ANNEX - C

LAND USE PLAN

ANNEX C LAND USE PLAN

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1. Objectives

Within the framework of the feasibility study on the agricultural development project for the Karak - Tafila Development Region (the Region), the land use study was carried out in order to set up the rationalized land use plan of the Region. This Annex deals with all the study results gathered through the land use study.

The Region is situated on the highland lying on the eastern plateau formed along the Dead Sea rift. The western half of the Region was selected as the study area with a total extent of 400,000 ha which is bordered by fringes of the escarpments in the west as well as the Desert Highway in the east as illustrated in Figure C.1.1. Annual rainfall changes from 300 mm in the western part of the study area to 50 mm in the eastern part. Landscape varies from flat desert to dissected valleys with elevation ranges between El. 600 m and 1,400 m. Drainage patterns are generally of structure-controlled with the west-east direction and collected by large wadis, namely Wala, Mujib, Hasa, Feifa and Khuneizira which finally flow into the Dead Sea.

In the course of discussion held between the Government of the Hashemite Kingdom of Jordan and the Government of Japan through Ministry of Planning (MOP) and Japan International Cooperation Agency (JICA), three priority areas were selected within the study area. Each of the priority areas has representative natures of the study area in terms of present land use conditions, rainfall distribution and physiography (Figure C.1.1). The extent of the priority areas is tabulated below.

Priority Area	Extent (ha)
Dhiban	43,100
Abyad	35,700
Tafila	57,000
Total	135,800

The present study was carried out stepwise by three (3) work phases, namely (i) present land use analysis, (ii) land capability classification and (iii) land use planning, of which objectives and work procedure are outlined below.

The present land use analysis aims at (i) clarification of the prevailing land use patterns and (ii) verification of constraints against maximum exploitation of land resources for agricultural development. At present, out of 135,800 ha of the priority areas, 40,300 ha or 30% are used for rainfed farming with cereals and tree crops. To identify physical

constraints which local farmers are facing in their current farming activities, main ancillary land elements such as (i) rainfall distribution, (ii) topography, and (iii) location of villages and road network were analyzed. Distribution pattern of farmland shows a high coincidence with rainfall distribution and physiographic conditions. The study results are presented in Chapter 2.

The potentials of land development by means of soil and water conservation measures were assessed. Referring to the previous studies, the land classification criteria suitable for the present study were set up on the basis of three elements, namely (i) rainfall, (ii) slope and (iii) soil depth, considering their particular importance for the local agriculture. In view of limited soil information for the Region, the soil investigation was carried out with full use of aerial photography. Based on the soil survey results, the soil maps were prepared for the priority areas. According to the criteria, land capability was classified for both existing farmland and potential land on the soil maps prepared. The methodology and results of land classification are spelled out in Chapter 3.

Land use plan was formulated as an ultimate product of the present study taking all the study results of agronomy, land capability classification, meteorology, hydrology, socio- and agro-economy into consideration. Through agro-economic analysis on demand-supply balance and profitability of various crops, some promising crops were selected under the conditions with soil and water conservation measures. The selected crop alternatives combined with particular water-harvesting measures were incorporated into the guideline for land use planning of the Region. According to the guideline, suitable land use system was selected for each land capability class. The proposed land use plan for the Region is presented in Chapter 4.

2. Present Land Use

2.1 Study Area

Through the Master Plan Study (JICA, 1984), the present land use of the Region was investigated. On the basis of the result of the Master Plan Study, the present land use conditions of the study area are estimated as follows.

Land Use Category	Extent (ha)	Proportion (%)
Field crops	24,400	6.1
Irrigated vegetables	900	0.2
Tree crops	3,600	0.9
(Sub-total)	(28,900)	(7.2)
Fallow	75,800	19.0
Forest	17,800	4.5
Sparse grasses/brush	275,600	68.8
Build-up areas	1,900	0.5
Total	400,000	100.0

Under limited rainfall, biomass production is less active particularly in the eastern part of the study area. Almost 70% of the study area is covered by low vegetation, i.e. grasses and brush. Forest coverage is less than 5% of the study area.

Actively cultivated land amounts to 28,900 ha or 7.2% of the study area in total. Wheat leads the other crops in both planted area and production although they fluctuate year by year. Large-scale wheat production is managed where flat topography allows to introduce farm mechanization. In wheat zones, natural grazing is also prevailing. Herdsmen force flocks of sheep and goats to wadi floors and banks to obtain sparsely vegetating drought resistant grass species such as Artemisia brush. Plant residues and fallow land also provide feed sources. To make up low carrying capacity of natural vegetation, barley is planted in marginal land where wheat can not provide reasonable profit.

Apart from cereals and stock raising, tree crops are planted as important income sources for farmers in the Region. By selecting small parcels on gentle and lower topographic positions favorable for collection of runoff water, e.g. footslopes, wadi floors, wadi bottoms, etc., olives and other tree crops are planted. In some plots, water harvesting measures such as contour stone walls are applied. Irrigation farming is practiced to the limited extent. Reflecting better price setting of tree crops in recent years, however, farmers

have high intention to introduce irrigation techniques to tree crops even though considerable investment would be borne by farmers themselves.

2.2 Study Method

2.2.1 Thematic maps

For the priority areas, the present land use conditions were analyzed in depth. In order to clarify the present land use conditions and constraints against proper land use, extent of farm land as well as major ancillary elements, namely rainfall distribution, topographic conditions and distribution of villages/accessibility to farmland were investigated. The results were compiled into the following four (4) thematic maps.

i. Extent of farmland
ii. Rainfall distribution
iii. Slope
iv. Village and road network

In the present study, the existing topographic maps and panchromatic aerial photos were fully applied. Aerial photos were taken during the period from June to July 1984 with an approximate photo-scale of 1:25,000. The topographic maps used are of 1:25,000 scaled which were prepared in 1987 based on the said aerial photos.

In order to ensure systematic analysis of relation between distribution of farmland and other land information, the cell system was adopted. Unit cell is sized to 500 m x 500 m (25 ha) rigidly coincident with Palestine Grid System on the 1:25,000 topographic maps. Extent of farmland was graded into five (5) classes from 0% (0 ha) to 100% (25 ha), which were judged by eye-estimation. Rainfall distribution was mapped by transferring the isohyet map to cell system. The details of isohyet map are described in Annex A on Meteo- and Hydrology. Slope was estimated by counting number of contours passing through cell and generalized into five (5) classes from flat (0%) to mountainous (>30%). To grasp the elevation range, the elevation in selected cells were recorded and the cross-sections were drawn. Villages and road networks were identified by checking existence of their mapping symbols within cell.

2.2.2 Rating criteria

For the purposes of classification and categorization of land elements, the following rating criteria were applied.

(1) Extent of farmland

1.	0 %	(0.00 ha)
2.	25 %	(6.25 ha)
3.	50 %	(12.50 ha)
4.	75 %	(18.75 ha)
5.	100 %	(25.00 ha)

(2) Rainfall distribution

1.	50	-	100 mm
2.	100	-	150 mm
3.	150	-	200 mm
4.	200	-	250 mm
5.	250	-	300 mm

(3) Slope

1.	0	-	4 %
2.	4	-	8 %
3.	8	-	12 %
4.	12	-	30 %
5.	30 % <		

(4) Villages and accessibility

1. Villages
2. Paved of over 5 m wide
3. Non-paved but trafficable for vehicles and tractors
4. Non or footpath

2.3 Results

2.3.1 Present land use

The thematic maps, i.e.(i) extent of farmland, (ii) rainfall distribution, (iii) slope and (iv) villages and road networks, are presented in Figures C.2.1 to C.2.4 for Dhiban, Figures C.2.5 to C.2.8 for Abyad and Figures C.2.9 to C.2.12 for Tafila. Out of 135,800 ha of the priority area, 40,300 ha (29.6%) were used for crop production: 18,600 ha (43.3%) in Dhiban, 5,500 ha (15.2%) in Abyad and 16,200 ha (28.9%) in Tafila. The present land use conditions are summarized below.

Unit: ha

Land Use Category	Dhiban	Abyad	Tafila	Total
Field crops	18,500	5,450	15,700	39,700
Tree Crops	100	50	500	600
Forest	0	0	800	800
Grasses and brush	24,000	30,150	39,350	93,500
Villages	500	50	650	1,200
Total	43,100	35,700	57,000	135,800

(1) Dhiban

Dhiban falls in the rainfall classes from 300 mm in the west to 100 mm in the east (Figure C.2.2). The western part of the Dhiban area shows higher land use intensity than one in the eastern part (Figure C.2.1). Out of 43,100 ha, 18,600 ha or 43.3% are used for agriculture. Vast flat tracts of the quaternary plains allow the introduction of mechanized farming without any water harvesting measures. Average plot size is estimated to range from 1.5 ha to 2.0 ha in the western part of the Dhiban area and tends to be enlarged in the eastern area. As well, extent of fallow land is outstandingly increased in the eastern part of the area.

In the western plain, narrow but flat to gently sloping land covered by alluvial deposits, e.g. valley bottoms, are selectively used for olive tree planting. With a catchment area varying from 100 to 500 ha, check-dams are constructed on wadis and olive trees are planted on reservoir area with less than 2 ha. In the eastern plain, such vegetables as cabbage and watermelon are planted by means of drip irrigation to the limited scales.

Between both quaternary plains, the erosional plain on limestone is formed. By incision of gullies and valleys draining into Wadi Mujib in south and Wadi Wala in north, irregular topography and higher rockiness are recognized there. As a result, the land use intensity in these physiographic units are lower than one of quaternary plains. They are extensively utilized for grazing purposes.

(2) Abyad

Rainfall classes range from 200 mm to 50 mm resulting in limited extent of farmland (Figure C.2.6). Out of 35,700 ha, 5,500 ha or 15.2% are used for cereal farming (Figure C.2.5). Tree crops are not common in Abyad. The land use pattern is highly coincidence with physiography. Showing the pronounced structure-controlled pattern with NW-ES direction, broad valley traverses the area. Due to high water availability and flatter topography, this valley bottom is extensively used for cereal production. In contrast, the limestone upland with gravel covered soils are left as grassland because of shallow soils and frequent rock outcrops even under higher rainfall of 200 mm to 250 mm.

Erosional plain extending southward from Muhai village is used for cereals. Gravel coverage is one of the major constraints in this physiographic unit. Prior to land leveling and planting, stone clearing is essential practice.

(3) Tafila

The smaller patches of farm plot distribute almost evenly in the areas less dependent upon rainfall distribution (Figures C.2.9 and C.2.10). Out of 57,000 ha, 16,200 ha or 28.9% are used for farming. The local farmers have introduced cereals as well as tree crops by selecting lower slopes and valley bottoms covered by thick alluvial-colluvial deposits derived from basic rocks, e.g. limestone, basalt, etc. For tree crops, contour stone walls are broadly applied.

Ministry of Agriculture (MOA) has paid the particular attention to soil conservation measures. In fact, some 800 ha in and around Tafila town have already been covered by afforestation. Besides, it should be noted that the MOA's research work is running for tree crops at Twana. Their activities extend not only to improvement of farming practices for tree maintenance but also to selection of suitable tree crops and varieties. In terms of future tree crop expansion, the on-going experiments are expected to contribute the regional agriculture.

2.3.2 Constraints

By revealing the relation between farmland distribution and rainfall-slope conditions, the farmers' intention in selection of farmland was clarified. The results are presented in Table C.2.1. It is obvious that the local farmers have selected their farmland with favourable natural conditions as much as they could. Besides, the study results verified the marginal conditions in rainfed farming of the study area as summarized below.

- Flat land with 0-8% slope under over 200 mm of rainfall is firstly selected. More than 80% of the land under such conditions is already utilized for agricultural purposes.

- Secondly, the farmers prefer to utilize (i) land with 8-12% slope under over 200 mm and (ii) flat land with 0-4% slope under over 150 mm of rainfall.

- Thirdly, (i) steeper land with over 12% slope under over 250 mm of rainfall and (ii) flatter land with 4-8% slope under over 150 mm of rainfall are selected.

- The rests with other marginal conditions are sparsely used or left out as barren land. Especially, dry land with below 100 mm of rainfall and steeper land with over 30% slope are not suited to rainfed agriculture.

Socio-economic condition is another important factor governing the present land use patterns of the study area. The distribution pattern of farmland shows a significant relation with (i) location of villages and (ii) road density. Besides, fragmentation and shared ownership of farmland may also be constraints against rational land use as reported in the other highland regions.

