected cropping. NSO statistics for 2004-5 for vegetable marrows monthly average values are in the range extremes of 5c to 81c per kg (two-year average). However, the most common prices are in the range of 15c to 30c per Kg. Given returns at an average of 20c per Kg, this would fetch an average gross value in the range of Lm500 - Lm600 per tumolo. But the value may be as low as Lm125 – Lm200. The land preparation expense in producing vegetable marrow is similar to potato production, but more money is spent on protection, fertiliser, pesticide, and irrigation - water pumping and laying of drip lines, and less on seed. The product is perishable and needs daily harvesting. Overall, it is therefore more labour intensive. Expenses, excluding labour, are expected to be around Lm150 especially under protected cropping. Net gain per tumolo is expected to be in the Lm350 - Lm450 range. Therefore, total expected returns from summer marrow cultivation for an estimated total area of 23.6 tumoli is between Lm8,260 - Lm10,620, and for winter marrow cultivation of an estimated total area of 15.8 tumoli, it is between Lm5,530 – Lm7,110.

Potatoes

6.8. Potato cropping has been estimated to around 2.8 % of the winter cultivated land equivalent to 1.21 hectares or 10.7 tumoli, which is sown to winter or spring potatoes according to the workability of the soil in the location. During the time of the summer survey, the spring potato crop had already been uprooted at the time the survey was carried out, and could not be recorded. Therefore, the figures given are more relevant to the winter potato production. Manure application is 1.25 – 1.5 tonnes per tumolo; this will be used for at least two successive crops. The cost for half a truckload of well-worked manure is Lm40.00 per truckload, so that a cost of Lm20.00 per tumolo is assigned. Additional ammonium sulphate application - 50 to 100 Kg per tumolo costs Lm4.50 per 50 Kg or a compound fertiliser 12-12-17-2 costs Lm9.50 per 50 Kg. Pesticide for late blight costs Lm10.00 per can of Mancozeb fungicide. Seed potato costs for150 Kg or 200 Kg per tumolo is Lm24 – Lm32. For a good year, the yield is between 8 – 10 times the seeded amount, or between 1,200 and 1,500 Kg per tumolo. The following summarises the costing for a potato crop per tumolo of land. The net income, excluding labour, is Lm56 or Lm77, less than the values given in the following table; these are shown in the subsequent table.

Table 13: Costing for potato cropping per tumolo of land

	Seed cost	Manure	Ammonium sulphate	Fungicide	Yield	Gross income @ 10 – 20c/kg
150 kg/tm	Lm24.00	Lm18.00	Lm9.00	Lm8.00	1200 kg/tm	Lm120 - 240
					1500 kg/tm	Lm150 - 300
200 kg/tm	Lm32.00	Lm18.00	Lm12.00	Lm8.00	1500 kg/tm	Lm150 - 300
					2000 kg/tm	Lm200 - 400

Table 14: Net income range per tumolo of potatoes

Seed rate	Total cost	Yield range	Net income per tumolo
150 kg/tm	Lm59	1200 kg/tm	Lm61 - 181

Seed rate	Total cost	Yield range	Net income per tumolo
		1500 kg/tm	Lm91 - 241
200 kg/tm	Lm70	1500 kg/tm	Lm80 - 230
		2000 kg/tm	Lm130 - 330

6.9. A total land area of 1.21 hectares or 10.7 tumoli given to the potato crop, gives a net agricultural contribution, excluding labour, in the range of Lm653 to Lm3,531. The figures can be doubled if two potato crops are sown per year. Certain operations cannot be performed single-handed; for example, hired-labour must be brought in during sowing and lifting, which would tend to erode returns. Hence, the total profit would be marginal if the hours of labour and extra help were to be factored-in. This is the principal reason for the small area given to potato cultivation. It is estimated that 10 tumoli are the upper limit that a single full time potato farmer can work using conventional means. The profit made from the land area given to potato cropping would be sufficient to support a single farmer working full-time for one season.

Broad beans

6.10. The total area given to broad bean production is low, with just under 1 hectare or 8.65 tumoli or 2.2% of the land under assessment. Broad beans are grown on land that is well worked and has usually been manured in the previous year. Other fertiliser input is usually also limited for broad bean production; potassium and phosphorous being more important than nitrogen. A major requirement is that the land must be sufficiently sheltered and that rainfall is not limiting during the growing stage. Broad beans cropping does not seem to be very extensive; crops of variable quality were observed on different holdings. Given input costs and gross returns similar to those for onion and garlic (i.e. Lm35 per tumolo; Lm108 - Lm270 gross returns), the net profit from 8.65 tumoli is estimated to be between Lm631 and Lm2,032.

Other winter vegetables

6.11. It is estimated that the remaining winter produce, including products such as globe artichoke, carrots, lettuce, herbs and strawberry does not amount to more than 2.43 hectares or 21.7 tumoli.

6.12. Using an average gross return of Lm108 - Lm270 per tumolo and Lm50 per tumolo expenses, the net profit from 21.7 tumoli is estimated to be between Lm1,259 and Lm4,774.

6.13. A total of 5.6 hectares (50 tumoli) of ploughed and harrowed land did not have a crop at the time of the wet season survey, the net profit is estimated to be in the range of Lm2,900 and Lm11,000.

SUMMER VEGETABLES

6.14. Summer vegetables were summer brassicas, vegetable marrow, shallots, sugar melons, tomatoes, lettuce, and watermelons in decreasing order. All the summer crops require some irrigation. Brassica crops that are started off in summer require some irrigation until it they are established has been considered above. The same applies for vegetable marrow and shallots.

6.15. Summer vegetable gardening is not only very labour intensive, fertiliser and water input is also high. Whereas a number of weedy species associated with the fodder crop areas are tolerated, the vegetable plots both in summer and winter must be very well kept and free from weeds, otherwise the level of productivity would fall considerably. Problems such as fungal and insect pests are also considerably increased in summer. More intensive care and, therefore, a larger labour input are needed for summer vegetable gardening.

Melon Production and Costing

6.16. Sugar melons/cantaloupes and water melon accounts for 4.75 % of the total arable land percentage. This works out to 2.06 hectares or 18.39 tumoli. Production costs and yields for melon and watermelon are expected be similar to those for vegetable marrow production, though selling prices start off high (usually at around 30c per Kg but can reach as much as 95c per kg), falling considerably as the season progresses to around 7c per Kg, rarely lower. Taking as an average 10c - 20c range per Kg gross and a yield of 2,500 – 3,000 Kg per tumolo, gross income is expected to be between Lm250/300 - Lm500/600. Expenses, excluding labour, work out at around Lm150 per tumolo particularly under protected cropping. This results in a net income of around Lm100/150 - Lm350/450 per tumolo. Total net returns for 18.39 tumoli are expected to be Lm1,839 / Lm2,759 - Lm6,436 / Lm,8275.

Tomato Production and Costing

6.17. Some 3.6 % of the summer land under cultivation is given to tomato cropping, equivalent to 0.942 hectares or 8.4 tumoli. Land preparation is similar to that for potatoes but fertilisers, irrigation and pesticide costs are higher. Seed cost is lower, but seedling production involves more labour and material including compost and seed. Drip lines add to the costs.

6.18. Compound fertilisers are applied at the rate of 1 Kg per tumolo per day for the first 70 days and 2 Kg per tumolo per day up to day 110 which corresponds to end of cropping. This results in a total of 150 Kg of compound fertiliser per tumolo for one growing season, which, with other expenses including drip lines and pesticides, gives an average expense of around Lm120 per tumolo. Although seed is also expensive, sometimes the major canning industry producers provide the seed or even the seedlings free of charge in order to ensure the product of their choice.

6.19. Harvest per tumolo is in the 3,000 Kg range and two-year average range of prices 10 to 20c per kg (though prices for the cold months may reach the 60 to 70c per kg). This results in gross returns per tumolo of Lm300 – Lm600. The net return after deducting fertilisers, manure, pesticides and water, but excluding labour costs would be around Lm180 – Lm380 per tumolo.. The total returns for 8.4 tumoli is estimated to be Lm1,512 - Lm3,192.

A FURTHER NOTE ON VEGETABLE CROP PRODUCTION

6.20. A distinction must be made between a crop that is started in the dry season and continues to mature in the wet season, such as brassicas. This appears in the dry and wet season survey but the return is strictly a single event i.e. wet season, hence and the maximum area surveyed will be taken. On the other hand, some crops appear in the dry and wet season and the returns must be calculated separately since the products mature and are sold in the different seasons. These are usually those crops that have a short growing period. The table below summarises the range of net returns as calculated for the year 2005 dry and wet seasons on the XHGCDA.

Table 15: Estimated net returns for the 2005 dry and wet seasons

	Summer Period		Winter Period	
Produce	**Area**	**Net returns Lm**	**Area**	**Net returns Lm**
Fodder (a)	7.9 Ha / 70.6 tm	1,412 – 3,106		
Fodder (b)			13.5 Ha /120.5 tm	2,410 – 5,302
Brassicas*	3.29 Ha / 29.4 tm		4.57Ha / 40.8 tm	13,872 -17,952
Onions	2.13 Ha / 19 tm	1,387 – 4,465	3.25 Ha / 29 tm	2,117 – 6,815
Garlic			0.86 Ha / 7.3 tm	818 – 4,549
Vegetable marrows	2.64 Ha / 23.6 tm	(2,950 – 4,720) 8,260 – 10,620	1.77 Ha / 15.8 tm	(1,975 – 3,160) 5,530 – 7,110
Potato			1.21Ha / 10.7 tm	653 – 3,531
Remaining Vegetables			2.43 Ha / 21.7 tm	1,259 – 4,774

	Summer Period		Winter Period	
Produce	Area	Net returns Lm	Area	Net returns Lm
P & H (CP) Vegetables			5.6 Ha / 50 tm	2,900 – 11,000
Melons (averages)			2.06 Ha /18.39 tm	4,598 – 7,355
Tomato	0.942 Ha / 8.4 tm	1,512 – 3,192		

* These returns are started in summer but continue into the wet season

FRUIT TREES

6.21. Some holdings are given entirely to fruit tree production and a number of fruit trees are present around the periphery of some holdings. The following trees or groupings have been observed under intensive cultivation:

- Vines (Gheneb) *Vitis vinifera;*
- The stone fruit group including Peaches/Nectarines and cultivars (Hawh/Nuciprisk) as well as *Prunus persica* and Plums and cultivars (Ghajn Baqar) *Prunus domestica* ;
- Olives; and
- Figs and cultivars(Bajtar/ Farkizzan/ Tin) *Ficus carica*

6.22. The following is a list of fruit trees that are not under intensive cultivation but are planted round field margins or to provide shelter.

- Prickly Pear (Bajtar tax-xewk) *Opuntia ficus-indica*;
- Pomegranate (Rummien) *Punica granatum*;
- Pear and cultivars (Langas u Bambinella) *Pyrus communis* and cultivars;
- Apple and cultivars (Tuffieh) *Malus communis*;
- Almonds (Lewz) *Prunus dulcis* and *Prunus amygdalus*;
- Loquat (Naspli) *Eriobotrya japonica*; and
- Black and White Mulberry (Tut u Cawsli) *Morus nigra* and *Morus alba.*

6.23. Of the above mentioned fruit trees, only the vines, stone fruit and figs are grown on a sufficiently large scale that they can be assessed for economic returns. The others are sporadically cultivated, usually along field margins and include trees that are not harvested regularly for their fruit such as the prickly pear. Trees under this grouping are to be considered as contributing some financial returns; the return has been calculated at a quarter that given for stone fruit of equivalent area. The total area and returns are given below.