3. Land Capability Classification

3.1 Criteria

3.1.1 Land elements

To assess land development potentials of the study area, the land capability classification was carried out. Since there exist no criteria applicable for agricultural development with water harvesting measures, firstly, the land classification criteria prepared for the previous studies were reviewed. The followings are representative among the existing land classification standards in Jordan.

i. Land Classification Basis for Land Use Capability Planning (World Bank, 1981)
ii. Land Classification System Applied for the Zarqa River Basin Project (MOA, 1983)
iii. Land Classification System Proposed by Land Use Capability Planning-Jordan (MOA, 1983)

The land classification standards set up by the World Bank and the Zarqa Project aim mainly at introduction of soil and water conservation measures. As presented in Table C.3.1, the system by the World Bank is based on slope classes. For farmland with less 25% slope, soil conservation measures were proposed to be introduced. The land classification standard for the Zarqa Project is based on soil depth, slope and rockiness as presented in Table C.3.2. The main objective of the Zarqa Project is to control sediment load draining into the reservoir of the King Talal, i.e. an important water supplier for Amman. Therefore, the land classification aims to assess the susceptibility of soil erosion hazard and to select appropriate soil conservation measures within the proposal for the overall watershed management. Third system was prepared for nationwide land use capability classification. The system was based on the former two systems as presented in Table C.3.3. Referring to these previous studies, such three land elements as soil depth, slope and rockiness were taken up for land evaluation of the present study.

Slope is dealt with as the most important factor in the previous land classification systems because of strong influences to erosion susceptibility and workability in both manual and mechanized farming. Slope is not only an indication of the topographic conditions but also an index summarizing all the physiographic conditions such as soil depth, stone cover, rock outcrops, and micro-vegetation of land. On steep slops the soil cover is very shallow, sometimes only a few centimeters, and the surface is not only covered with stones but also

broken by the outcrops of fissured rocks. In contrast, on the gentle slopes the soil depth may reach over 100 cm and very few rock outcrops.

Soil depth should be discussed from the viewpoints not only of effective soil depth to ensure sufficient root extension but also of water storage releasing soil moisture to plants in longer period. Slope classification maps by cell-system can be interpreted as soil depth maps to the certain extent. However, slope form is another factor when soil depth is estimated by interpreting slope information. In general, shallow soils with coarse texture occur on convex slopes, while deep fine soils on concave slopes. This fact implies the limitation of cell system for soil study and the necessity of further soil survey to make up lack of information about soil depth.

Rock outcrops do not occur frequently in the study area comparing with the other highland regions. Rock outcrops can be observed only on highly eroded land, e.g. escarpment, upper slopes of dissected upland, wadi bottoms, etc. In the present study, rock outcrops coverage is dealt with in order to estimate actually cultivable land.

3.1.2 Rating specifications

The land capability classification for the present study is based on (i) slope, (ii) soil depth and (iii) rock outcrops coverage, of which rating specification is as follows.

(1) Slope

1.	Flat to almost flat	0 - 4 %
2.	Undulating	4 - 8 %
3.	Rolling	8 - 12 %
4.	Hilly	12 - 30 %
5.	Mountainous	30 % <

(2) Soil depth

1.	Deep	100 cm <
2.	Deep to moderately deep	100 - 50 cm
3.	Moderately deep	50 - 20 cm
4.	Shallow	20 cm >

(3) Rock outcrops coverage

1.	Non rocky	0 - 10%
2.	Rocky	10 - 25%

3.	Very rocky	25 - 50 %
4.	Extremely rocky	50 % <

3.2 Soil Study

3.2.1 Objectives

As mentioned above, the existing soil information including soil depth is too limited to assess land capability of the study area. The soil survey was carried out to collect detail soil information of the study area with the following objectives.

i. Identification and classification of major soil units of the study area paying particular attention to soil depth and rock outcrop coverage

ii. Clarification of distribution pattern of major soil units and their physiographic positions

iii. Verification of physical and chemical properties of major soil units by laboratory test

Excluding the desert zone of the Tafila area and the escarpments of wadi systems of the Dhiban area, the survey area was selected and demarcated within the priority areas. The total survey area amounts to 121,100 ha or 90% of the priority areas, i.e. the whole Dhiban except for Wadi Mujib and Wadi Wala with 36,300 ha, the whole area of Abyad with 36,700 ha, and the western Tafila with 48,100 ha except for desert area.

Firstly, the provisional soil map was prepared by physiographic interpretation of aerial photography scaled on 1:25.000. Secondly, the profile pit and/or auger boring were made at the selected points on the provisional soil map. The total observation amounts to 75 of which 17 were of profile observation by digging test pit and described according to the FAO Guideline for Soil Profile Description. At 12 representative sites out of 17 sites, 32 soil samples were collected for the later laboratory test. The soil profile descriptions are presented in Appendix-1.

3.2.2 Major soils

The major soils are classified into Typic Caliciorthids, Xeric Calciorthids and Typic Camborthids derived from quaternary deposits and limestones according to the U.S. Soil

Taxonomy. They are characterized by well-developed B horizon containing $CaCO_3$ nodules, reddish colour and fine to medium texture with higher gravel contents. In places, crust formation was observed on soil surfaces. On summits and upper slopes of hills, Lithic Calciorthids occur. They are characterized by shallow topsoils underlain by cherty limestone. The soil genesis and distribution pattern show the high relation with their physiographic positions. In general, deep soils (> 100 cm deep) occur on quaternary deposits, while moderately deep (50 - 20 cm) to shallow (< 20 cm) soils on dissected upland of limestone.

The legends of soil maps are presented in Tables C.3.4 to C.3.6. The necessary information required for land classification, i.e. topography, soil depth and rockiness, is given for each mapping units. The distribution of each unit can be referred to on the physiographic soil maps on a scale of 1:25,000 illustrated on Figure C.3.1 for Dhiban, Figure C.3.2 for Abyad and Figure C.3.3 for Tafila.

3.3 Results

For each cell, the land class was assessed according to the land classification criteria. The results are presented in Tables C.3.7 to C.3.9. The tables show total area, farmland, non-farmland, and expansible area falling in each land class defined by (i) topography and (ii) soil depth under each annual rainfall class. Extent of non-farmland was simply obtained by deducting extent of farmland from total area. Expansible area was calculated by deducting rock covered area from non-farmland. In view of potential assessment of land development, the total area and expansible area excluding shallow soils (< 50 cm deep) are summarized below.

Unit: 1000 ha

Rainfall (mm)		Slope (%)				
		0-8	8-12	12-30	30 <	Total
Dhiban						
300-200	Total	3.3	0.9	0.6	0.0	4.8
	Expansible	0.1	0.2	0.3	0.0	0.6
200-100	Total	16.2	3.1	1.7	0.2	21.2
	Expansible	5.9	1.4	1.3	0.2	8.8
Abyad						
300-200	Total	0.3	0.1	0.0	0.0	0.4
	Expansible	0.1	0.1	0.0	0.0	0.2
200-100	Total	11.4	2.2	0.8	0.7	15.1
	Expansible	7.1	1.8	0.7	0.2	9.8
Tafila						
300-200	Total	1.6	3.4	9.4	1.7	16.1
	Expansible	0.2	0.8	3.7	0.7	5.4
200-100	Total	0.6	0.8	1.5	0.2	3.1
	Expansible	0.1	0.3	0.9	0.2	1.5

It is apparent that most of flatter land under 300 - 200 mm rainfall class is already used for agriculture. Although 5,400 ha under 300 - 200 mm rainfall class of Tafila are expansible, some 80% occurs on sloping land with over 12 % gradient. As a whole, the expansible area under this rainfall class is limited. Under below 200 mm of rainfall, considerable extent of flat land is left in Dhiban and Abyad. The distribution pattern of land classes is illustrated in Figures C.3.4 to C.3.5.

4. Land Use Plan

4.1 Principles

To set up the land use guidelines, the basic consideration was made on the national policies for agricultural and regional development and the suitable land use alternatives proposed by the previous studies. As a result, the following principles were established for land use planning.

i. Staple crop production will be encouraged for higher potential land with flatter topography under over 200 mm of rainfall.

ii. Tree crops will be planted on sloping land covered by deeper soils by introducing water harvesting measures under over 200 mm of rainfall.

iii. Land under rainfall class of 200-100 mm will be used mainly for fodder shrub development.

iv. Dry land under below 100 mm of rainfall is excluded from the land use planning. They will be left for natural grazing land as they are.

v. Steeper land with over 30% slope is excluded from the land use planning and will be defined as afforestation area.

The marginal condition for staple crop production is 200 mm rainfall according to the definition of MOA. This principle has affected the land tenure system in Jordan. The Government pays her particular attention to the registration of dry lands. Because of severe circumstance under desert climate, adequate approach is indispensable for assuring reasonable economic return from any agricultural activities. Considerable parts of dry land to be transferred to nomads will be abandoned without technical and financial support by the Government. Therefore, the Government has dealt with land registration with great care.

In the guideline, crop production is recommended for the higher rainfall zones with over 200 mm rainfall. In such zones, most of farmland is owned by small farmers. By promoting water harvesting measures, production of cereals and tree crops will be encouraged. On the other hand, dry land with less 200 mm rainfall is presently left barren. Selecting the 200 - 100 mm rainfall zones, fodder shrub will be introduced. Since the land

ownership is kept mainly by the Government,the large-scale national project for livestock industry can be launched without any conflicts in land acquisition.

As clarified through the present land use analysis, the dry zones under less 100 mm rainfall are not used by local farmers. Although there would be some possibilities to develop them by means of modern farming techniques, the present study proposes to leave them as they are. As well, the steep land with over 30% slope are to be left and protected by afforestation.

In line with the principles, for setting up the land use proposals, the guideline was prepared as presented in Table C.4.1. The water harvesting measures proposed in the guideline are (i) micro-catchment, (ii) contour stone walls and (iii) earth banks of which features and functions are mentioned in Annex-E on Facilities Development Plan. According to the guidelines, the extent of land potentials were evaluated from the technical viewpoint. Based on this result, the optimum land use plan is to be justified from the standpoints of (i) land and water development potentials, (ii) agronomic studies for crop selection and farming practices by introducing the water harvesting measures, and (iii) socio-economic analyses for both demand-supply balance of farm products, profitability of crop alternatives and farm economy.

4.2 Land Development Potential

According to the guideline, land capability classes were categorized into each potential land class for crop production and fodder shrub development as presented in Tables C.4.2 to C.4.4.

The phased land use plan is proposed for each priority area. For successful introduction of water harvesting measures, several technical and financial aspects have to be ensured. Following the pre-implementation phase for institutional set-up, Phase-I is to be implemented as a first step aiming at establishment of suitable water harvesting measures under the indigenous climatic and soil conditions by selecting the rather higher potential land. By applying the experience obtained through Phase-I, Phase-II is to be implemented. Since the time scale of project implementation is to be carefully discussed from the activities and capacity of current agricultural support system, e.g. research, extension,m credit, etc. In this Chapter, the component of each phase is defined.

The existing fields and crops are to be sustained in the land use planning. However, crop selection with necessary measures will be proposed by the land use plan according to the land use guideline in Table C.4.1. This means that the irresponsible land development

should be controlled not to accelerate soil erosion and crop diversification is also taken into account.

i. Dhiban

Phase-I

The large portions of the higher potential land with 300-200 mm rainfall are already used for crop production. Particularly of flat land (0-8%), more than 90% is used for mechanized wheat. Such cereal production will be sustained according to the national agricultural policy on stabilized staple food production. In addition, although extent is limited, some 140 ha will be newly developed for cereals and legumes. Tree crops will be expanded to 570 ha on 8-30 % slope under 300-200 mm rainfall by introducing water harvesting measures.

Phase-II

Land development in less rainfall zone (200-100 mm) should carefully be planned. At present, out of 31,200 ha under 200-100 mm rainfall, 14,500 ha are used mainly for wheat production. They extend mainly in the eastern plain along the Desert Highway. Cropping intensity and productivity are considerably low. By introducing water harvesting measures, a part of existing wheat fields and fallow land will be planted with tree crops and fodder shrubs according to the long term development plan. The priority in land selection should be given to wadi floors and wadi courses without irregular micro-relief. The experience obtained would be applied for the further expansible area, 5,900 ha for tree crops and 1,400 ha for fodder shrubs.

ii. Abyad

Phase-I

The land development potential of Abyad is lower than ones of Dhiban and Tafila. In parallel to improvement of productivity of the existing farmland with a total area of 160 ha of deeper soils on 0-12% under 300-200 mm rainfall, cereals and legumes will be introduced in 190 ha locating mainly in and along the flat valley bottoms.

Phase-II

At present, 5,100 ha under 200-100 mm rainfall are used for agriculture. Because of lower rainfall and shallow soils, productivity is low and unstable. In fact, they are often used for grazing purposes instead of harvesting of grain. In long term plan, improvement of productivity in the existing farmland and new land development will be considered. The total expansible areas are estimated to be 5,700 ha on 0-12% slope for fodder shrubs and 3,200 ha of deep soils on 0-8% for tree crops by applying water harvesting measures.

iii. Tafila

Phase-I

In terms of area size, Tafila has higher development potentials. The land in several slope classes is already used for both tree crops and wheat. The total planted area under 300-200 mm rainfall is as large as 12,600 ha. In places, sloping land with 0-30 % gradient is used for wheat without any necessary soil conservation measures. The Phase-I is initiated by promotion of soil and water conservation project in the existing farmland. By introduction of contour furrow as well as stone walls, the existing plots will be protected. On steeper land with over 12% slope, wheat will be replaced by fodder shrubs with a total area of 4,500 ha and tree crops of high value, e.g. peaches, apples, pistachio, etc., with 160 ha.