VINES

6.24. Some 9.4% of the total cultivated area under assessment, equivalent to 4.09 hectares or 36.56 tumoli of land is given to vines. If planted out at maximum efficiency between 5,000 to 6,250 vines per hectare, the expected yield per hectare of vines over three years old (depending on variety), is expected to be 3 kg to 5 kg per vine or from 15 to18 tonnes per hectare to 25 to 30 tonnes per hectare. Prices depend on quality, variety, and demand but grapes are expected to fetch anything from 20c per Kg to 30c per Kg for very high quality, noble grapes. This gives the gross income per hectare of 3kg per vine, 5,000 vines per hectare @ 25c average price per kg, results in Lm3,750 per hectare or Lm421 per tumolo. At 5kg per vine and 5000 vines per hectare @ 25c per kg, the gross return would be Lm6,250 per hectare or Lm702 per tumolo. These values are based on the average Pitkali price for the last two year; it may vary for grapes taken to the wine producers.

6.25. The largest expense is in capital expenditure required to set up the vineyard. This is estimated to be between Lm10,000 to Lm12,000 per hectare, which must be reinvested every 20 years, (calculated as the average productive life-span of a vineyard). This value does not include investment on machinery, which averages Lm700 per hectare and which must be reinvested every 7 years. These must be factored in as an annual cost and depreciation. The average running costs of a vineyard are around Lm2,500 per hectare or Lm280 per tumolo; they include costs of fertilisers and labour input to harvest and prune. If the running costs of Lm280 per tumolo are deducted, the net return per tumolo, will be Lm141 - 422 including deductions for labour but excluding capital and machinery. For the current 9.4 % of the assessed area or 4.09 hectares of vines on the XHGCDA, this would work out to 36.56 tumoli giving a net gain range of Lm5,155 - Lm15,428.

STONE FRUIT AND OTHER ORCHARDS

6.26. About 3.2% of the total worked land under assessment, equivalent to 1.42 hectares or 12.68 tumoli is given stone-fruit, figs and other fruit. The stone fruit and fig orchards are of a mixed state age with some very old and underproductive and others quite young and productive. The largest stone fruit orchards are on the south sector, with mixed plantings of a range of species and cultivars.

6.27. Most of the olive groves are relatively young and most are reasonably well organised and tended. Investment in water storage, and drip irrigation is also evident. Returns from such small-scale olive, stone fruit and fig orchards are not very easy to estimate, but using the assumption that fruit tree production should give net returns equivalent to half that for vines, that is between Lm70 - Lm210, the net returns for the 12.68 tumoli should be between Lm887 to Lm2,663.

A Further Note on Fruit Tree Production

6.28. The number of efficiently planted fruit tree orchards is rather limited and the returns, if the produce is sold, are not expected to exceed the maximum value given. However, other fruit tree areas need to be included, namely the 1.48 hectares of mixed fruit orchards. Returns from such trees have not been factored into calculations given above and should be estimated at another 1 hectare equivalent. If the average net figure given above for 2.48 hectare or 22 tumoli of land, then average net returns between Lm70 - Lm210; this would be equal to Lm1,540 to Lm4,620.

Table 16: Estimated returns from Fruit Trees

	Summer Period		**Winter Period**	
Fruit Production	**Area**	**Net returns Lm**	**Area**	**Net returns Lm**
Vines	4.09 Ha = 36.56 tm	5155 - 15428	NA	NA
Stone fruit and others	1.42 Ha / 12.68 tm	887 - 2663	NA	NA
Mixed /Field Margins	2.48 Ha / 22 tm	1540 - 4620.	NA	NA

7. AGRICULTURAL POTENTIAL

7.1. Land capability is measured as **the potential gross margin of the currently most profitable crop grown**. Based on this definition, the most profitable crop grown is grapes followed by vegetable market products such as potatoes, vegetable marrow or garlic. The latter can be grown at two different seasons on dry cultivated to semi-irrigated land, effectively doubling the returns. If soil conditions would permit and all year round irrigation is possible, then three crops would be possible. However, the possibility is severely limited by soil condition and water inadequacy.

7.2. Vegetable growing has additional major drawbacks. Vegetable market gardening is highly labour intensive and there is also the added problem of over-production and drastically fall in prices in times of glut.

7.3. A land capability assessment is usually based on a vegetable crop that has a high guaranteed return such as potatoes. Potato production, which in other localities in Malta is considered as a good cash crop that is not subject to overproduction and a consequent drop in prices because it is exported, is not suitable for here since it is subject to wind damage due to the exposure of the site.

7.4. A land capability measurement based on a vegetable crop other than potato is superfluous in this situation.

7.5. A land capability assessment based on grape production is more practical. Grapes find a ready market and the prices are not subject to wide fluctuations since the demand in the local wine producing industry is still unmet, and the wine producers are still reliant on imported grapes. The major drawback with vineyards is that they require extensive capital investment. However, assuming all conditions are favourable, if all 386 tumoli are given to vine production as the most profitable crop, then the following land capability emerges.

7.6. The cultivation of 386 tumoli of grapes @ Lm141 - Lm422 per tumolo gives a return of Lm54,426 - Lm162,892. Labour costs have been factored in but not capital investments and machinery. If capital and amortisation figures given earlier are taken, this will amount to around Lm700 per hectare per year which, on 43.4 hectares, results in an annual deduction of Lm30,380. Therefore, the minimum and maximum total annual profit from such production within the XHGCDA will amount to around Lm24,046 to Lm132,512, or an average of Lm78,279.

7.7. Given this scenario, if the current cultivated area in the XHGCDA is put under vines, this would provide an income for around 80 part-time farmers each working an average of 5 tumoli.

7.8. In practise, a number of factors act as constraints on land capability. Factors such as soil type, depth, structure, and fertility, exposure, pests and diseases, water availability and water storage facilities determine whether the land can be farmed at its maximum potential.

7.9. There is also the problem of supply and demand that, at times, creates a glut and lowers the margin of profit below the sustainability level. Cost of labour, including hidden costs such as transport, fuel etc., is not to be ignored. As explained earlier a number of factors are deemed disadvantageous on several holdings in the XHGCDA. The exposure of the site to the damaging action of wind that cannot be sustained by crops such as broad beans and potato (especially in the north sector), is a major limitation. In addition, there are other problems associated with the terrain, such as limited soil depth and water availability.

7.10. Labour expense is the next most probable reason for the land use pattern in the XHGCDA. The higher the labour input required to produce a crop and the lower the reliability of good returns, the smaller the proportion of land given to its production. These two factors alone should explain why only a small proportion of the area is given to market crops.

7.11. Therefore, one can say that the present crops grown are those which have the widest tolerance of the environmental factors present and which give a decent return with the minimum of labour input. Even if amendments are made to eliminate or reduce the disadvantages of soil depth and water shortage and hence increase the land area and variety of crops grown, problems will arise with over supply and reduced profit. This has been an eternal problem with Maltese agriculture because very rarely are crops given a guaranteed price.

7.12. There are also compounding factors such as quota restrictions on production for export. As long as there are no cooperative services to advise farmers and work out projections for market garden produce, these problems will continue and full time market gardening (and land farming in general) in any area will continue to remain unreliable.

7.13. Since the 1950s, land use pattern in the area has changed somewhat where even the most marginal land was farmed - mostly for legumes such as sulla or vetches and cereals for animal fodder. These marginal plots could be worked for one season since it was possible to plough the small shallow plots using mule or donkey, and there was a surplus of manpower.

7.14. The advent of better paid jobs and the consequent land abandonment or, at best, part-time farming as well as mechanised tools that are not suitable for shallow soil, has seen the abandonment of shallow marginal land. The result is that land that, in the 1950s, was almost entirely cultivated is now only partly so. In this XHGCDA area, more tumoli are now under vines and olives on deeper soil and vegetable market gardening takes place on protected and deep soil. The trend seems to be for more land under vines and protected cropping under plastic, where returns are more reliable.

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Appendix 1:

Figures

Figure 1: Golf Course Site and Area of Influence

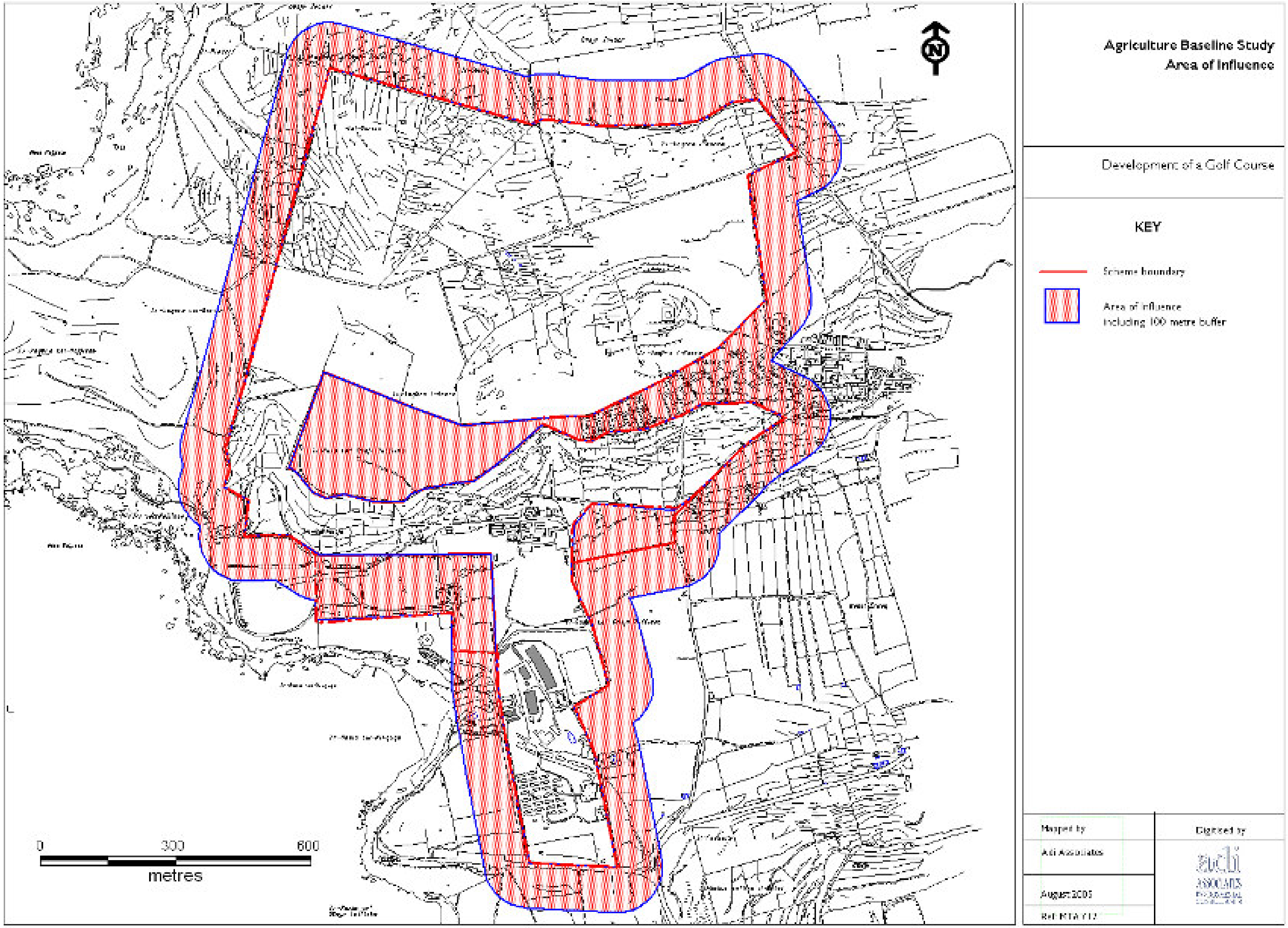


Figure 2: Agricultural Sectors and sub-sectors

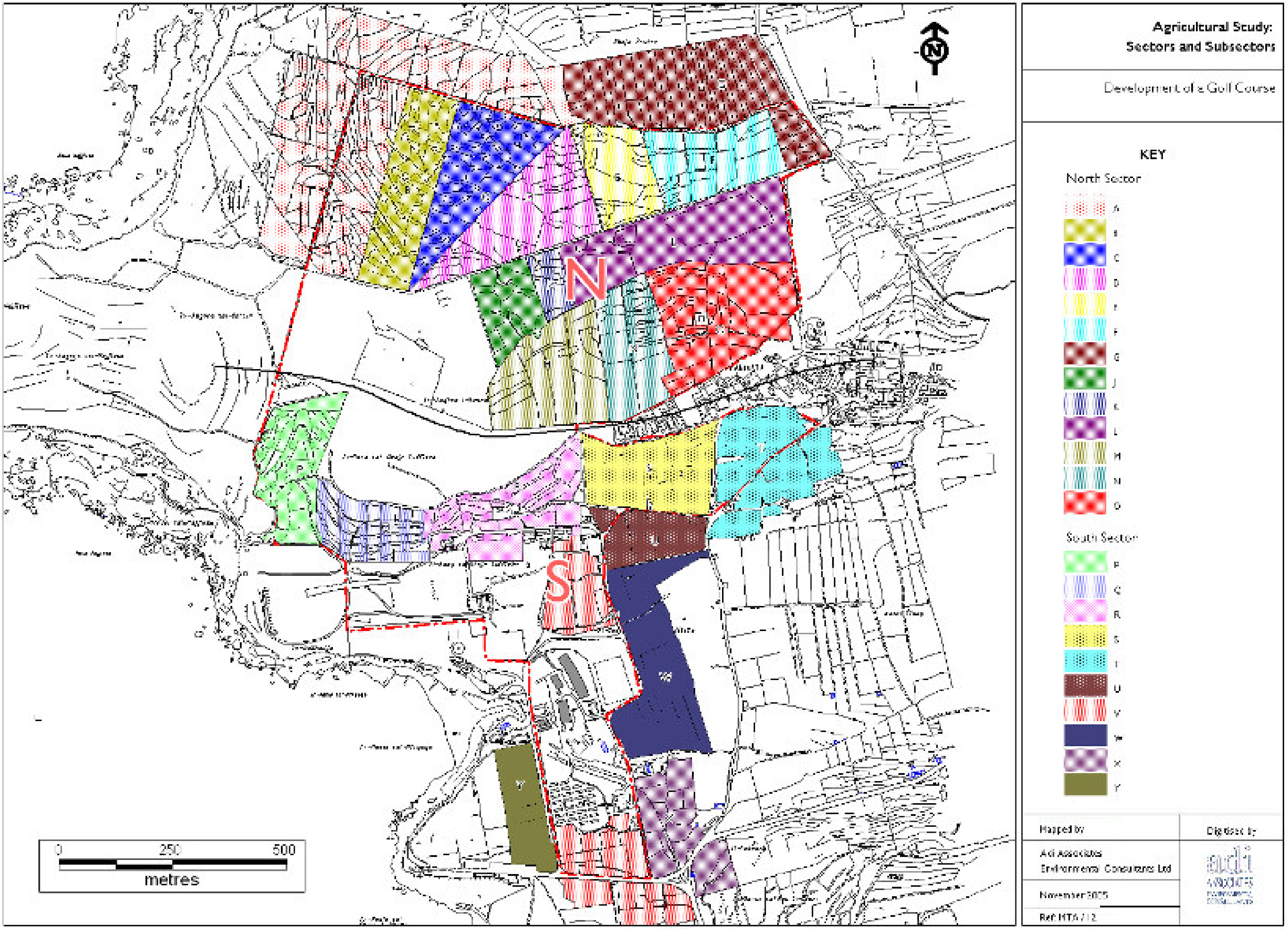
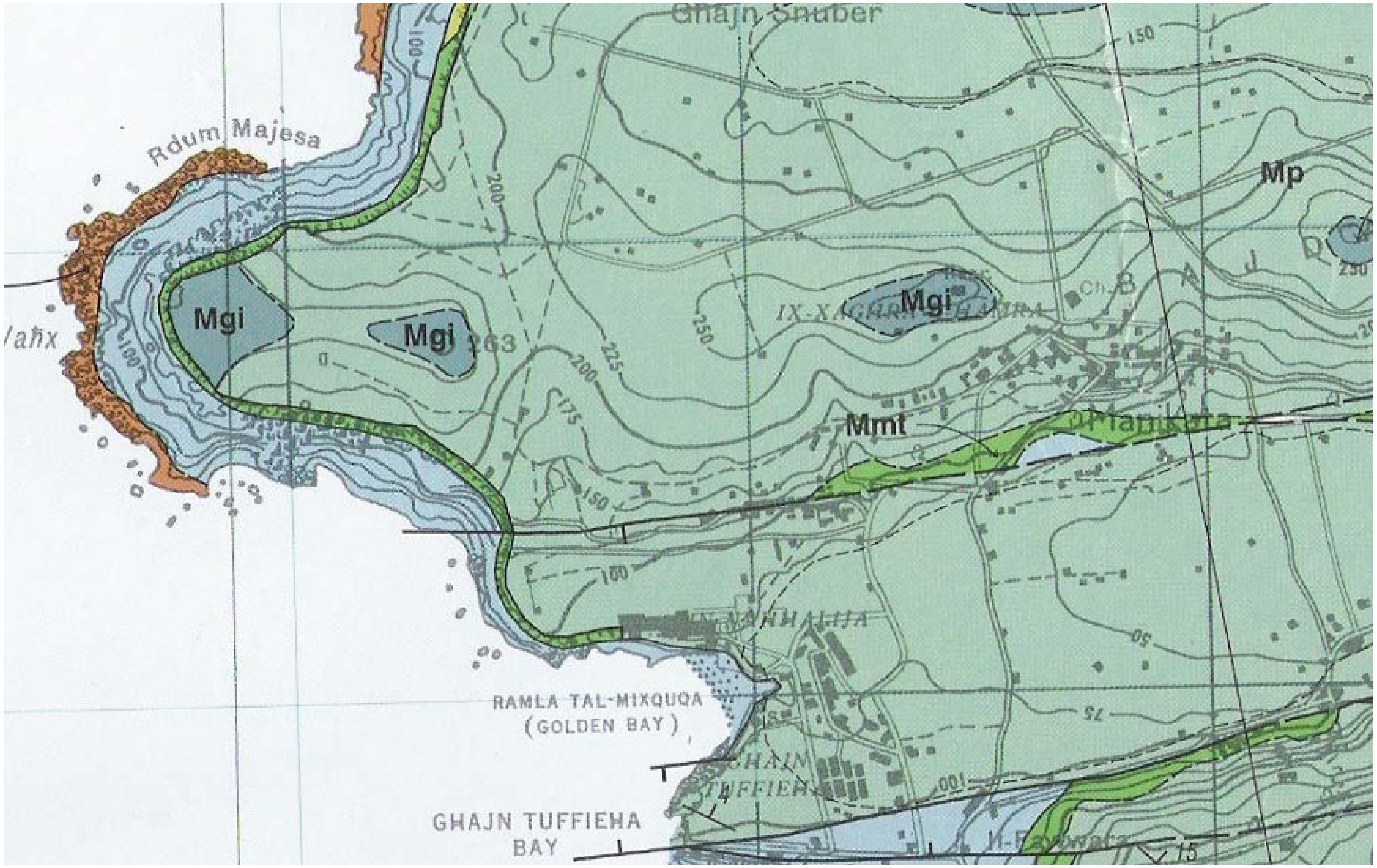


Figure 3: Geological subdivisions



Key to colours and abbreviations

Blue Mgi: Miocene Period - Upper Coralline Limestone – Gebel Imbarak Member.

Bluish Green Miocene Period - Upper Coralline Limestone – Tal-Pitkal Member.

Green Mmt: Miocene Period – Upper Coralline limestone – Mtarfa Member.

Figure 4: Transects

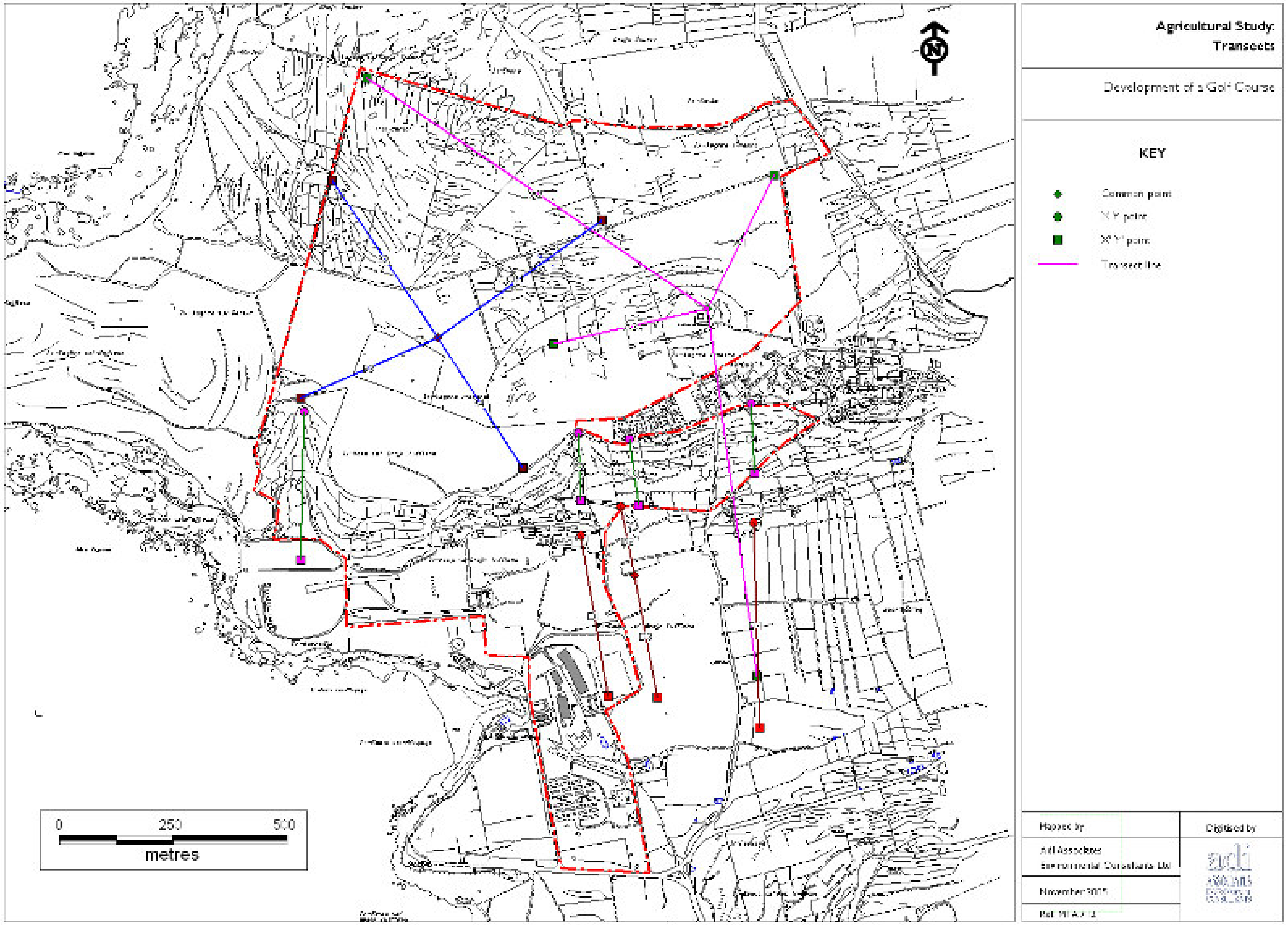


Figure 5: Soil Sampling Sites

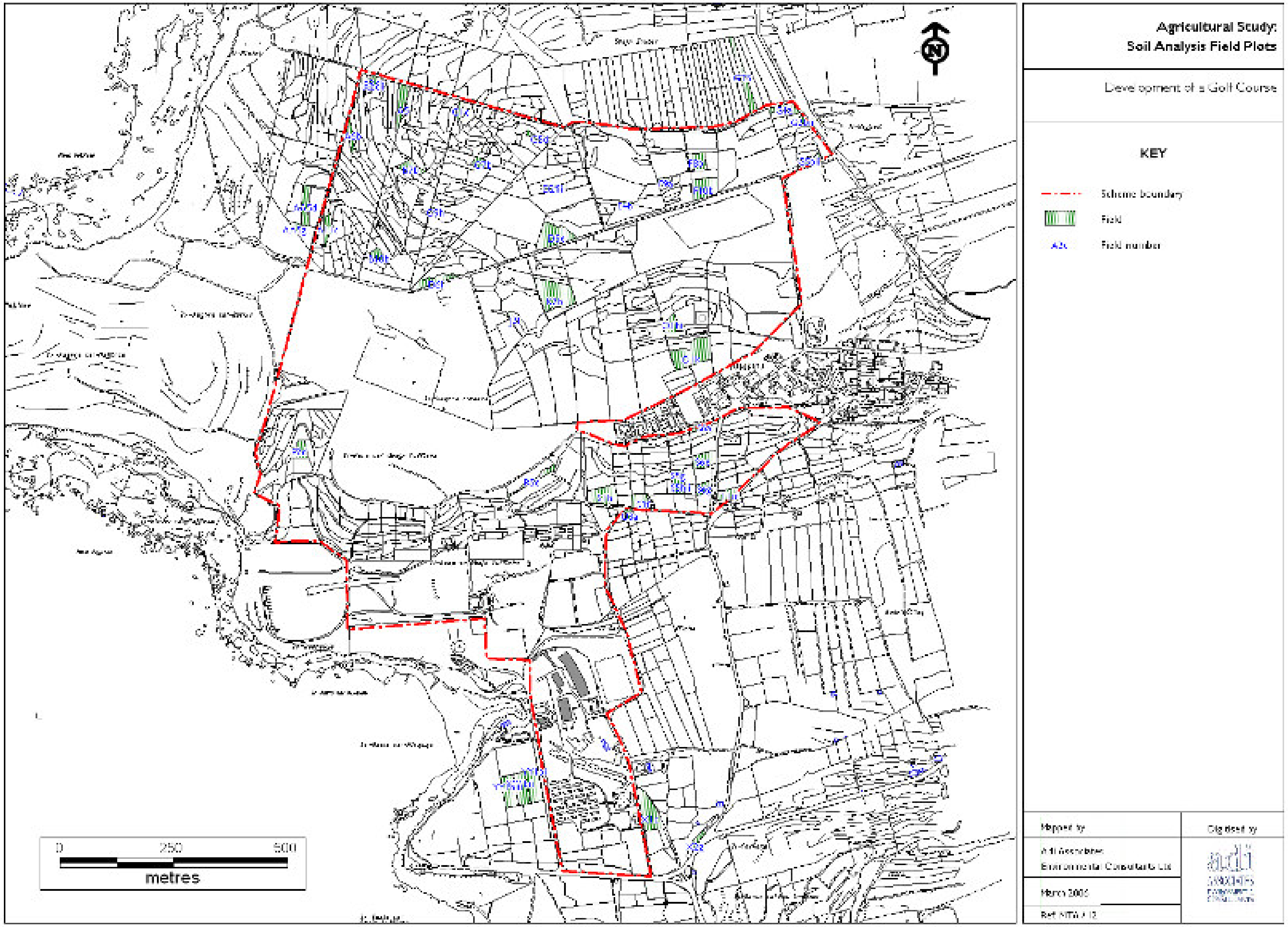


Figure 6: Soil type distribution

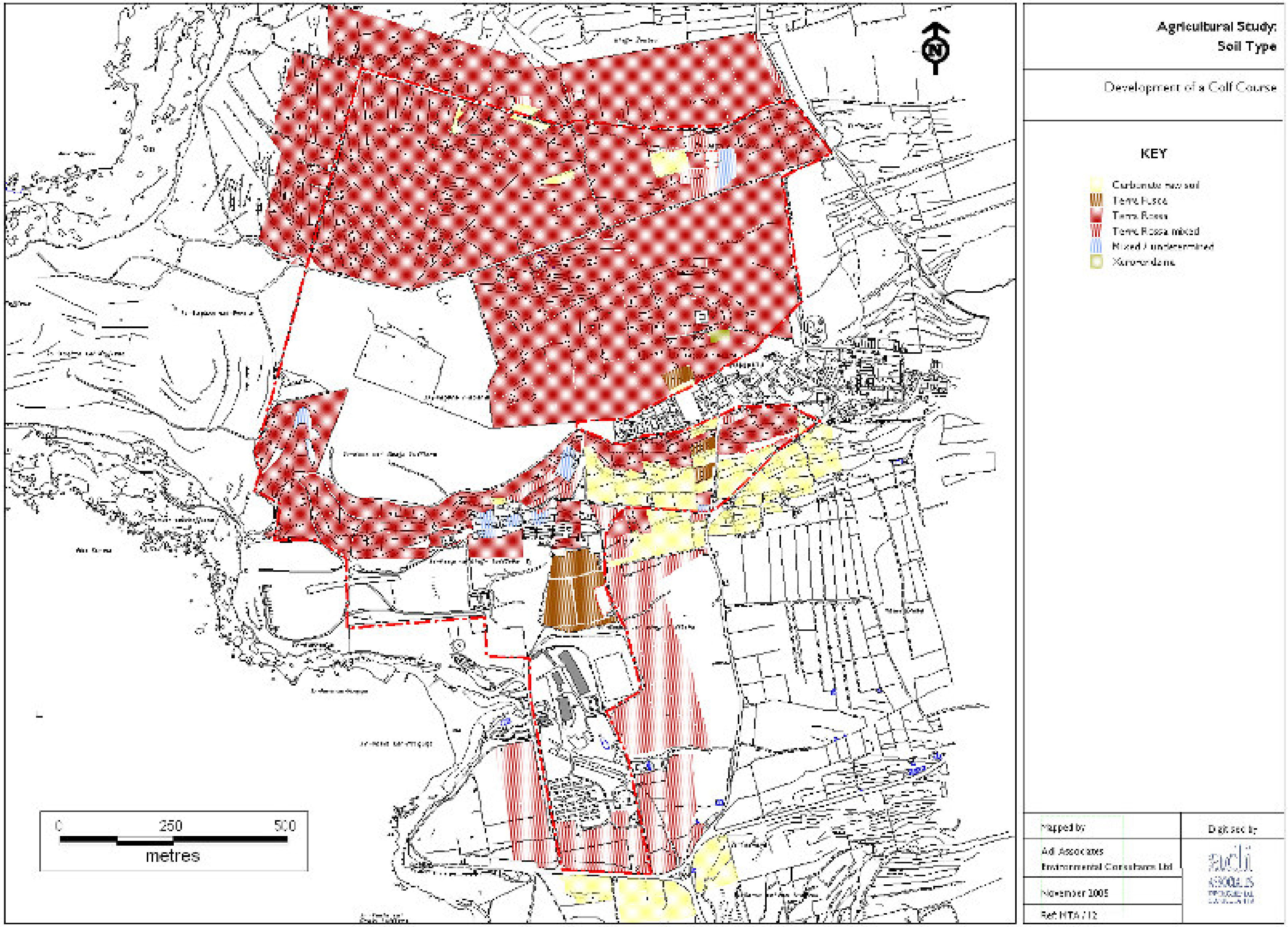


Figure 7: Soil depth distribution