About 990 ha on 0-12% slope will be expanded for wheat. Expansible area for tree crops is limited to be 30 ha of deep soils on 8-30% slope. In contrast, fodder shrub can be expanded to 3,600 ha. By selecting favourable location from villages, 1,000 ha will be developed with fodder shrubs.

Phase-II

Some 300 ha on 8-12% slope under 200-100 mm rainfall will be developed by applying experience obtained in previous stages.

The expansible areas are summarized in Table C.4.5. Through the phased land development plan, the expansible areas will be opened as summarized below.

Area Phase	Rainfall	Land Development Programme
Dhiban		
Phase-I	300-200 mm	1. Field crop expansion to 140 ha on 0-8% slope
		2. Tree crops expansion to 250 ha on 8-12% slope and 320 ha on 12-30% slope by introducing earth banks and stone walls
Phase-II	200-100 mm	1. Expansion of tree crops to 5,900 ha of deep soils on 0-8% slope
		2. Expansion of fodder crops to 1,400 ha of deep to moderately deep soils on 8-12% slopes
Abyad		
Phase-I	300-200 mm	1. Expansion of field crops to 190 ha on 0-12% slope
Phase-II	200-100 mm	1. Expansion of tree crops to 3,200 ha of deep soils on 0-8% slopes
		2. Expansion of fodder shrubs to 3,900 ha on 0-8% and 1,800 ha on 8-12%
Tafila		
Phase-I	300-200 mm	1. Expansion of field crops with 990 ha on 0-12% slopes
		2. Expansion of tree crops with 30 ha
		3. Expansion of barley and forage with 3,600 ha on 12-30%
Phase-II	200-100 mm	1. Expansion of tree crops with 70 ha
		2. Expansion of fodder shrubs with 350 ha on 0-120%

Taking the expansion of farmland mentioned above, the land use planning maps are prepared as illustrated in Figures C.4.1 to C.4.3. (See Plates 1 to 3 in Main Report)

4.3 Other Land Development Measures

4.3.1 General

Around the concept of soil and water conservation, the land use plan was established. In addition to the water harvesting measures proposed in the land use guideline, i.e. micro-catchment, contour-farrow, and earth bank, the other specific measures for development of wadi-bottoms with running water can be considered. Winter irrigation schemes and check-

dams would be the promising ones suitable for the Region. Their purposes are to trap, retain and store running water by means of embankment on drainage ways, and to ensure elongated release of stored water to plants during the dry seasons.

4.3.2 Winter irrigation schemes

Winter irrigation schemes have been taken up through the Master Plan Study. They aim at reserve of run-off of wadis during the wet seasons and supply it to down-stream areas to be planted with wheat and other crops. The present study goes into details of assessment of technical and financial feasibility of the schemes planned at the selected four (4) sites. The details are presented in Annex-E on Facilities Development Plan.

4.3.3 Check dams

(1) Present conditions

The check-dam is one of prevailing water conservation measures in the Dhiban area. As mentioned in Section 2.3.1 on Present Land Use, check-dam aims at trapping and storing run-off in soils plugging reservoir of dam. In general, reservoir areas are sized to less than 2 ha. Although optimum size of catchment is unknown, local farmers construct a check-dam with catchment varying from 100 ha to 500 ha under the annual rainfall of over 100 mm. At present, nine (9) sites are identified on the topographic maps.

(2) Potentials

First of all, the planning criteria have to be discussed on the basis of water balance in soils of reservoir area. Inflow to reservoir can be computed based simply on (i) catchment size, (ii) run-off coefficient and (iii) rainfall. Those variables are dependent highly upon indigenous conditions, e.g.soils and geology of catchment area, topography, land cover, etc. Run-off charged in soils is to be partly wasted by percolation and evaporation from a system and to be partly consumed by trees. Therefore, total soil moisture available for tree crops is changed by soil internal characteristics, namely water holding capacity, infiltration rate, occurrence of cracks, and so on. Since those basic information is limited, the present conditions of existing check-dams are fully taken up as follows.

- Check-dam should be planned in higher rainfall zones with over 100 mm. It is possible to plan dam on permanent stream with rather steady and reasonable

discharge even though rainfall is less 100 mm per annum. To verify such potential sites, further intensive survey will be required.

- The proposed catchment area is to be tentatively 300 ha. Land use conditions of catchment area directly affect run-off coefficient. If water harvesting measures are to be widely applied in the catchment area, optimum size of catchment should be reviewed.

- Check-dam should be planned within rather flatter landscape in order to obtain the larger reservoir area. Taking the present conditions into consideration, land slope should be less 30%.

According to the facility plan study, the average reservoir area is limited only to 0.3 ha in case that gabion-made check dam of 30 m wide and 3.5 m high is constructed on typical wadi bottoms. By letting top of dam set at the level of bottoms of upslope dam, several dams can be constructed at one location for expanding the reservoir area as practiced at the existing sites. In the present study, the conservative estimation was made on the development potentials of check dam as follows.

Priority Area	Study Area (ha)	Potential Zone (ha)	Site (no.)	Planted Area (ha)
Dhiban	36,300	29,200	97	29
Abyad	35,700	28,100	94	28
Tafila	48,000	36,100	120	36
Total	120,000	93,400	311	93

Note: Potential zones are on less 30% slope under over 100 mm of rainfall.

Table C.2.1 Relation between Extent of Farm Land and Rainfall-Slope Class

(1) Total Study Area

Unit: ha

Annual Rainfall	Slope (%)					
	0 - 4	4 - 8	8 - 12	12 - 30	30 <	Total
250 - 300	275	1,150	1,425	7,600	6,150	16,600
200 - 250	1,225	2,550	4,425	16,575	5,000	29,775
150 - 200	10,625	10,725	7,225	7,825	2,800	39,200
100 - 150	9,775	7,825	8,075	10,400	3,400	39,475
50 - 100	4,300	1,525	1,700	2,850	350	10,725
Total	26,200	23,775	22,850	45,250	17,700	135,775

(2) Extent of Farmland

Unit: ha

Annual Rainfall	Slope (%)					
	0 - 4	4 - 8	8 - 12	12 - 30	30 <	Total
250 - 300	275	963	869	3,307	2,944	8,358
200 - 250	1,200	2,325	2,857	4,869	244	11,495
150 - 200	6,544	5,188	2,575	1,469	163	15,938
100 - 150	1,738	2,212	1,494	781	31	6,257
50 - 100	156	81	13	19	0	269
Total	9,913	10,770	7,808	10,445	3,382	42,316

(3) Intensity of Farmland

Unit: %

Annual Rainfall	Slope (%)					Total
	0 - 4	4 - 8	8 - 12	12 - 30	30 <	
250 - 300	100	84	61	44	48	50
200 - 250	98	91	65	29	5	39
150 - 200	62	48	36	19	6	41
100 - 150	18	28	19	8	1	16
50 - 100	4	5	1	1	0	3
Total	38	45	34	23	19	31

Data: (3) = (2)/ (1) x 100

Table C.3.1 Land Classification Basis for Land Use Capability Planning by the World Bank (1981)

Class	Slope	Rockiness	Soil Conservation Practices Required	Others
I	< 1%		No soil conservation required	
II	1-9%		Contour cultivation required using permanent marks and occasional widely spaced earth bank	
III	10-14%		Closely spaced earth contour banks, gully control, water disposal areas contour cultivation	
IV	Flat to nearly flat	> 50%		
V	15-25%		Intensive soil conservation practice using gradoni or stone terraces	
VI	> 25%			
VII	Steep slope range land			
VIII				Roadsides village areas

Table C.3.2 Land Classification System Applied for the Zarqa River Basin Project (1983)

Class	Soil Depth	Slope	Rickiness
I	Deep (> 100 cm)	0-3%	Non rocky (0-10%)
II	Moderately deep (100-30 cm)	0-7%	Non rocky (0-10%)
	Deep (> 100 cm)	3-7%	
III	Moderately deep (100-30 cm)	8-14%	Non rocky (0-10%)
IV	Deep (> 100 cm)	0-24%	Non rocky (0-10%)
		15-24%	Rocky (10-25%)
V	Moderately deep (100-30 cm)	0-34%	Mostly rocky (25-75%)
		15-34%	Non rocky (0-10%)
VI	Moderately deep (100-30 cm)	35-49%	Rocky to non rocky (0-25%)
		25-34%	Very rocky (> 75%)
VII	Shallow (< 30 cm)	irrespective to slope	irrespective to rockiness
	Moderately deep (100-30 cm)	irrespective to slope	Very rocky (> 75%)
VIII	irrespective to depth	> 50%	irrespective to rockiness

Sub-class Symbols

s: Slope is limiting factor.
r: Rockiness is limitation. surface rock comprises 10-25% of the area
v: Very rocky land; surface rock comprises 25-75% of the area
d: Depth is insufficient.

Table C.3.3 Land Classification System Proposed by Land Use Capability Planninng - Jordan (MOA,1983)

Class	Soil Depth	Rickiness	Slope	Soil Texture
I	Deep (> 100 cm)	Non rocky (0-10%)	0-2%	clay to sandy loam
II	Deep to Moderately deep (100-50 cm)	Non rocky (0-10%)	3-7%	clay to sandy loam
III	Deep to Moderately deep (100-50 cm)	Non rocky (0-10%)	8-14%	clay to sandy loam
IV	Moderately deep (50-20 cm)	Non rocky (0-10%)	15-25%	clay to sandy loam
V	Moderately deep (50-20 cm)	Rocky (10-25%)	0-24%	coarser than loamy sand
VI	Moderately deep (50-20 cm)	Rocky to non rocky (0-25%)	25-50%	
VII	Shallow (< 20 cm)	> 50%	irrespective to slope	irrespective to texture
VIII	irrespective to depth	irrespective to rockiness	> 50%	irrespective to texture

Table C.3.4 Legend for Physiographic Soil Map of Dhiban

Physiography	Mapping Symbol	Topography	Soil Depth	Rock Outcrops
L EROSIONAL PLAIN OF CHERTY LIMESTONE				
L1 Rounded tops	L1	Flat to undulating, convex	Mod. deep	10-20%
L2 Slopes L21 Undulating to rolling	L21	Undulating to rolling	Mod. deep	5 - 10%
L22 Flat to undulating	L22	Flat to undulating	Deep to Mod. deep	None
L3 Wadis	L3	Flat with micro-relief	Deep	None
W QUARTENARY PLAIN WEST (DHIBAN-MUSHARFEH)				
W1 Summits	W1	Flat convex	Deep	None
W2 Slopes W21 Upper to middle, convex	W21	Gently undulating	Deep	None
W22 Lower slope	W22	Flat to gently undulating	Deep	None
W3 Wadis	W3	Flat with micro-relief	Mod. deep	None
E QUARTENARY PLAIN EAST (ALRASAS-DESERT HIGHWAY)				
E1 Summit	E1	Undulating, convex	Deep	None
E2 Slopes E21 Undulating	E21	Undulating	Deep	None
E22 Flat to gently undulating	E22	Flat to gently undulating	Deep	None
E3 Wadis	E3	Flat with micro-relief	Mod. deep	None
V DISSECTED VALLEY OF CHERTY LIMESTONE				
V1 Upper slopes V11 Convex	V11	Undulating to rolling	Deep to Mod. deep	0 - 5%
V12 Straight to concave	V12	Undulating to rolling	Deep to Mod. deep	0 - 5%
V2 Lower slopes V21 Convex	V21	Undulating	Shallow	10 - 20%
V22 Straight to concave	V22	Undulating	Mod. deep	5 - 10%
V3 Wadis	V3	Undulating	Shallow	30 - 50%
S WADI MUJIB SYSTEM & WADI WALA SYSTEM				
S1 Escarpment	S1	Mountainous	Shallow	> 50%
S2 Wadi courses	S2	Flat to steep micro-relief	Shallow	> 50%

Table C.3.5 Legend for Physiographic Soil Map of Abyad

Physiography	Mapping Symbol	Topography	Soil Depth	Rock Outcrops
U DISSECTED UPLAND OF CHERTY LIMESTONE				
U1 Rounded tops	U1	Undulating, convex	Gravel covered/ Shallow	25-50%
U2 Slopes U21 Upper to middle slopes	U21	Hilly to undulating	Gravel covered/ Mod. deep	5-10 %
U22 Lower slopes	U22	Flat to gently undulating	Deep to Mod. deep	None
U3 Wadis U31 Wadi floors	U31	Flat	Mod. deep	None
U32 Wadi courses	U32	Flat with micro-relief	Deep to Mod. deep	None
E EROSIONAL PLAIN OF CHERTY LIMESTONE				
E1 Summits	E1	Flat to undulating, convex	Mod. deep	10-25%
E2 Slopes E21 Dissected, barren	E21	Undulating to rolling	Mod. deep	5-10%
E22 Smooth surface, arable	E22	Flat to undulating	Deep to Mod. deep	None
E3 Wadis	E3	Flat with micro-relief	Deep	None
Q QUATERNARY SYSTEM				
Q1 Structure-controlled valley	Q1	Flat with micro-relief	Deep	None
Q2 Flat to gently undulating plains	Q2	Flat to almost flat	Deep	None
Q3 Wadis Q31 Wadi floors	Q31	Flat	Deep	None
Q32 Wadi courses	Q32	Flat with micro-relief	Deep	None
H WADI HASA SYSTEM				
H1 Convex summits	H1	Flat	Shallow	20 - 50%
H2 Escarpment	H2	Very steep	Shallow	> 50%
H3 Slopes H31 Highly dissected	H31	Rolling to hilly	Shallow	> 50%
H32 Smooth surface, barren	H32	Rolling to hilly	Shallow	25 - 50%
H33 Smooth surface, arable	H33	Undulating to rolling	Deep to Mod. deep	None
H4 Wadi courses	H4	Flat to almost flat, micro-relief	Shallow	> 50%