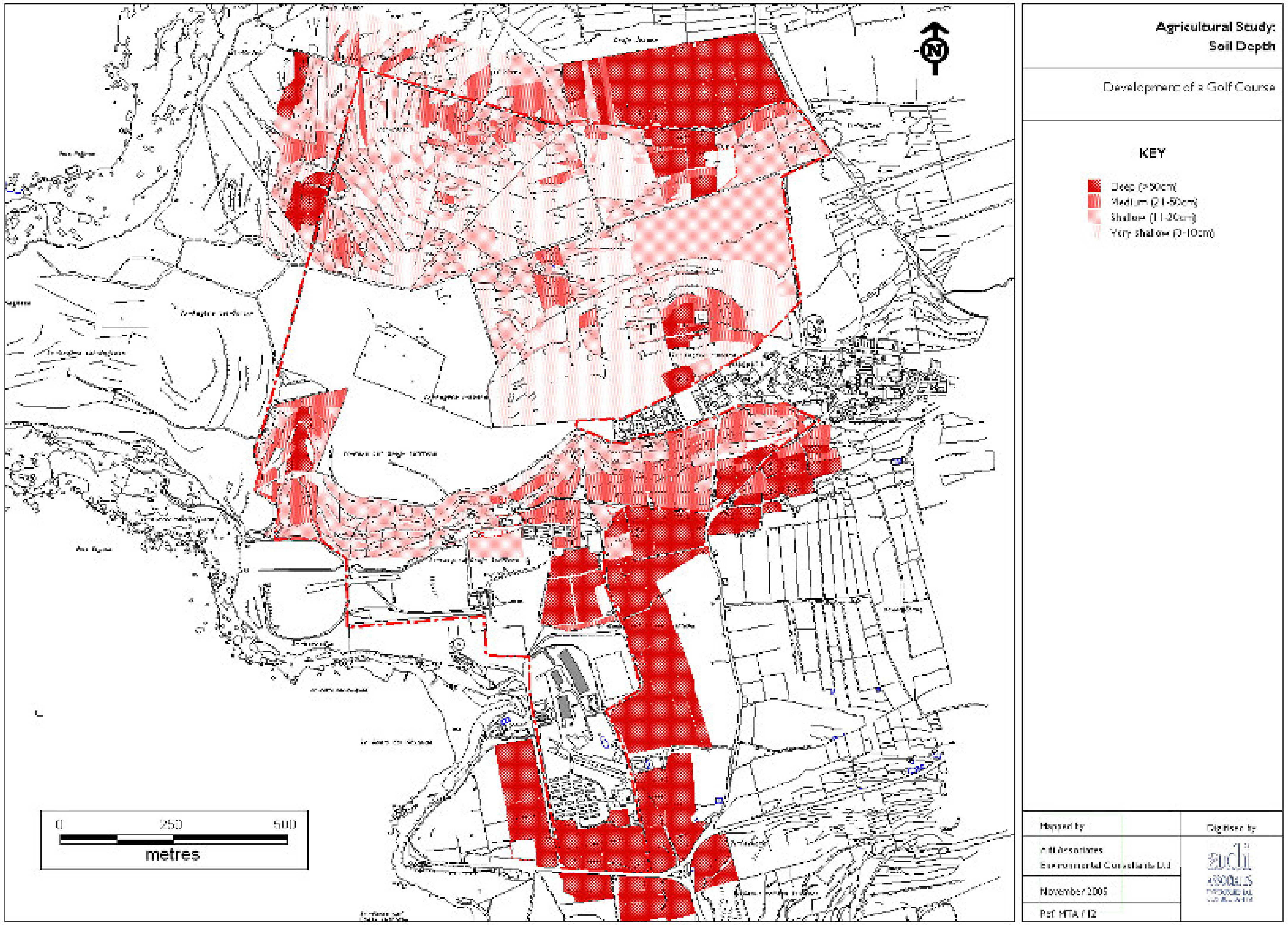


Figure 8: Boreholes

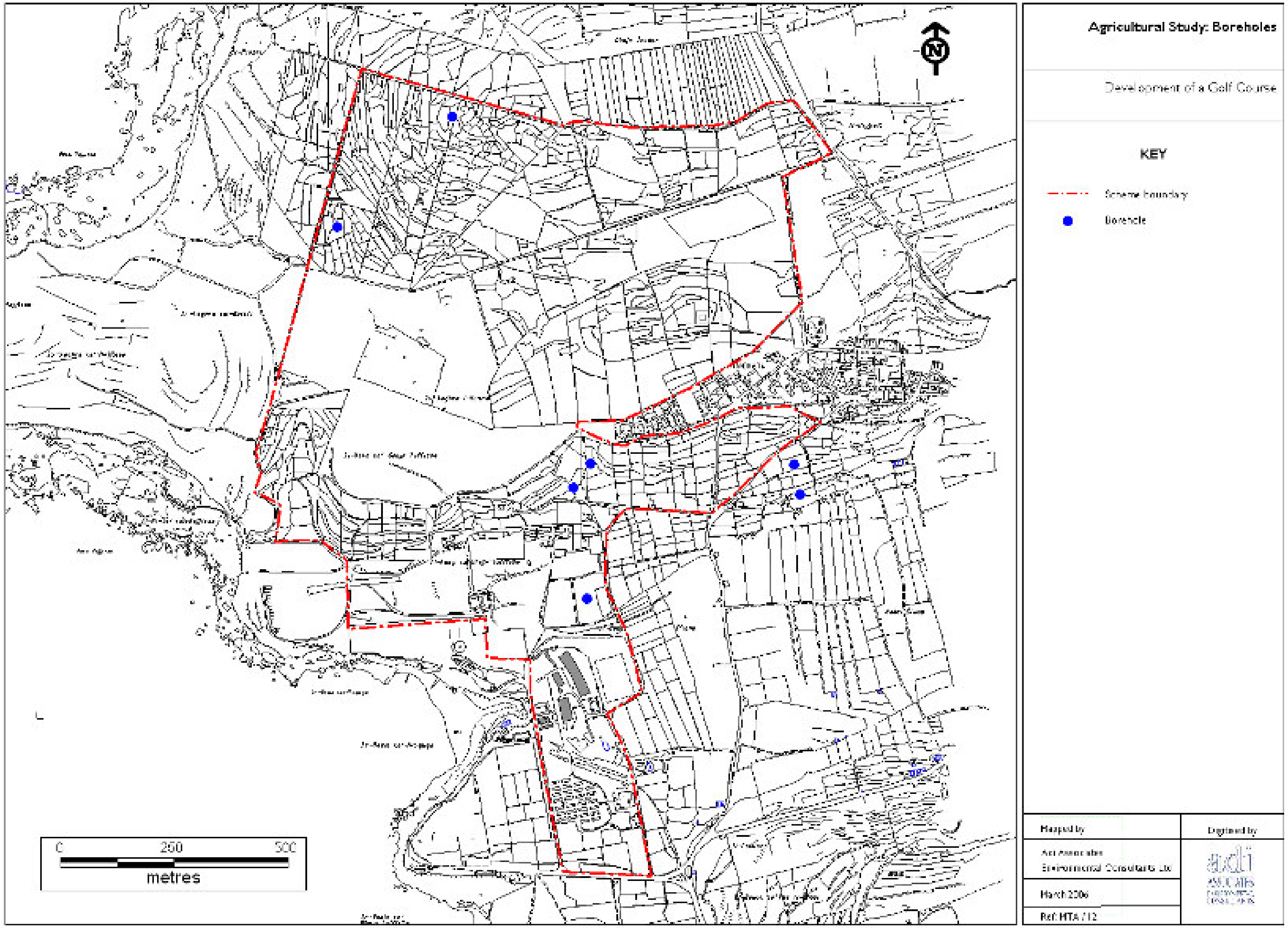


Figure 9: Agricultural land use: Summer 2005

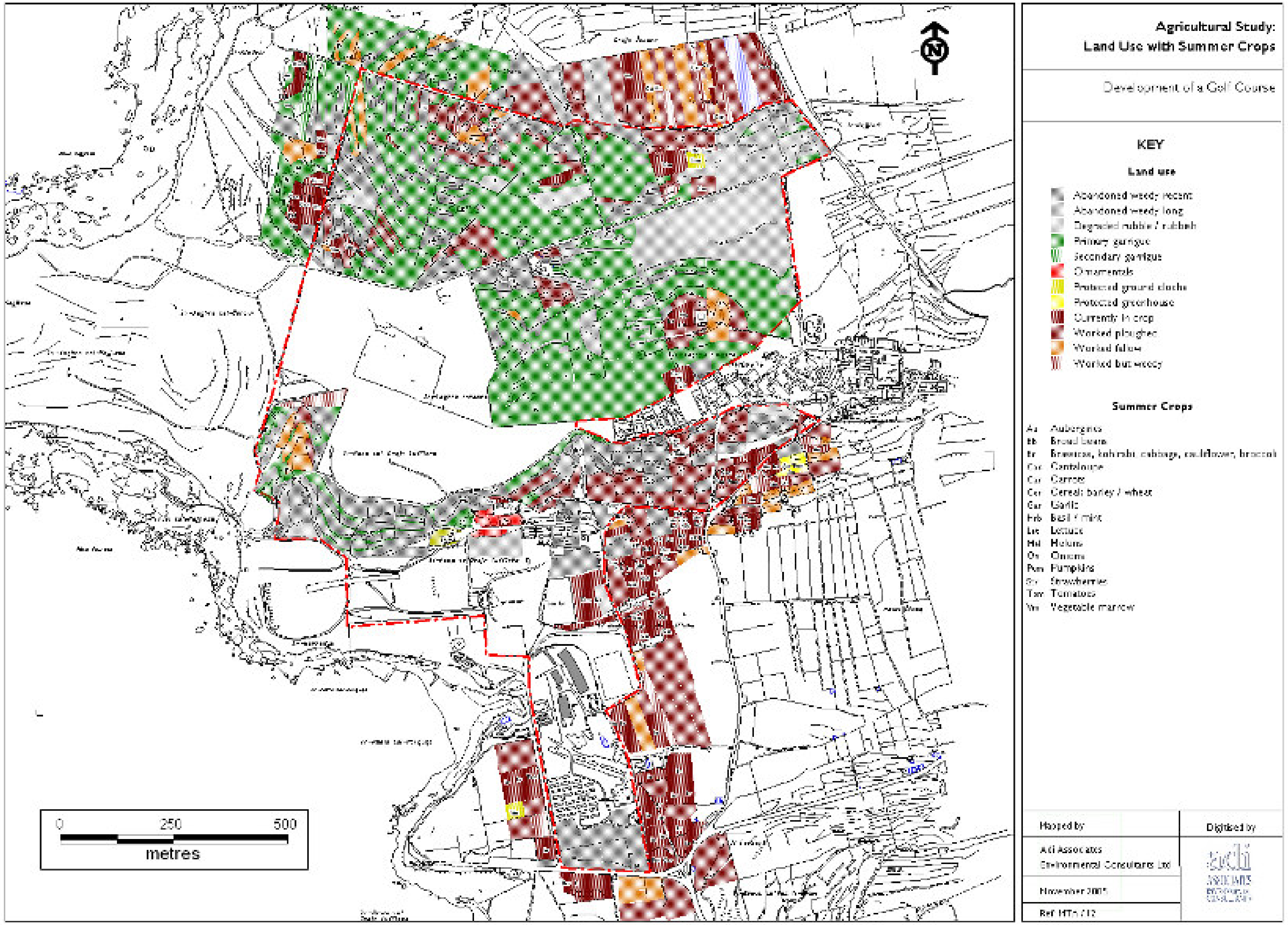


Figure 10: Field & standing crops: Summer 2005

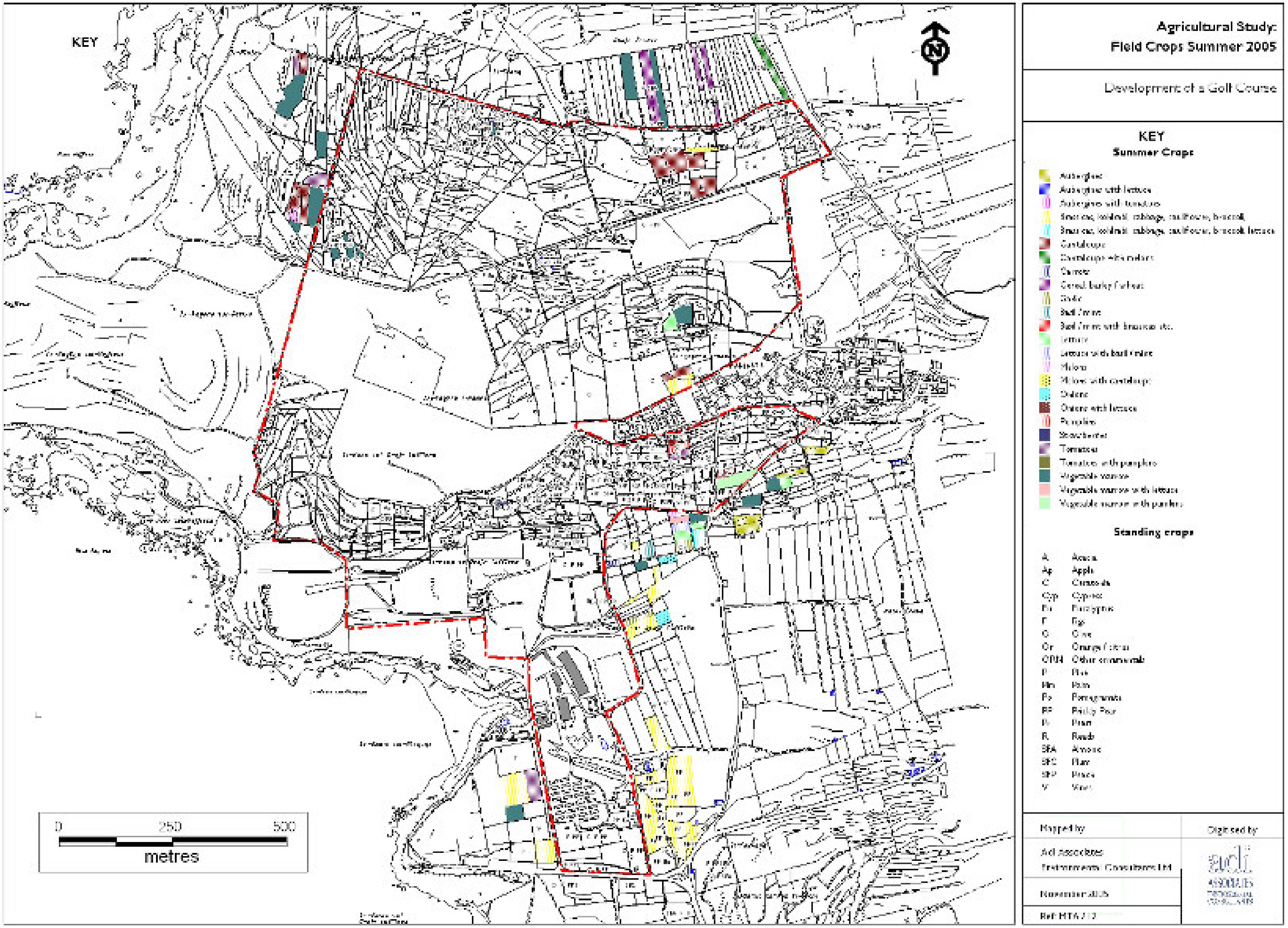


Figure 11: Agricultural land use: Winter 2005

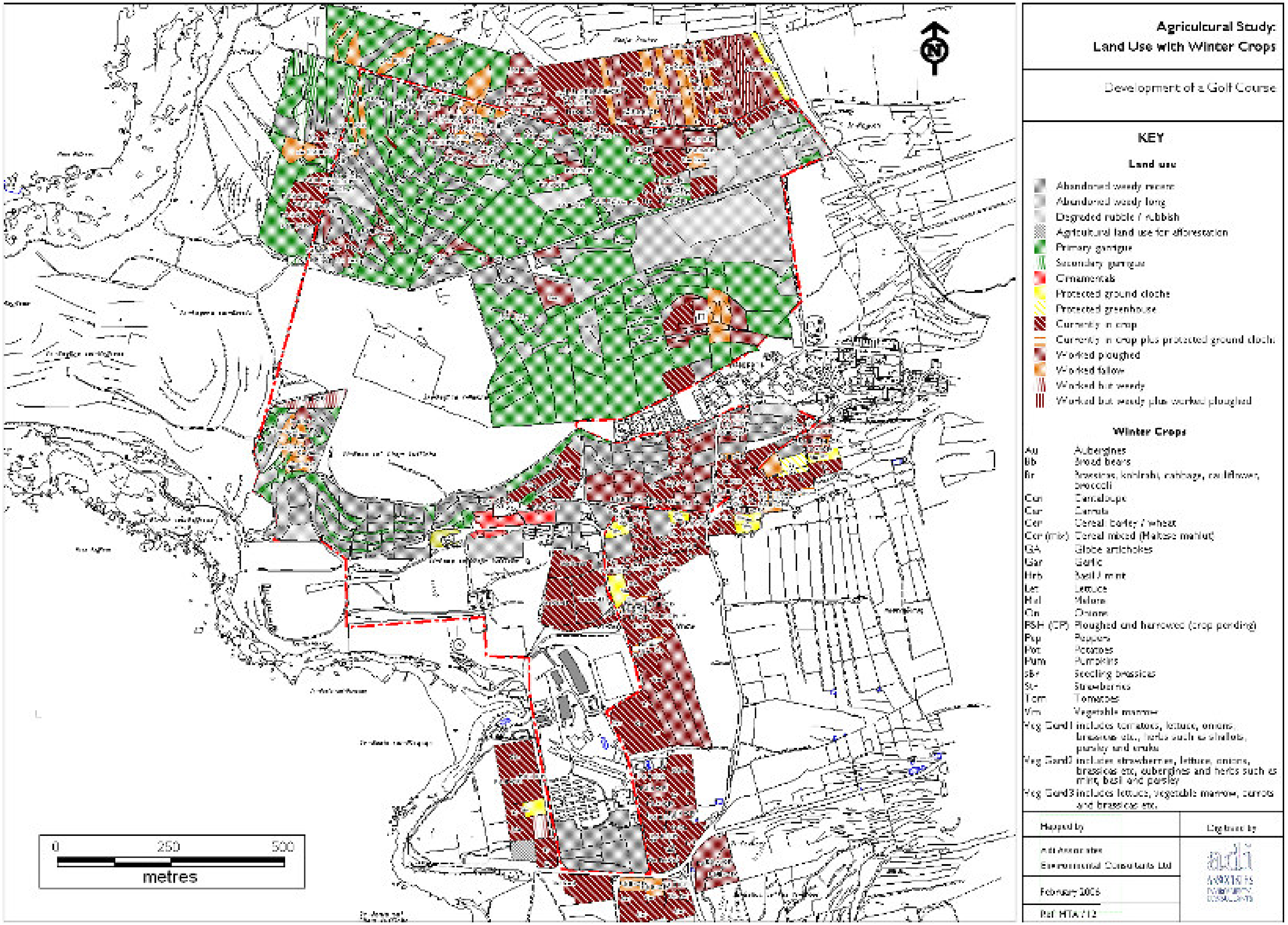


Figure 12: Field crops: Winter 2005

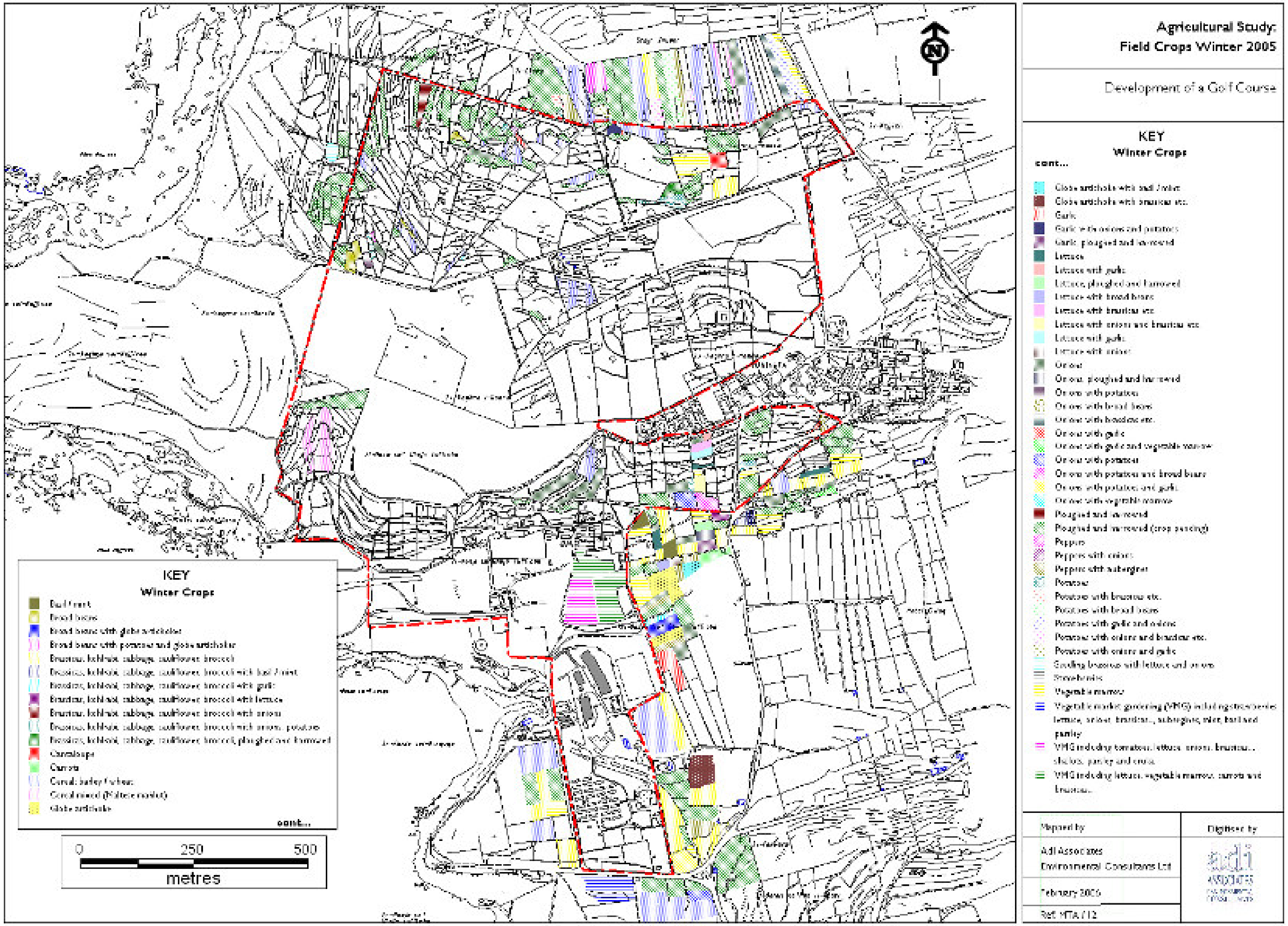
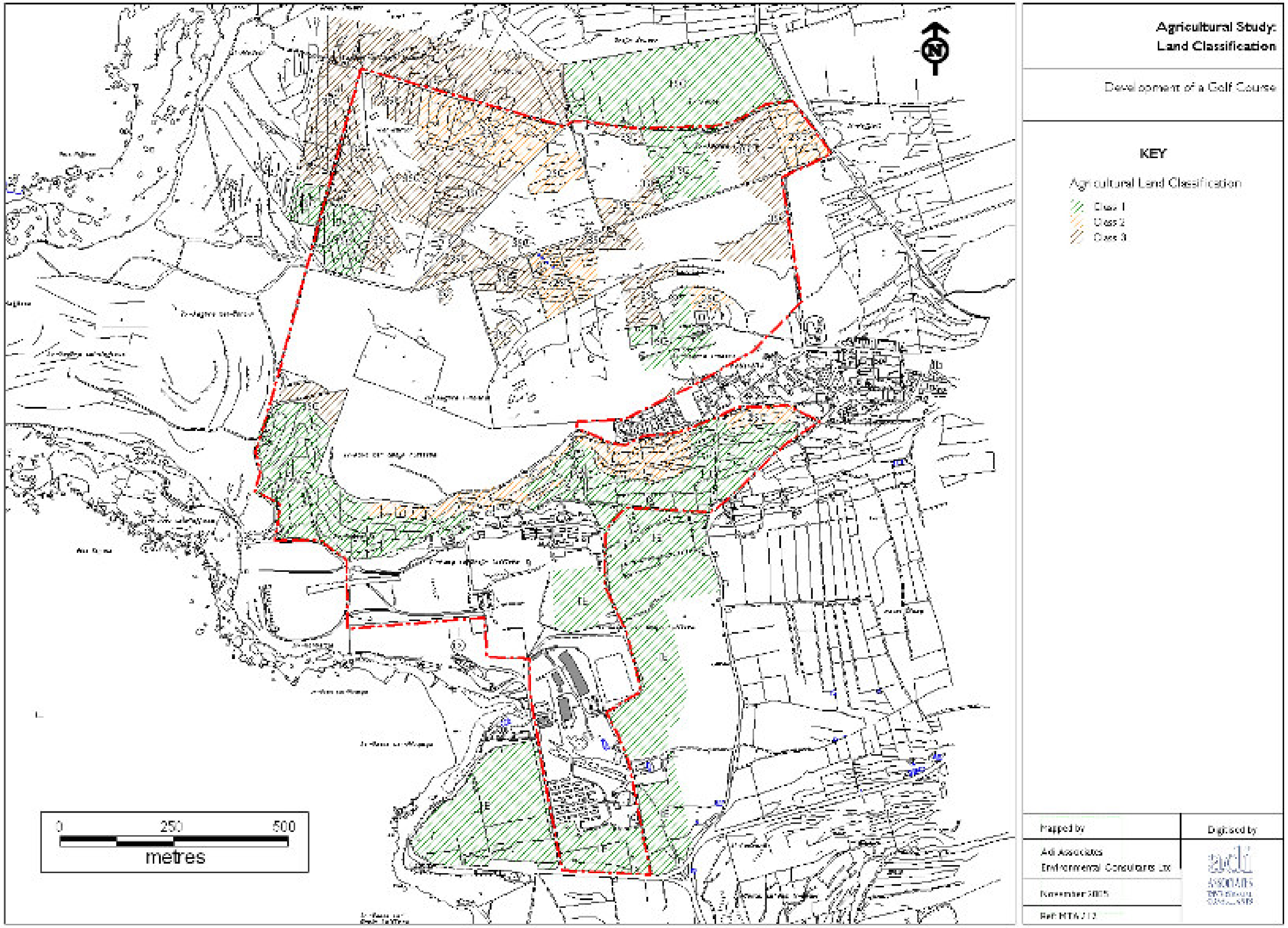