Table C.3.6 Legend of Physiographic Soil Map of Tafila

Physiography	Mapping Symbol	Topography	Soil Depth	Rock Outcrops
E EROSIONAL PLAIN OF BELQA LIMESTONE				
E1 Summints	E11	Undulating, convex	Gravel covered/ Mod. deep	25 - 50 %
E2 Slopes E21 Very steep slopes of valleys, not arable	E21	Mountainous (> 30%)	Gravel covered/ Mod. deep to shallow	25 - 50 %
E22 Steep slopes	E22	Hilly (12-30%)	Mod. deep	10 -25 %
E23 Sloping to gently sloping, arable	E23	Rolling to Undulating (4-12%)	Deep to Mod. deep	0 - 10 %
E3 Wadis	E3	Flat to Undulating (0-8%)	Mod. deep	10 - 25 %
B BASALT CONES				
B1 Summits	B1	Flat to undulating, convex	Mod. deep to shallow	50 % <
B2 Slopes B21 Upper to middle slopes	B21	Rolling to mountainous	Mod. deep	10 - 25 %
B22 Lower slopes	B22	Flat to undulating	Deep to Mod. deep	0 - 10 %
B3 Ridges	B3	Flat to almost flat	Deep to Mod. deep	0 - 10 %
Q QUATERNARY SYSTEM				
Q1 Alluvial Plain	Q1	Flat with micro-relief	Deep	None
Q2 Wadis	Q2	Flat to almost flat	Deep	None
C CREEP (FRINGE OF PLATEAU), MARL AND GYPSUM				
C1 Dissected Sloping Land C11 Rounded top	C11	Convex, Rolling	Mod. deep	50 % <
C12 Slopes	C12	Rolling to hilly	Deep to Mod. deep	25 - 50 %
C2 Land slip	C2	Undulating to rolling	Deep to Mod. deep	10 - 25%
S WADI SALIM AND AIMA SYSTEMS				
S1 Naur limestone S11 Very steep	S11	Mountainous	Shallow	> 50%
S12 Steep, arable	S12	Mountainous	Mod. deep to shallow	> 50%
S2 Kurnub sandstone	S2	Mountainous	Shallow	> 50%

Table C.3.7 Potential Area Distribution of Dhiban

(Unit: ha)

Slope (%)	0 - 4			4 - 8			8 - 12			12 - 30			30 <			Total
Soil Depth (cm)	0-50	50-100	100<	0-50	50-100	100<	0-50	50-100	100<	0-50	50-100	100<	0-50	50-100	100<	
Annual Rainfall																
300 - 250 mm			275	25		925	100		550	125		375	175		25	2,575
			275	6		806	75		325	19		119	6		6	1,637
			0	19		119	25		225	106		256	169		19	938
			0	17		107	23		203	27		231	42		17	667
250 - 200 mm																
			450			1,575	50		325	50		225	175			2,850
			444			1,544	44		269	13		131	31			2,476
			6			31	6		56	38		94	144			375
			6			28	2		51	9		84	36			216
200 - 150 mm																
	925	25	7,525	2,625	50	5,750	2,025	325	2,125	1,300	975	450	1,175	200	25	25,500
	544	25	4,613	1,188	31	3,294	581	219	919	188	75	163	44	0	6	11,890
	381	0	2,913	1,438	19	2,456	1,444	106	1,206	1,112	900	288	1,131	200	19	13,613
	343	0	2,621	1,294	17	2,211	1,267	96	1,086	835	810	259	348	180	17	11,384
150 - 100 mm																
			1,250	100		1,625	225		625	875		275	375			5,350
			638	63		1,094	138		375	238		50	25			2,621
			613	38		531	88		250	638		225	350			2,733
			551	17		478	79		225	492		203	185			2,230
Total																
	925	25	9,500	2,750	50	9,875	2,400	325	3,625	2,350	975	1,325	1,900	200	50	36,275
	544	25	5,970	1,257	31	6,738	838	219	1,888	458	75	463	106	0	12	18,624
	381	0	3,532	1,495	19	3,137	1,563	106	1,737	1,894	900	863	1,794	200	38	17,659
	343	0	3,178	1,328	17	2,824	1,371	96	1,565	1,363	810	777	611	180	34	14,497

Remark: Four (4) figures in each class indicate (i) Total Area, (ii) Extent of Farmland, (iii) Extent of Non-Farmland and (iv) Expansible Area from top to bottom in order.

Table C.3.8 Potential Area Distribution of Abyad

(Unit: ha)

Slope (%)	0 - 4			4 - 8			8 - 12			12 - 30			30 <			Total
Soil Depth (cm)	0-50	50-100	100<	0-50	50-100	100<	0-50	50-100	100<	0-50	50-100	100<	0-50	50-100	100<	
Annual Rainfall																
250 - 200 mm		75	200	25		25	175	75		700						1,275
		63	81	13		0	119	19		138						433
		13	119	13		25	56	56		563						845
		11	107	11		23	51	51		506						760
200 - 150 mm																
	200	375	1,300	975	800	25	1,025	250	25	700	50					5,725
	106	256	544	325	225	25	350	113	19	206	0					2,169
	94	119	756	650	575	0	675	138	6	494	50					3,557
	84	107	681	585	518	0	608	124	6	444	45					3,202
150 - 100 mm																
	1,875	2,575	3,825	2,750	2,250	250	3,325	1,925	25	2,400	700		650			22,550
	188	750	1,238	100	444	94	6	88	13	0	0		0			2,921
	1,688	1,825	2,588	2,650	1,806	156	3,319	1,838	13	2,400	700		650			19,633
	1,519	1,643	2,329	2,385	1,626	141	2,987	1,654	11	2,160	630		163			17,248
100 - 50 mm																
	1,200	225	2,650	850	150	100	475			325			125			6,100
	0	0	0	0	0	0	0			0			0			0
	1,200	225	2,650	850	150	100	475			325			125			6,100
	1,080	203	2,385	765	135	90	428			293			113			5,492
Total																
	3,275	3,250	7,975	4,600	3,200	400	5,000	2,250	50	4,125	750	0	775	0	0	35,650
	294	1,069	1,863	438	669	119	475	220	32	344	0	0	0	0	0	5,523
	2,982	2,182	6,113	4,163	2,531	281	4,525	2,032	19	3,782	750	0	775	0	0	30,135
	2,683	1,964	5,502	3,746	2,279	254	4,074	1,829	17	3,403	675	0	276	0	0	26,702

Remark: Four (4) figures in each class indicate (i) Total Area, (ii) Extent of Farmland, (iii) Extent of Non-Farmland and (iv) Expansible Area from top to bottom in order.

Table C.3.9 Potential Area Distribution of Tafila

(Unit: ha)

Slope (%)	0 - 4			4 - 8			8 - 12			12 - 30			30 <			Total
Soil Depth (cm)	0-50	50-100	100<	0-50	50-100	100<	0-50	50-100	100<	0-50	50-100	100<	0-50	50-100	100<	
Annual Rainfall																
300 - 250 mm				25	175		125	650		3,100	4,000		4,925	1,025		14,025
				19	132		31	438		894	2,275		556	350		4,695
				6	44		94	213		2,207	1,726		4,369	675		9,334
				5	37		58	158		1,339	1,197		1,355	325		4,474
250 - 200 mm																
		175	325	50	650	225	1,025	2,600	175	10,225	5,325	25	4,100	625		25,525
		175	313	38	538	181	456	1,881	144	2,444	2,244	19	138	76		8,647
		0	13	13	112	44	569	719	31	7,782	3,082	6	3,963	551		16,885
		0	11	9	99	39	421	637	28	5,656	2,448	6	1,291	358		11,003
200 - 150 mm																
		25	225	100	150	175	600	800		2,775	1,175		650	125		6,800
		19	213	75	106	113	225	481		513	481		87	25		2,338
		6	13	25	44	63	375	319		2,263	694		563	100		4,465
		6	11	19	39	56	281	287		1,684	624		317	90		3,414
150 - 100 mm																
								25		850	275	50	425	100		1,725
								6		25	25	6	6	0		68
								19		825	250	44	419	100		1,657
								17		606	225	39	234	90		1,211
Total																
	0	200	550	175	975	400	1,750	4,075	175	16,950	10,775	75	10,100	1,875	0	48,075
	0	194	526	132	776	294	712	2,806	144	3,876	5,025	25	787	451	0	15,748
	0	6	26	44	200	107	1,038	1,270	31	13,077	5,752	50	9,314	1,426	0	32,341
	0	6	22	33	175	95	760	1,099	28	9,285	4,494	45	3,197	863	0	20,102

Remark: Four (4) figures in each class indicate (i) Total Area, (ii) Extent of Farmland, (iii) Extent of Non-Farmland and (iv) Expansible Area from top to bottom in order.

Table C.4.1 Proposed Guideline for Land Use Planning

Slope (%)	0 - 8			8 - 12			12 - 30			30 <		
Soil Depth (cm)	0-50	50-100	100<	0-50	50-100	100<	0-50	50-100	100<	0-50	50-100	100<
Annual Rainfall 300 - 200 mm	Pasture	Field Crops (Mechanized Farming)		Pasture	Field Crops by Stone Walls or Contour Furrow	Fruit Trees by Stone Walls or Earth Banks	Pasture	Barley Forage Legume (Fodder Shrub) by Stone Walls or Contour Furrow	Fruit Trees by Stone Walls or Earth Banks		Forest	
200 - 100 mm	Natural Pasture	Fodder Shrubs by Micro-Catch-ment	Fruit Trees by Micro-Catch-ment	Natural Pasture	Fodder Shrubs by Contour Furrow or Stone Walls		Natural Pasture					

Table C.4.3 Land Development Potential of Abyad According to Land Use Guideline

(Unit: ha)

Slope (%)	0 - 8			8 - 12			12 - 30			30 <			Total (ha)
Soil Depth (cm)	0-50	50-100	100<	0-50	50-100	100<	0-50	50-100	100<	0-50	50-100	100<	
Annual Rainfall													
300 - 200 mm	25	300		175	75	0	700	0	0		0		35,650
	13	144		119	19	0	138	0	0		0		5,523
	13	157		56	56	0	563	0	0		0		30,135
	11	141		51	51	0	506	0	0		0		26,702
200 - 100 mm													
	5,800	6,000	5,400	4,350	2,225				4,500				35,650
	719	1,675	1,901	356	233				206				5,523
	5,082	4,325	3,500	3,994	1,995				4,294				30,135
	4,573	3,894	3,151	3,595	1,795				3,442				26,702
100 - 50 mm													
						6,100							35,650
						0							5,523
						6,100							30,135
						5,492							26,702

Remark: Four (4) figures in each class indicate (i) Total Area, (ii) Extent of Farmland, (iii) Extent of Non-Farmland and (iv) Expansible Area from top to bottom in order.

Table C.4.2 Land Development Potential of Dhiban According to Land Use Guideline

(Unit: ha)

Slope (%)	0 - 8			8 - 12			12 - 30			30 <			Total (ha)
Soil Depth (cm)	0-50	50-100	100<	0-50	50-100	100<	0-50	50-100	100<	0-50	50-100	100<	
Annual Rainfall													
300 - 200 mm	25	3,225		150	0	875	175	0	600		50		36,275
	6	3,069		119	0	594	32	0	250		12		18,624
	19	156		31	0	281	144	0	350		38		17,659
	17	141		25	0	254	36	0	315		34		14,497
200 - 100 mm													
	3,650	75	16,150	2,250	3,075				5,975				
	1,795	56	9,639	719	1,513				820				
	1,857	19	6,513	1,532	1,562				5,157				
	1,654	17	5,861	1,346	1,407				3,390				
100 - 50 mm													
						0							
						0							
						0							
						0							

Remark: Four (4) figures in each class indicate (i) Total Area, (ii) Extent of Farmland, (iii) Extent of Non-Farmland and (iv) Expansible Area from top to bottom in order.

Table C.4.4 Land Development Potential of Tafila According to Land Use Guideline

(Unit: ha)

Slope (%)	0 - 8			8 - 12			12 - 30			30 <			Total (ha)
Soil Depth (cm)	0-50	50-100	100<	0-50	50-100	100<	0-50	50-100	100<	0-50	50-100	100<	
Annual Rainfall													
300 - 200 mm	75	1,550		1,150	3,250	175	13,325	9,325	25		1,650		48,075
	57	1,339		487	2,319	144	3,338	4,519	19		426		15,748
	19	213		663	932	31	9,989	4,808	6		1,226		32,341
	14	186		479	795	28	6,995	3,645	6		683		20,102
200 - 100 mm													
	100	175	400	600	825				15,450				
	75	125	326	225	487				1,862				
	25	50	76	375	338				13,590				
	19	45	67	281	304				6,555				
100 - 50 mm													
						0							
						0							
						0							
						0							

Remark: Four (4) figures in each class indicate (i) Total Area, (ii) Extent of Farmland, (iii) Extent of Non-Farmland and (iv) Expansible Area from top to bottom in order.

Table C.4.5 Summary of Expansible Area according to Land Use Guideline

LAND USE GUIDELINE

Slope (%)	0 - 8			8 - 12			12 - 30			30 <		
Soil Depth (cm)	0-50	50-100	100<	0-50	50-100	100<	0-50	50-100	100<	0-50	50-100	100<
Annual Rainfall 300 - 200 mm	Pasture	Field Crops (Mechanized Farming)		Pasture	Field Crops by Stone Walls or Contour Furrow	Fruit Trees by Stone Walls or Earth Banks	Pasture	Barley Forage Legume (Fodder Shrub) by Stone Walls or Contour Furrow	Fruit Trees by Stone Walls or Earth Banks		Forest	
200 - 100 mm	Natural Pasture	Fodder Shrubs by Micro-Catch-ment	Fruit Trees by Micro-Catch-ment	Natural Pasture	Fodder Shrubs by Contour Furrow or Stone Walls		Natural Pasture					

TOTAL

Slope (%)	0 - 8			8 - 12			12 - 30			30 <		
Soil Depth (cm)	0-50	50-100	100<	0-50	50-100	100<	0-50	50-100	100<	0-50	50-100	100<
Annual Rainfall 300 - 200 mm	42		468	555	846	282	7,537	3,645	321			717
200 - 100 mm	6,246	3,956	9,079	5,222		3,506		13,387				

DHIBAN

Slope (%)	0 - 8			8 - 12			12 - 30			30 <		
Soil Depth (cm)	0-50	50-100	100<	0-50	50-100	100<	0-50	50-100	100<	0-50	50-100	100<
Annual Rainfall 300 - 200 mm	17		141	25	0	254	36	0	315			34
200 - 100 mm	1,654	17	5,861	1,346		1,407		3,390				

ABYAD

Slope (%)	0 - 8			8 - 12			12 - 30			30 <		
Soil Depth (cm)	0-50	50-100	100<	0-50	50-100	100<	0-50	50-100	100<	0-50	50-100	100<
Annual Rainfall 300 - 200 mm	11		141	51	51	0	506	0	0			0
200 - 100 mm	4,573	3,894	3,151	3,595		1,795		3,442				

TAFILA

Slope (%)	0 - 8			8 - 12			12 - 30			30 <		
Soil Depth (cm)	0-50	50-100	100<	0-50	50-100	100<	0-50	50-100	100<	0-50	50-100	100<
Annual Rainfall 300 - 200 mm	14		186	479	795	28	6,995	3,645	6			683
200 - 100 mm	19	45	67	281		304		6,555				

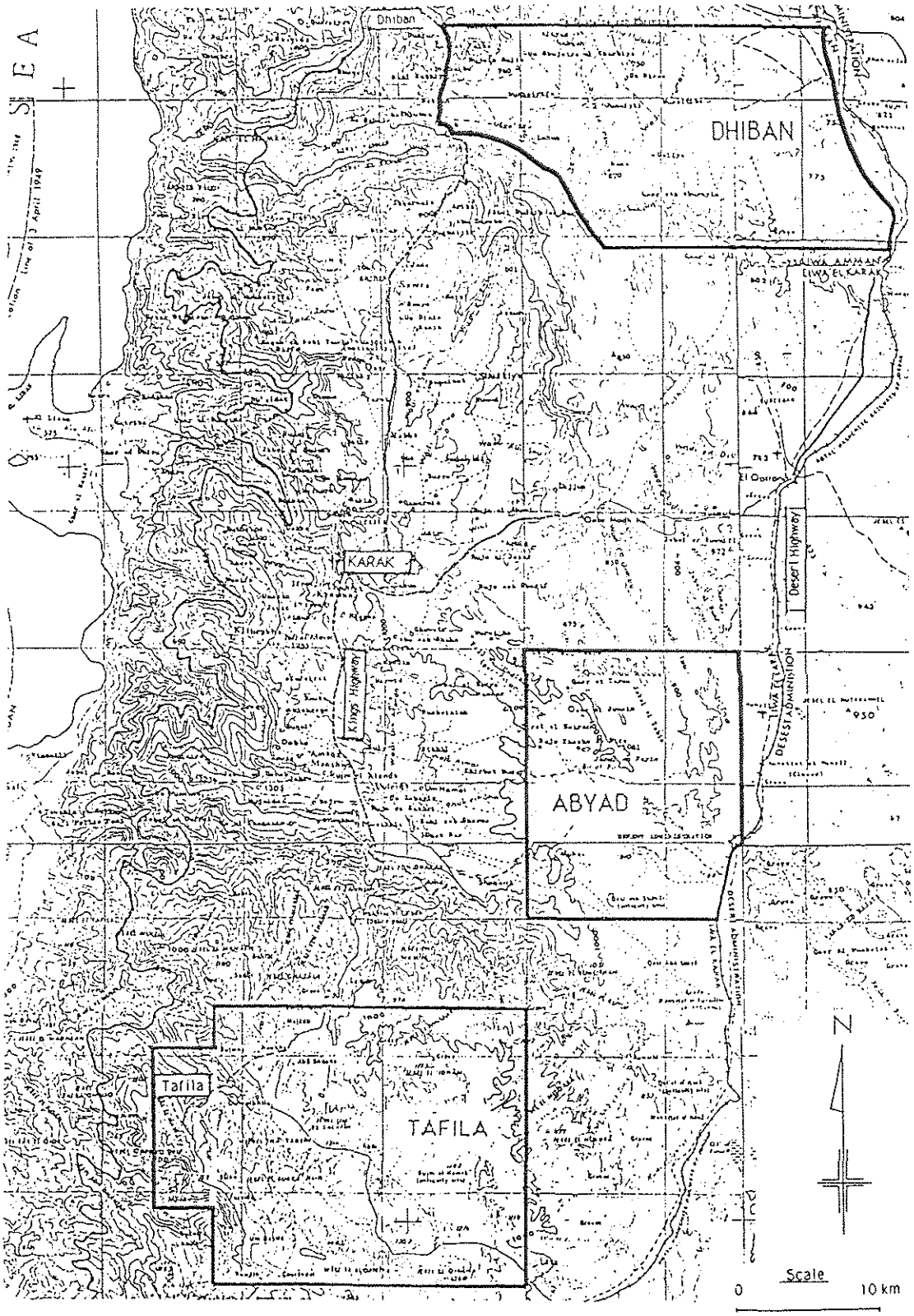
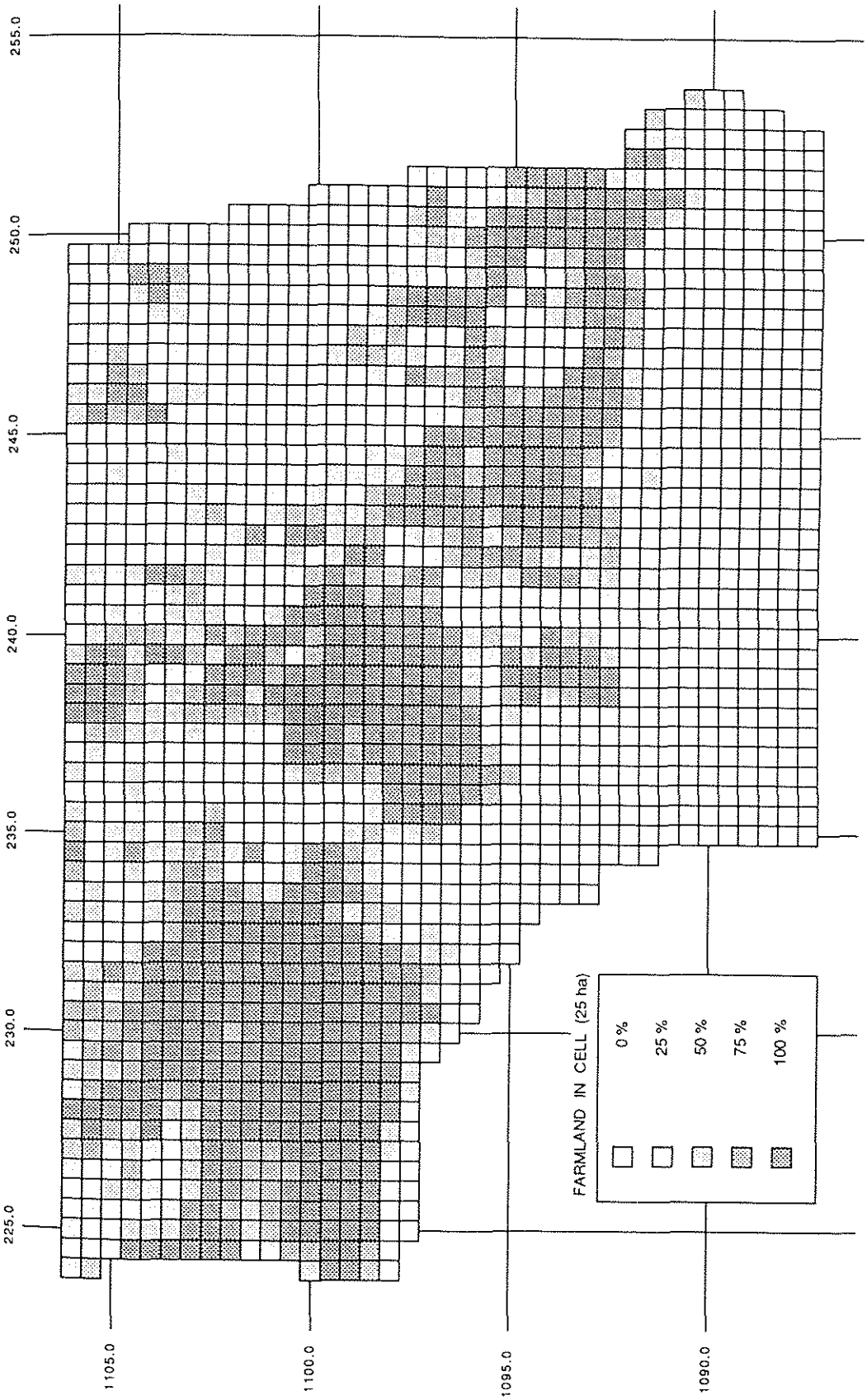