Figure 13: Agricultural Land Classification



Appendix 2

Method Statement

PROPOSED GOLF COURSE AND SUPPORTING FACILITIES

Ix-Xaghra l-Hamra and Tal-Qortin, l/o Mellieha

AGRICULTURE METHOD STATEMENT

INTRODUCTION

1. This method statement provides information on the agriculture input to the Environmental Impact Statement related to the construction and operation of an 18 hole golf course and supporting facilities at Ix-Xaghra l-Hamra and Tal-Qortin, l/o Mellieha

Terms of Reference

2. The draft ToR issued by MEPA require the following:

2.0 DESCRIPTION OF THE SITE AND ITS SURROUNDINGS

This description is identified by the area of influence for each relevant parameter. The area of influence for each parameter shall be determined by the consultant who shall also justify the extent of the chosen sphere of influence. This must be approved by the Malta Environment and Planning Authority prior to commencement of the EIA. This description should include:

2.2 Land cover, agricultural quality and produce

This should include a multi-seasonal study with:

A field-by-field survey with adequate maps, plans, diagrams, photographs;
Details of crops, trees and vegetation in general;
Cropping pattern;
A description of how the land was used over the past years;
A description of the physical quality and productivity of agricultural land;
The agricultural value of the land;
A description of the agricultural potential of the land;

A description of the soil type, depth and texture is also required. This section should also include the drainage potential of the site in line with the soil type and underlying rock;

A classification of the land;

The impact of loss of land on the viability of the holding and the effect on agricultural operations in the locality.

5.0 ASSESSMENT OF THE ENVIRONMENTAL IMPACTS AND RISKS OF THE PROPOSED DEVELOPMENT

All significant impacts of and risks posed by the proposed project, during construction and operation, should be assessed, given the environmental characteristics of the site outlined in Sections 1 and 2 and the policies outlined in Section 3. A descriptive and quantitative analysis (including significance, magnitudes and timing) of the impacts of the proposed development should be made, and presented in summary chart format. The various techniques, methods and assumptions used in the analysis and predictions should be outlined. It is recommended that impact assessment should include:

(i) description of impact;

(ii) magnitude and significance;

(iii) duration (temporary and permanent);

(iv) extent (in relation to site coverage and surroundings and associated features);

(v) whether direct or indirect;

(vi) adverse or beneficial;

(vii) reversible or irreversible effects of the impact and extent of irreversibility as well as a description of any associated conditions / assumptions for irreversibility;

(viii) sensitivity of resources to impacts;

(ix) probability of impact occurring;

(x) confidence levels/limits to impact prediction;

(xi) scope of mitigation / enhancement; and

(xii) residual impacts

Worse case scenarios should be assessed where relevant.

The impacts may include:

Note: the draft ToR omit reference to the impacts of the Scheme on agriculture.

6.0 DESIGN OF MITIGATION MEASURES

6.1 This should include a description of the measures envisaged to prevent, minimise and where possible offset any significant adverse effects on the environment of the project, (including reference to consideration of alternatives). Such measures could include technological features; operational management techniques; enhanced site-planning and management; aesthetic measures; conservation measures; reduction of magnitude of project; and health and safety measures. Scope for positive mitigation, where existing assets can be enhanced, should also be considered.

Any residual impacts that will remain following implementation of mitigation measures or resulting from the mitigation measures themselves should also be assessed.

6.2 Management plans

The following management plans shall be submitted:

Environment Management Plan – to contain measures to safeguard any environmental assets on site, throughout the demolition, construction and operation

The management plans should include measures to deal with seasonal issues, if relevant. Detailed terms or reference for the content of these plans should be prepared by the consultants and agreed to by MEPA prior to their preparation.

6.3 Monitoring

The consultants must propose a monitoring program which should take into account monitoring of those features that are considered to be impacted negatively or the impact on which is uncertain. The program must be proposed at different stages: before, during and *after construction. Details regarding type of and frequency of monitoring must also be given.*

AREA OF INFLUENCE

3. The Area of Influence (A of I) for the agriculture baseline study has been defined by examining the potential impact of the Scheme on agriculture. Additionally, the A of I has been extended to 100 metres from the site boundary as shown in **Figure 1**. It is should be noted that in some areas the A of I has been extended to paths, roads, and boundary walls to facilitate mapping of agriculture features; the A of I has been reduced in the urban fringes.

ASSESSMENT METHODOLOGY

Competence of surveyors

4. The surveys will be undertaken by Mr Joseph Buhagiar. The impact assessment will be carried out by Adi Associates and Mr Buhagiar.

Study Methodology

5. In meeting MEPA's draft ToR, the Agriculture Study will comprise:

    - A detailed study of the general physical parameters of the site, including the climatic constraints imposed on the site, soil depth and physical properties, and any major disadvantages associated with the working of the land;
    - A detailed field-by-field survey of the area earmarked for development, including details of seasonal and standing crops, details of the current cropping pattern over two growing seasons, and changes in agricultural land use, if any, over the past years; and
    - The economic aspect of agricultural practice in the area, including the classification of the agricultural land, the current agricultural value of the land in terms of productivity, and an assessment of the agricultural potential of the land for different agricultural scenarios.

Literature Search

6. Based on literature searches and the consultants' knowledge of the area, a summary of previous survey work undertaken within the study area will be provided as context to the results of the current survey work. Use will also be

made of ordinance and geology survey maps and aerial photos for physical characteristics of the site. Land use changes especially with regards to standing crops, construction of retaining walls and reservoirs will be established through old ordinance survey maps and aerial survey photographs. Available literature surveys on Maltese soil as well as laboratory data on texture will be used.

7. Additional data will be collected from the Meteorological Office.

Mapping of Field Crops

8. The fields comprising the A of I will be surveyed for a number of parameters / criteria that are needed for the baseline survey. The data will be entered into a GIS system for ease of reference and analysis.

9. Both wet and dry season cropping will be covered by the survey. The following are the survey parameters:

   - Standing and seasonal crops by type and variety, and, where possible, quantity and stage of maturity;
   - Current cropping pattern for seasonal crops;
   - Growth condition of the crops; and
   - Soil type, depth and quality.

10. The mapping section of the study would be related to soil qualities on the individual allotments as well as crop protection measures and soil retention measures if present since these are useful parameters to determine produce quality.

11. Fruit trees by type or varieties that are deemed of conservation importance due to their horticultural value or rarity in the Maltese Islands, will also be noted.

IDENTIFICATION OF POTENTIAL IMPACTS

12. The main impact on agriculture is the loss of agricultural land. The most sensitive agricultural areas will be identified in the baseline survey. The potential impacts of the proposed golf course and supporting facilities on these sensitive agricultural areas could include:

    - Taking of land for the golf course and supporting facilities;

- Permanent loss of good quality agricultural land through permanent land take, leading to loss of agricultural production;
- Loss of agricultural land supporting standing crops that need conservation because of varieties being grown are rare; and
- Displacement of farming activities in the area as well as potential loss of employment for farmers.

PREDICTION OF IMPACTS

13. Each of the potential impacts listed above will be examined. The agriculture baseline survey information will be entered into a GIS, which will assist in the identification of:

- Agricultural areas that are considered sensitive and of agricultural conservation value;
- Areas of good quality agricultural land lost during construction and / or operation; and
- Agricultural areas liable to fall into decline due to land fragmentation and possible access difficulties.

IMPACT SIGNIFICANCE

14. This section will include for each potential impact the following information:

- Description of impact;
- Policy importance of impact (Local, National, International);
- Extent of effect;
- Duration of impact (temporary/permanent);
- Adverse or beneficial impact;
- Reversible/irreversible impact;
- Sensitivity of receptor;
- Probability of impact occurring (certain, likely, uncertain, unlikely, remote); and
- Scope for mitigation / enhancement (very good, good, none).

15. Based on the above criteria, a summary of the significance of the impact will be judged in terms of whether the impact is considered not significant, of minor significance, or of major significance:

- Not significant - no material change in agricultural quality and / or extent;
- Minor significance - small-scale loss / disturbance of agricultural land that is unlikely to affect the agricultural integrity of the site; and
- Major significance – large / small scale loss / disturbance to agricultural land that is likely to affect the agricultural integrity of the site.