Figure C.1.1 Location Map of the Study Area

THE HASHEMITE KINGDOM OF JORDAN

FEASIBILITY STUDY ON AGRICULTURAL DEVELOPMENT FOR THE KARAK - TAFILA DEVELOPMENT REGION

JAPAN INTERNATIONAL COOPERATION AGENCY



THE HASHEMITE KINGDOM OF JORDAN

FEASIBILITY STUDY ON AGRICULTURAL DEVELOPMENT FOR THE KARAK - TAFILA DEVELOPMENT REGION

JAPAN INTERNATIONAL COOPERATION AGENCY

Figure C.2.1 Extent of Farmland of Dhiban

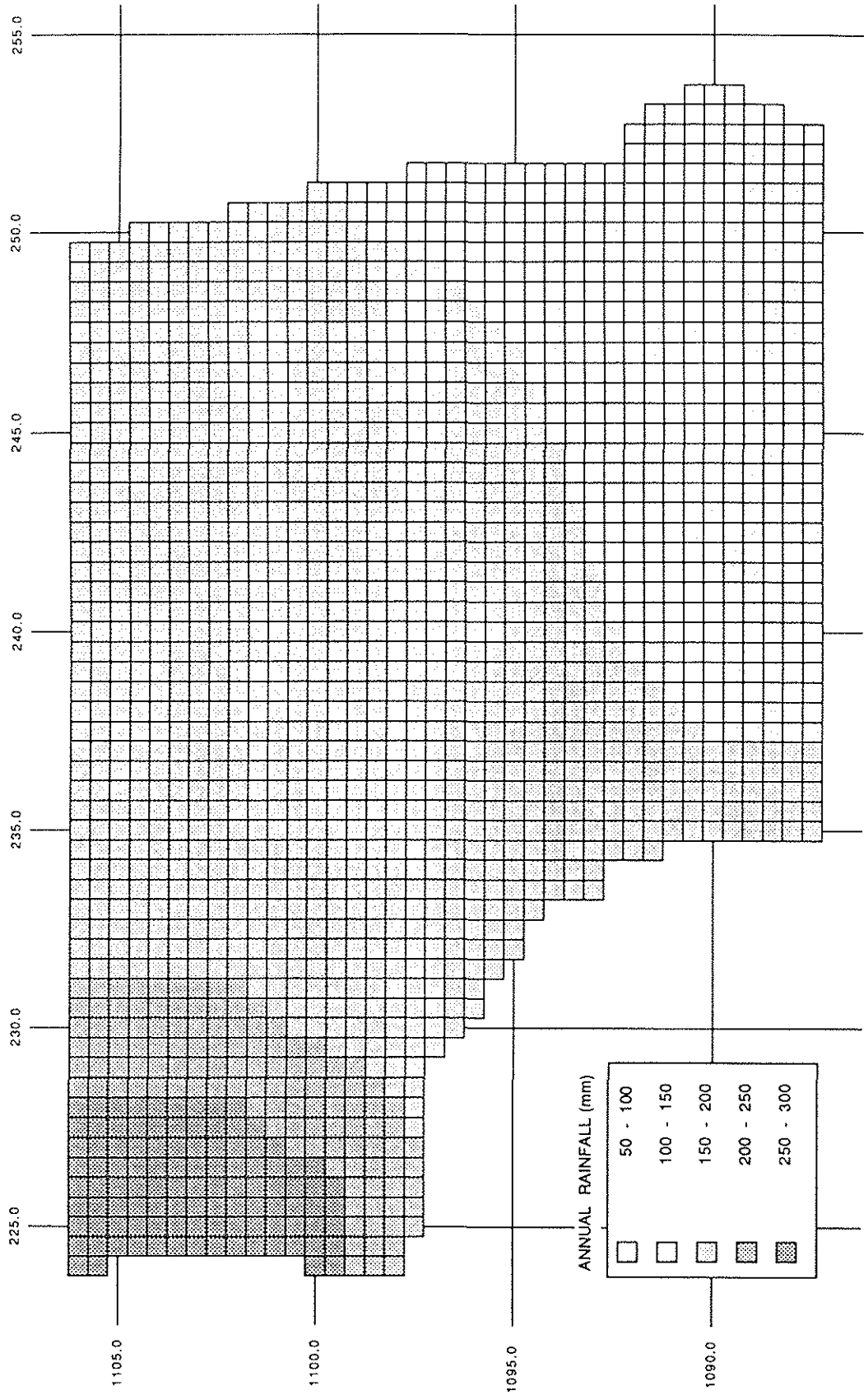


Figure C.2.2 Rainfall Distribution of Dhiban

THE HASHEMITE KINGDOM OF JORDAN

FEASIBILITY STUDY ON AGRICULTURAL DEVELOPMENT FOR THE KARAK - TAFILA DEVELOPMENT REGION

JAPAN INTERNATIONAL COOPERATION AGENCY

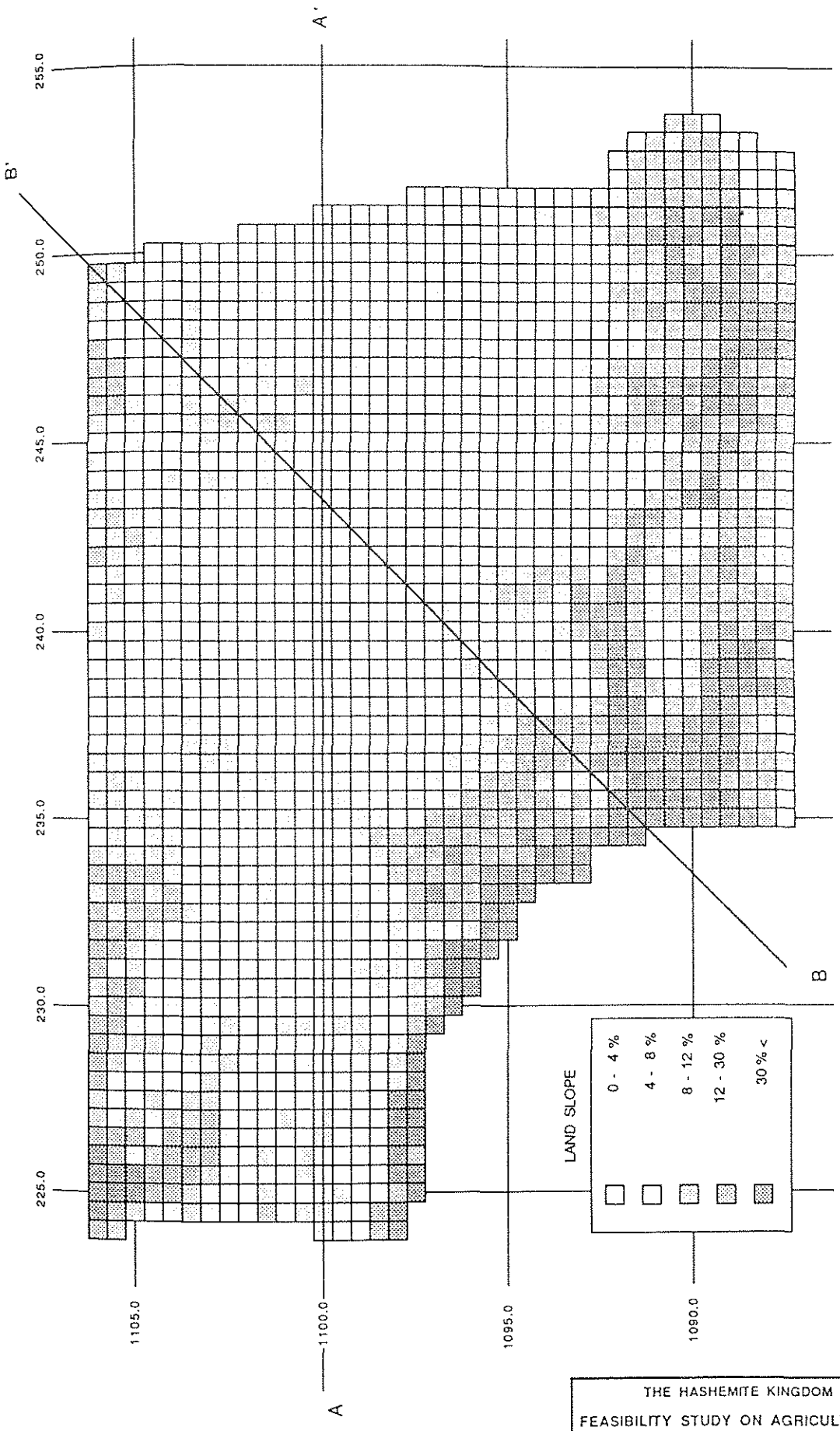


Figure C.2.3 Land Slope of Dhiban

THE HASHEMITE KINGDOM OF JORDAN

FEASIBILITY STUDY ON AGRICULTURAL DEVELOPMENT FOR THE KARAK - TAFILA DEVELOPMENT REGION

JAPAN INTERNATIONAL COOPERATION AGENCY

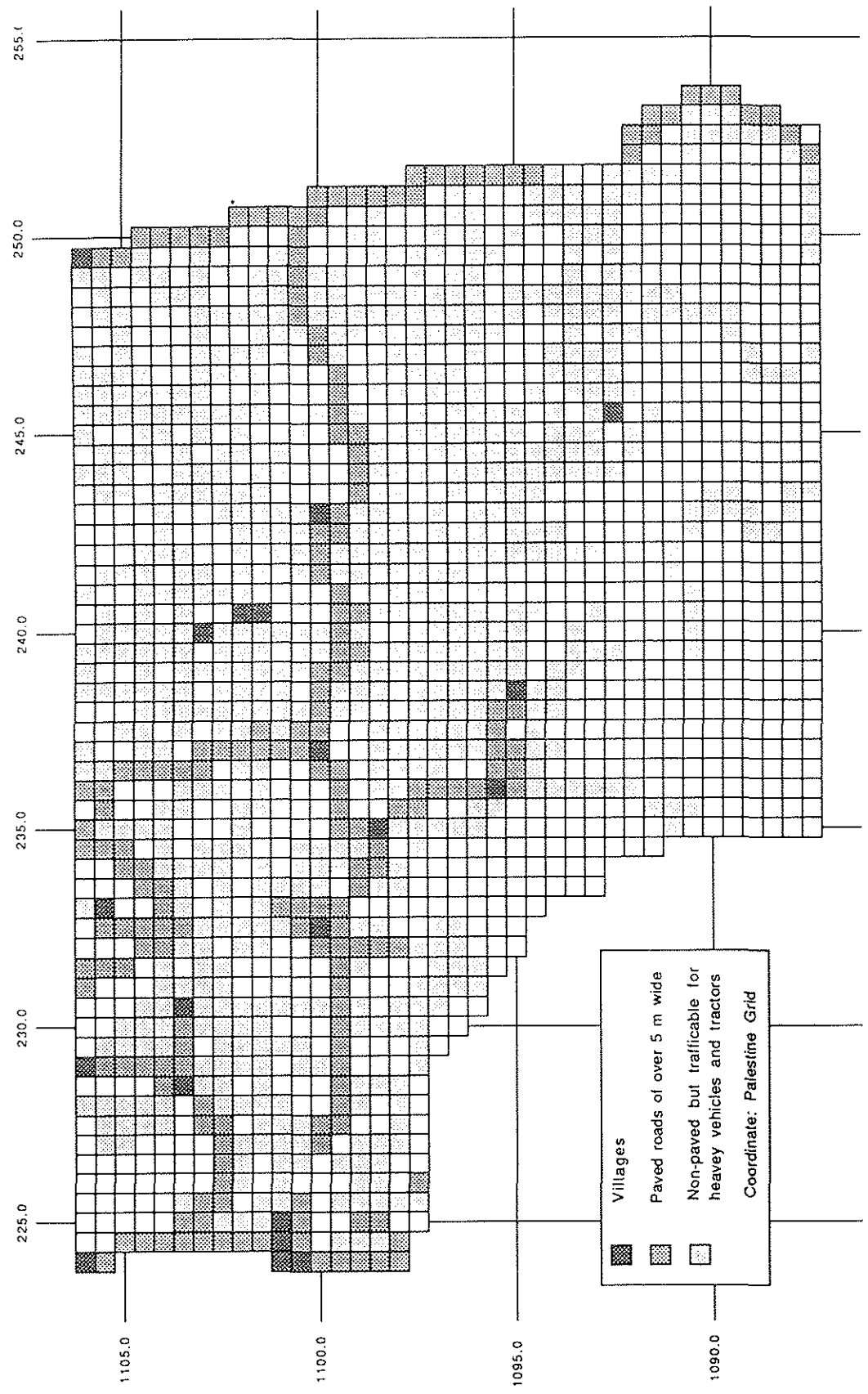


Figure C.2.4 Location of Villages and Road Network of Dhiban

THE HASHEMITE KINGDOM OF JORDAN

FEASIBILITY STUDY ON AGRICULTURAL DEVELOPMENT FOR THE KARAK - TAFILA DEVELOPMENT REGION

JAPAN INTERNATIONAL COOPERATION AGENCY

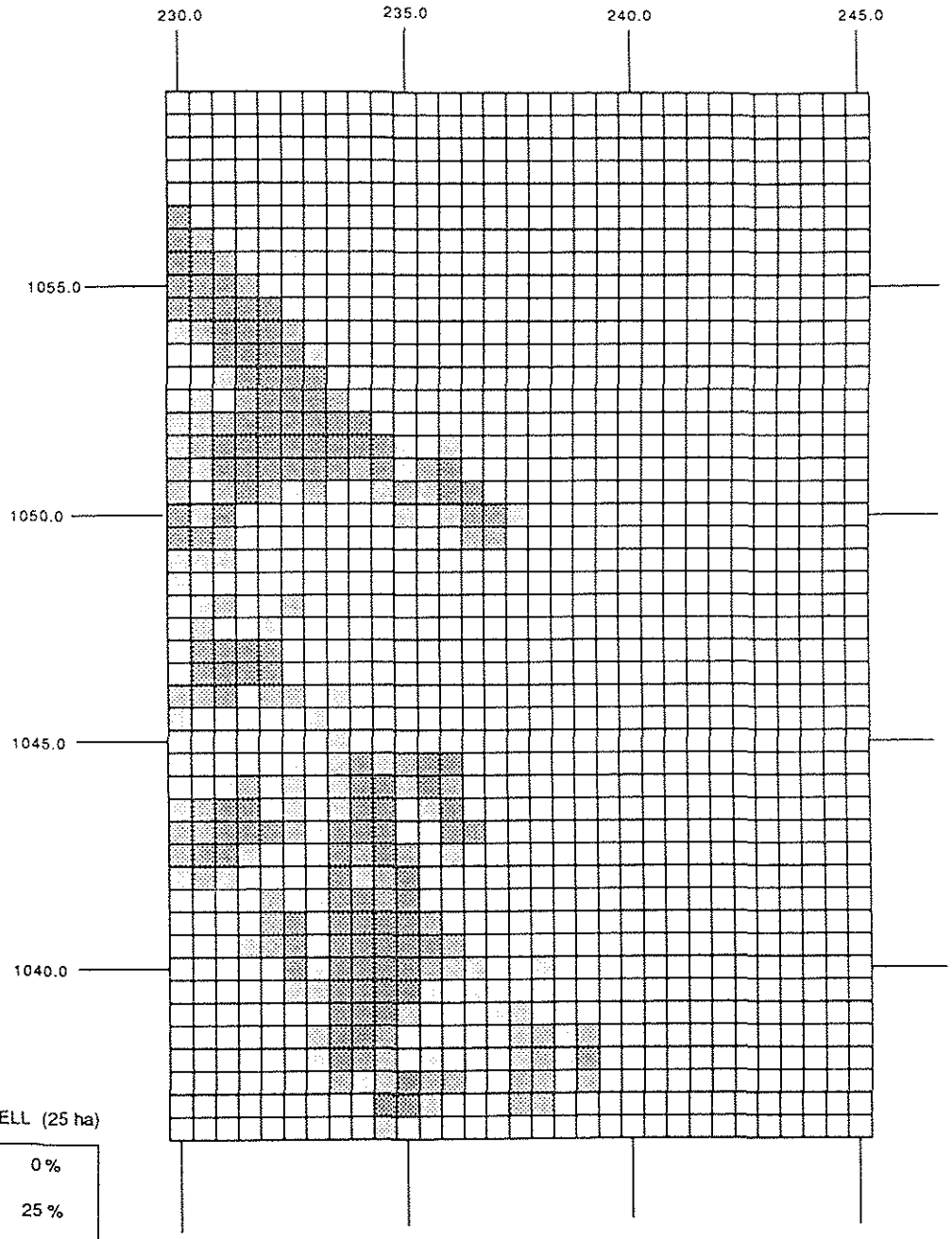


Figure C.2.5 Extent of Farmland of Abyad

THE HASHEMITE KINGDOM OF JORDAN

FEASIBILITY STUDY ON AGRICULTURAL DEVELOPMENT FOR THE KARAK - TAFILA DEVELOPMENT REGION

JAPAN INTERNATIONAL COOPERATION AGENCY

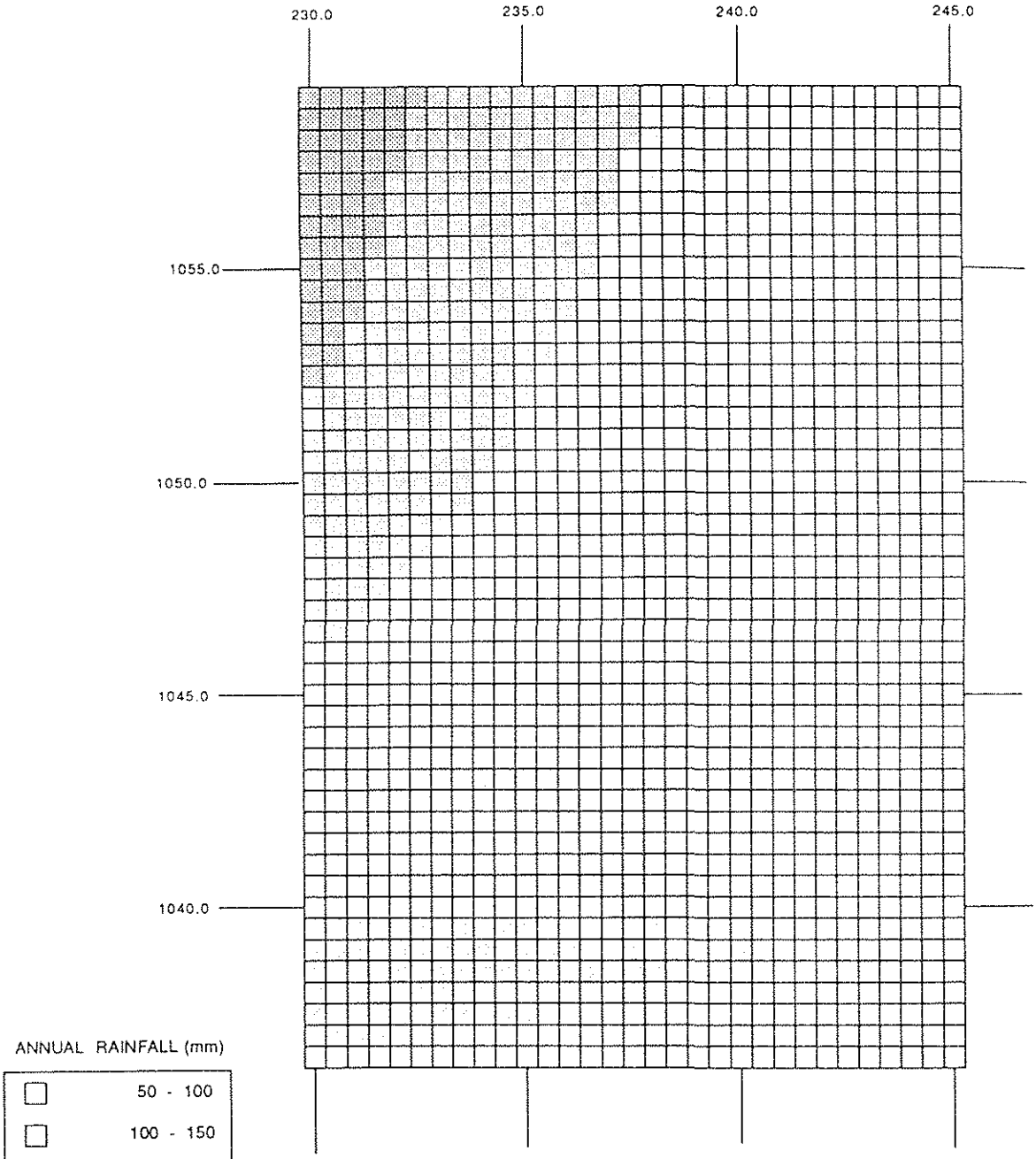


Figure C.2.6 Rainfall Distribution of Abyad

THE HASHEMITE KINGDOM OF JORDAN
FEASIBILITY STUDY ON AGRICULTURAL DEVELOPMENT FOR THE KARAK - TAFILA DEVELOPMENT REGION
JAPAN INTERNATIONAL COOPERATION AGENCY

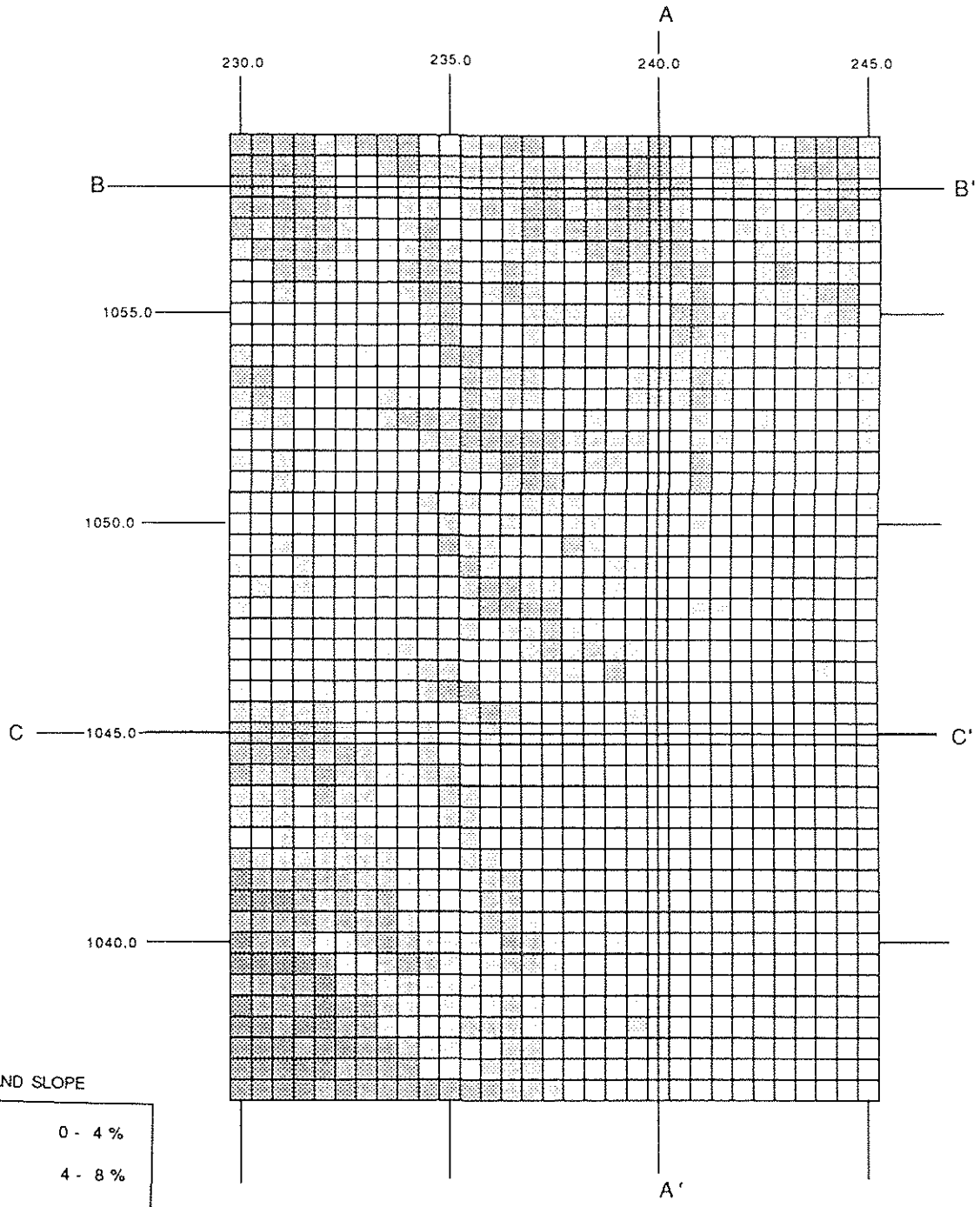


Figure C.2.7 Land Slope of Abyad

THE HASHEMITE KINGDOM OF JORDAN

FEASIBILITY STUDY ON AGRICULTURAL DEVELOPMENT FOR THE KARAK - TAFILA DEVELOPMENT REGION

JAPAN INTERNATIONAL COOPERATION AGENCY

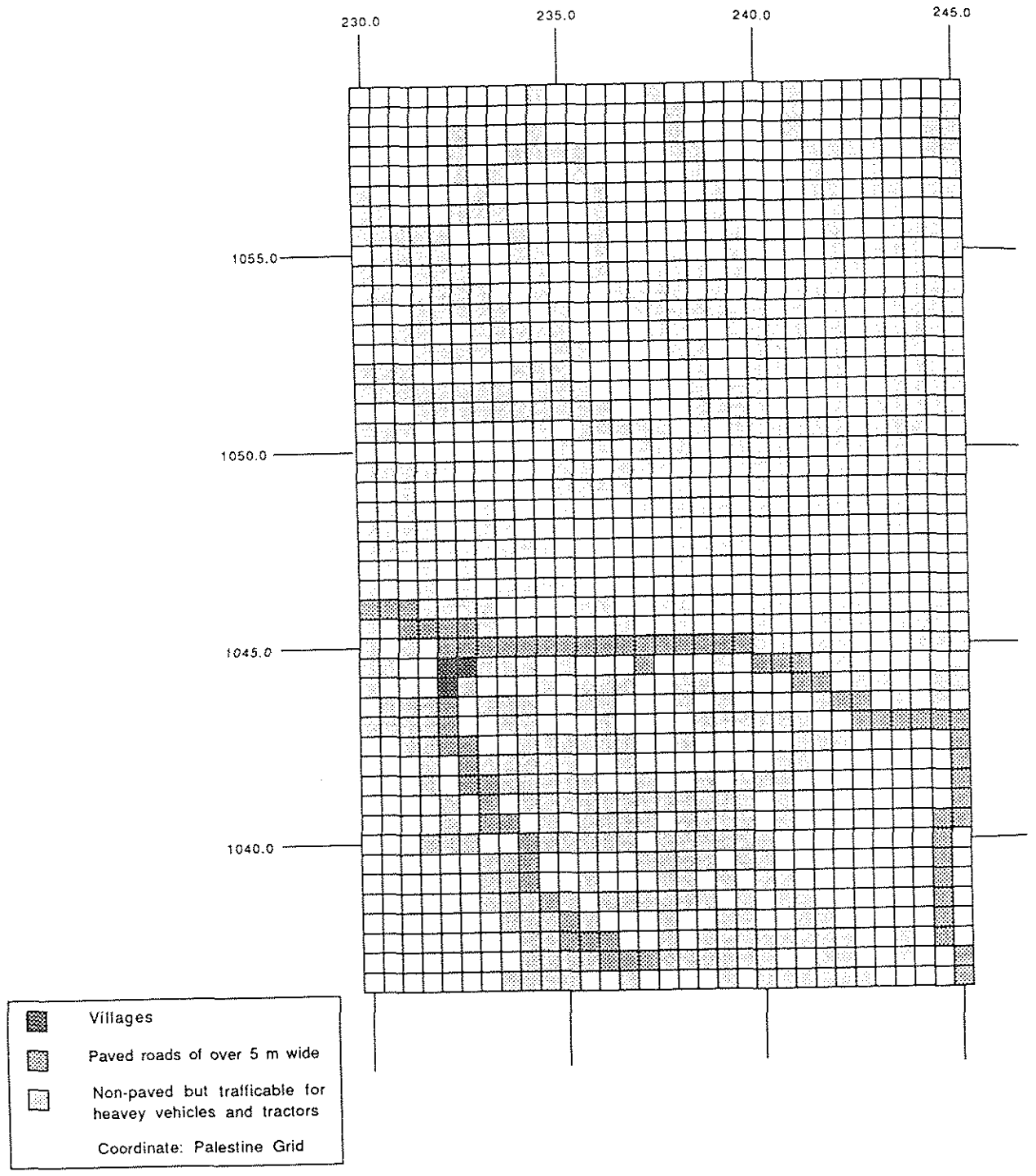


Figure C.2.8 Location of Villages and Road Network of Abyad

THE HASHEMITE KINGDOM OF JORDAN
FEASIBILITY STUDY ON AGRICULTURAL DEVELOPMENT FOR THE KARAK - TAFILA DEVELOPMENT REGION
JAPAN INTERNATIONAL COOPERATION AGENCY