MITIGATION AND MANAGEMENT PLANS

16. The scope for mitigation will be identified, and the need for monitoring of agricultural aspects of the A of I will be addressed in the EIS.

17. The ToR require the formulation of an Environmental Management Plan for the operational Scheme. It is proposed that the EIS will identify those matters that need to be addressed by the Plan with a view to including such matters in the Conditions of Permit.

Adi Associates Environmental Consultants Ltd & Mr. Joseph Buhagiar
August 2005

Appendix 3:

Soil Analysis results

Soil analysis for Xaghra l-Hamra field plots					Analysis carried out using standard protocols with classification given under figures						
Plot number	Soil Colour	Chloride	Chloride	Conductivity	pH (1:5)	Potassium	Na soluble	Na soluble	Soil Texture	- Hydrometer	
		(mg/l)	(mg/kg)	uS-1		mg/kg	(mg/l)	(mg/kg)	Silt %	Sand %	Clay %
AA5d	Dark Red	308	1540	2002.28	7.66	2266.8	245.1	1225.49	34.31	11.04	54.66
		Medium		Very Saline	Slight Alkaline	V. High	V. High		Class 12		Clay
AA5g	Dark Brown	16	80	394.63	7.9	514.55	26.47	132.35	36.31	22.93	40.76
		Low		Non-Saline	Slight Alkaline	V. High	V. Low		Class 12		Clay
A2c	Dark Red	12	60	222.89	7.87	805.38	26.47	132.35	38.35	15.01	46.64
		Low		Non-Saline	Slight Alkaline	V. High	V. Low		Class 12		Clay
A5	Dark Red	11	55	243.6	7.85	1301.5	27.45	137.26	39.43	15.38	45.18
		Low		Non-Saline	Slight Alkaline	V. High	V. Low		Class 12		Clay
A6b	Dark Red	19	95	33.6	7.77	2114.34	32.35	161.76	37.77	12.03	50.2
		Low		Non-Saline	Slight Alkaline	V. High	V. Low		Class 12		Clay
A11c	Dark Red	44	220	444.57	7.84	2526.12	35.29	176.47	35.25	13.17	51.58
		Low		Slight Saline	Slight Alkaline	V. High	V. Low		Class 12		Clay
B7b	Dark Red	12	60	290.12	7.74	970.99	31.37	156.86	31.77	16.91	51.33
		Low		Non-Saline	Slight Alkaline	V. High	V. Low		Class 12		Clay
B10b	Dark Red	11.6	58	267.96	7.83	898.32	28.43	142.16	38.54	16.53	44.93
		Low		Non-Saline	Slight Alkaline	V. High	V. Low		Class 12		Clay
C1c	Offwhite/very pale red	30	150	380.48	7.89	289.07	31.37	156.86	27.17	54.18	18.65
		Low		Non-Saline	Slight Alkaline	V. High	V. Low		Class 4		
C5d	Dark Red	40	200	499.38	7.78	1364.72	43.14	214.69	33.42	14.19	52.39
		Low		Slight Saline	Slight Alkaline	V. High	Low		Class 12		Clay
C7b	Dark Red	18	90	341.24	7.5	2018.2	34.31	171.57	33.41	15.45	51.14
		Low		Non-Saline	Slight Alkaline	V. High	V. Low		Class 12		Clay
C9h	Dark Red	33	165	398.32	7.6	859.98	35.29	176.47	40.27	15.79	43.94
		Low		Non-Saline	Slight Alkaline	V. High	V. Low		Class 10		Silty Clay
D2fiii	Dark Red	13.1	65.5	300.85	7.72	1357.95	24.51	122.55	23.38	10.35	65.27
		Low		Non-Saline	Slight Alkaline	V. High	V. Low		Class 12		Clay
D5e	Dark Red	6	30	216.4	7.83	1391.5	23.53	117.65	31.83	14.38	53.79

Soil analysis for Xaghra l-Hamra field plots					Analysis carried out using standard protocols with classification given under figures						
Plot number	Soil Colour	Chloride	Chloride	Conductivity	pH (1:5)	Potassium	Na soluble	Na soluble	Soil Texture	- Hydrometer	
		(mg/l)	(mg/kg)	uS-1		mg/kg	(mg/l)	(mg/kg)	Silt %	Sand %	Clay %
		Low		Non-Saline	Slight Alkaline	V. High	V. Low		Class 12		Clay
D6i	Dark Red	23	115	351.94	7.51	1456.73	30.39	151.96	36.86	14.3	48.84
		Low		Non-Saline	Slight Alkaline	V. High	V. Low		Class 12		Clay
E4b	Dark Red	21	105	329.35	7.71	2311.08	29.41	147.06	54.24	12.9	32.86
		Low		Non-Saline	Slight Alkaline	V. High	V. Low		Class 7		
F8b	Offwhite/very pale red	67	335	615.9	7.93	403.35	50.98	254.9	31.67	37.02	31.32
		Low		Slight Saline	Slight Alkaline	V. High	Low		Class 8		Clay Loam
F9a	Yellowish Brown	215	1075	1594.36	8.1	667.23	313.73	1568.63	26.88	6.26	66.86
		Medium		Moderately Saline	Moderately Alkaline	V. High	V. High		Class 12		Clay
F10b	Pale Chocolate Brown	150	750	1078.15	7.69	669.47	156.86	784.31	27.27	39.91	32.82
		Medium		Moderately Saline	Slight Alkaline	V. High	High		Class 8		Clay Loam
G1a	Dark Red	400	2000	2437.45	7.57	795.2	225.49	1127.45	28.97	30.85	40.18
		Medium		Very Saline	Slight Alkaline	V. High	V. High		Class 12		Clay
G2bii	Light Brown	12	60	321.03	7.75	591.16	23.53	117.65	30.64	34.71	34.65
		Low		Non-Saline	Slight Alkaline	V. High	V. Low		Class 8		Clay Loam
G5bii	Dark Red	7	35	254.45	7.48	649.72	22.55	112.75	26.91	30.78	42.31
		Low		Non-Saline	Slight Alkaline	V. High	V. Low		Class 12		Clay
GT5	Dark Red	65	325	627.27	8.18	936.89	156.86	784.31	36.65	24.41	38.94
		Low		Slight Saline	Moderately Alkaline	V. High	High		Class 8		Clay Loam
J2f	Dark Red	15	75	305.57	7.91	969.69	32.35	161.76	34.71	15.22	50.07
		Low		Non-Saline	Slight Alkaline	V. High	V. Low		Class 12		Clay
K2b	Dark Red	30	150	397.13	7.6	1028.58	32.35	161.76	34.37	10.4	65.23
		Low		Non-Saline	Slight Alkaline	V. High	V. Low		Class 12		Clay

Soil analysis for Xaghra l-Hamra field plots					Analysis carried out using standard protocols with classification given under figures							
Plot number	Soil Colour	Chloride	Chloride	Conductivity	pH (1:5)	Potassium	Na soluble	Na soluble	Soil Texture	- Hydrometer	
		(mg/l)	(mg/kg)	uS-1		mg/kg	(mg/l)	(mg/kg)	Silt %	Sand %	Clay %
O1ki	Light Greyish Brown	18	90	366.21	7.85	457.51	26.47	132.35	26.62	54.93	18.45
		Low		Non-Saline	Slight Alkaline	V. High	V. Low		Class 4		
O1hi	Dark Brown	20	100	429.95	8.04	954.06	47.06	235.29	27.69	21.12	51.19
		Low		Slight Saline	Moderately Alkaline	V. High	Low		Class 12		Clay
O1kii	Pale Chocolate Brown	105	525	972.6	7.49	510.44	137.25	686.27	33.17	48.66	18.17
		Medium		Moderately Saline	Slight Alkaline	V. High	High		Class 3		Loam
P2d	Pale Chocolate Brown	10	50	317.9	7.79	403.69	21.57	107.84	36.3	46.86	16.84
		Low		Non-Saline	Slight Alkaline	V. High	V. Low		Class 3		Loam
R5d	Light Red	300	1500	2058.42	7.46	780.18	245.1	1225.49	26.19	46.99	26.82
		Medium		Very Saline	Slight Alkaline	V. High	V. High		Class 9		
S1h	Pale Chocolate Brown	3	15	353.1	7.3	288.98	20.59	102.94	33.69	48.65	17.66
		Low		Non-Saline	Slight Alkaline	V. High	V. Low		Class 3		Loam
S3f	Pale Chocolate Brown	20	100	387.61	7.87	564.61	27.45	137.26	39.51	38.3	22.19
		Low		Non-Saline	Slight Alkaline	V. High	V. Low		Class 3		Loam
S5 hii	Offwhite/very pale red	350	1750	2097.4	7.78	389.9	254.9	1274.51	30.99	49.93	19.08
		Medium		Very Saline	Slight Alkaline	V. High	V. High		Class 3		Loam
S5g	Pale Chocolate Brown	11	55	286.55	7.86	565.27	17.65	88.24	16.79	67.74	15.47
		Low		Non-Saline	Slight Alkaline	V. High	V. Low		Class 4		
S6a	Dark Greyish Brown	16	80	487.2	7.92	1068.07	28.43	142.16	37.77	3.63	58.6
		Low		Slight Saline	Slight Alkaline	V. High	V. Low		Class 12		Clay
S6 e	Light Red	320	1600	2073.04	7.78	1008.13	254.9	1274.51	32.58	26.16	.41.26
		Medium		Very Saline	Slight Alkaline	V. High	V. High		Class 12		Clay
S6g	Pale Chocolate Brown	22	110	463.88	8	470.65	41.18	205.88	29.24	53.17	17.59
		Low		Slight Saline	Moderately Alkaline	V. High	Low		Class 4		Sandy
T1m	Light Red	10	50	320.33	8.09	370.02	34.31	171.57	38.99	28.14	32.87

Soil analysis for Xaghra l-Hamra field plots					Analysis carried out using standard protocols with classification given under figures						
Plot number	**Soil Colour**	**Chloride**	**Chloride**	**Conductivity**	**pH (1:5)**	**Potassium**	**Na soluble**	**Na soluble**	**Soil Texture**	**- Hydrometer**	
		(mg/l)	**(mg/kg)**	**uS-1**		**mg/kg**	**(mg/l)**	**(mg/kg)**	**Silt %**	**Sand %**	**Clay %**
		Low		Non-Saline	Moderately Alkaline	V. High	V. Low		Class 8		Clay Loam
U3a	Dark Brown	180	900	1601.67	7.51	739.5	196.08	980.39	31.53	27.13	41.34
		Medium		Very Saline	Slight alkaline	V. High	V. High		Class 12		Clay
X1c	Light Red	13	65	321.03	8	605.13	24.51	122.55	33.64	34.24	32.07
		Low		Non-Saline	Moderately Alkaline	V. High	V. Low		Clasas 8		Clay Loam
X5g	Light Red	1.5	7.5	347.13	7.6	450.12	18.63	93.14	27.16	44.05	28.79
		Low		Non-Saline	Slight AlkalineV. High		V. Low		Class 8		Clay Loam
YY1b	Pale Chocolate Brown	33	165	476.24	7.7	490.83	31.37	156.86	32.92	49.99	17.08
		Low		Slight Saline	Slight Alkaline	V. High	V. Low		Class 3		Loam