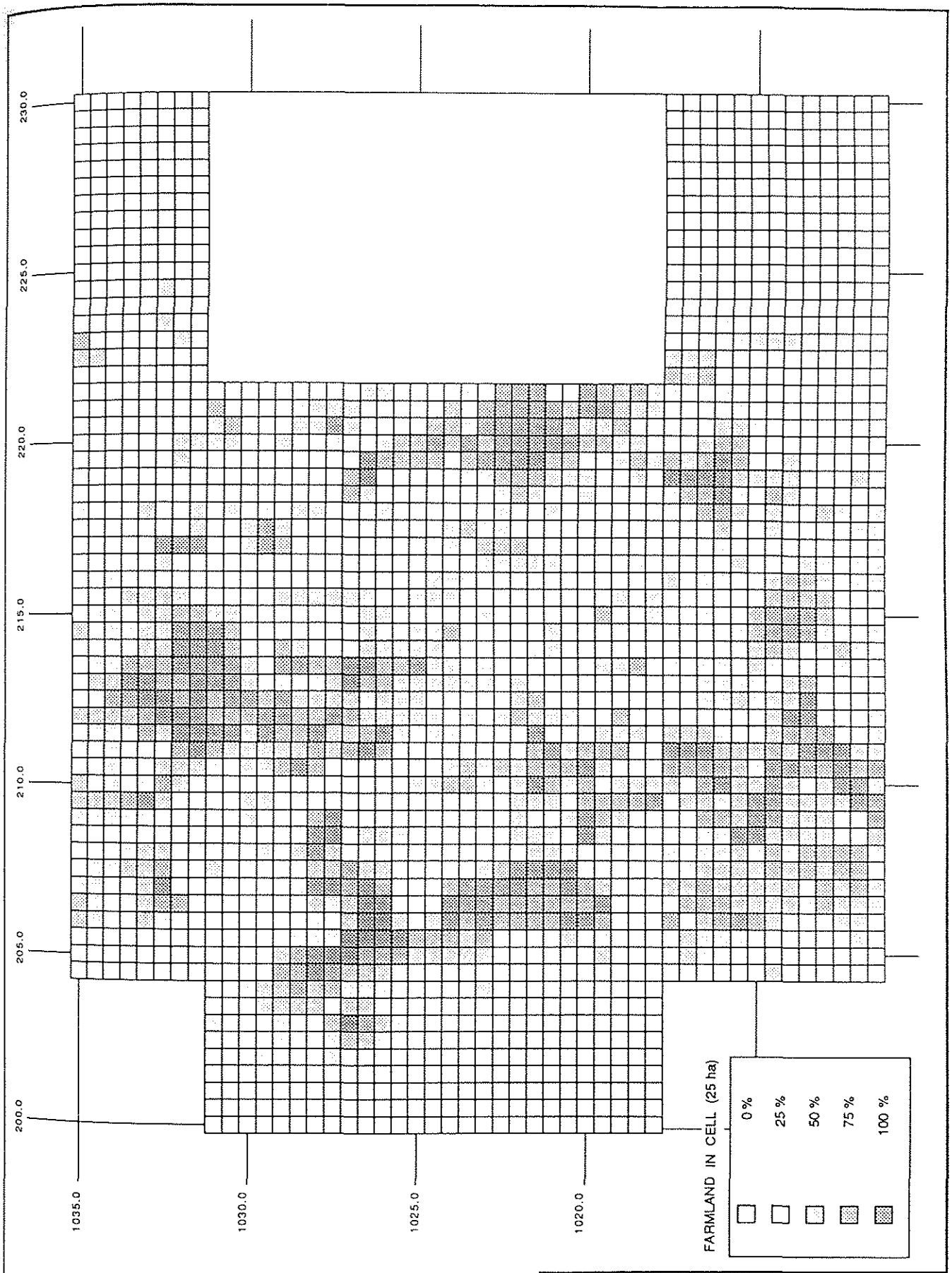


Figure C.2.9 Extent of Farmland of Tafila

THE HASHEMITE KINGDOM OF JORDAN

FEASIBILITY STUDY ON AGRICULTURAL DEVELOPMENT FOR THE KARAK - TAFILA DEVELOPMENT REGION

JAPAN INTERNATIONAL COOPERATION AGENCY

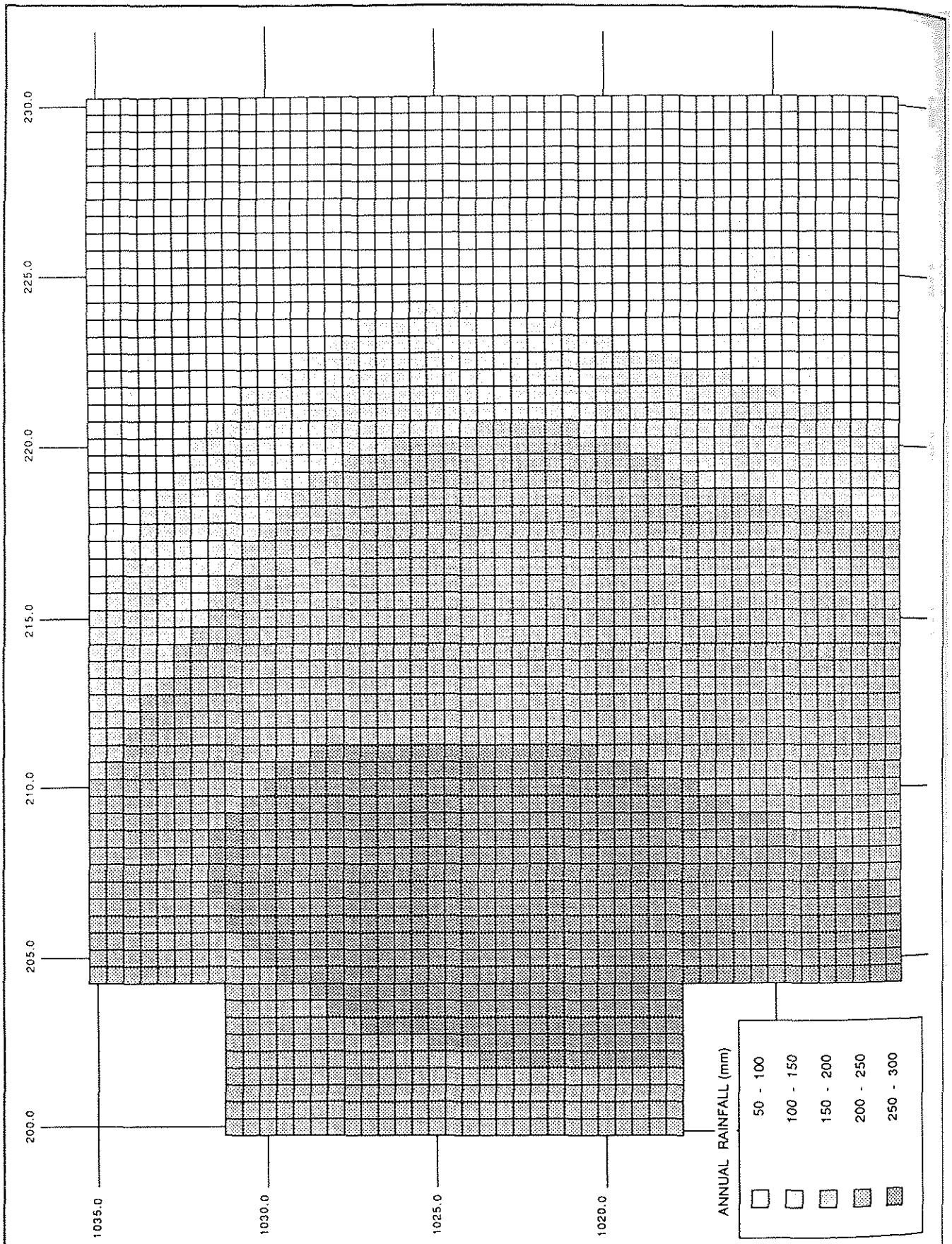
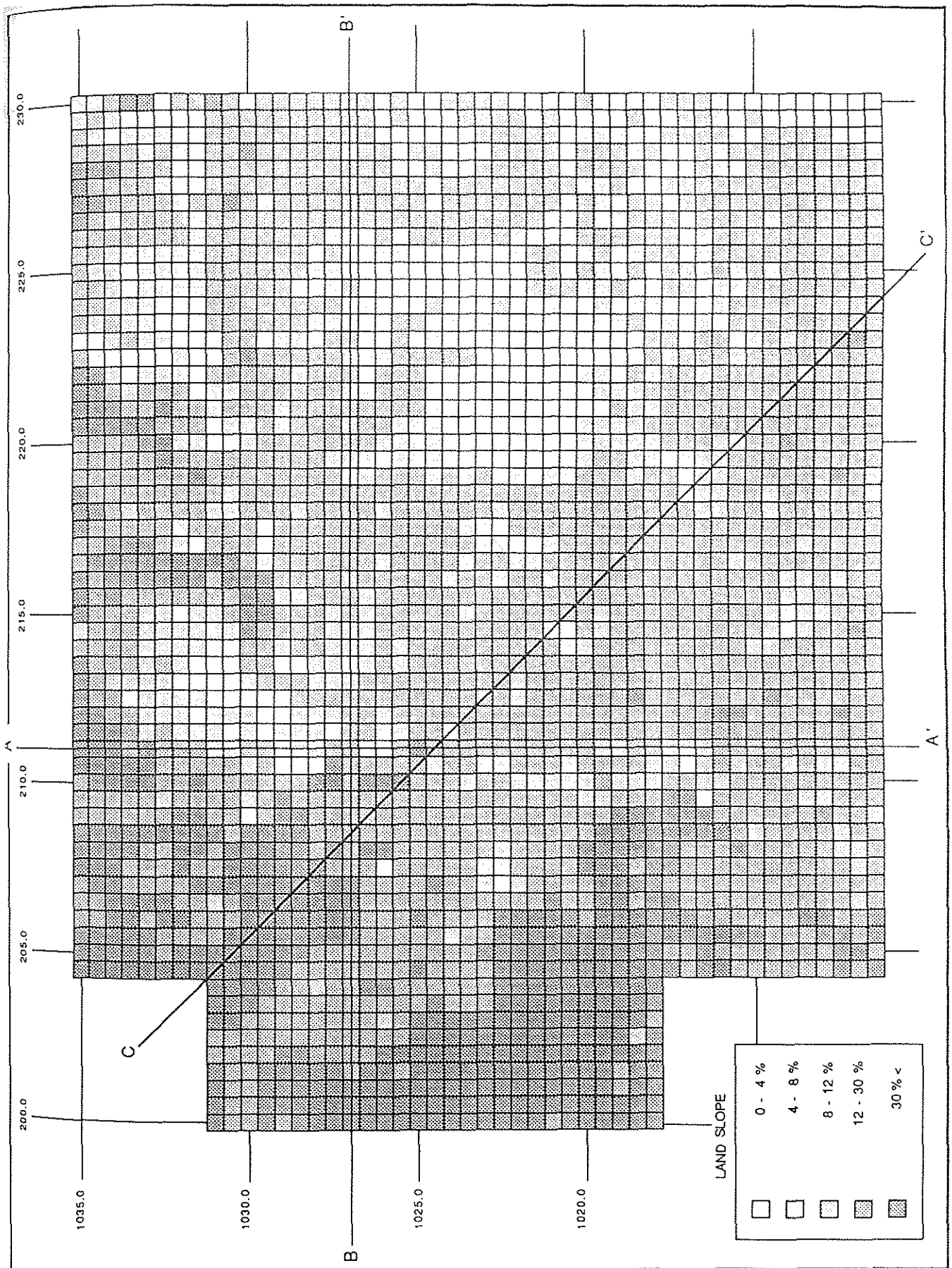


Figure C.2.10 Rainfall Distribution of Tafila

THE HASHEMITE KINGDOM OF JORDAN

FEASIBILITY STUDY ON AGRICULTURAL DEVELOPMENT FOR THE KARAK - TAFILA DEVELOPMENT REGION

JAPAN INTERNATIONAL COOPERATION AGENCY



THE HASHEMITE KINGDOM OF JORDAN

FEASIBILITY STUDY ON AGRICULTURAL DEVELOPMENT FOR THE KARAK - TAFILA DEVELOPMENT REGION

JAPAN INTERNATIONAL COOPERATION AGENCY

Figure C.2.11 Land Slope of Tafila

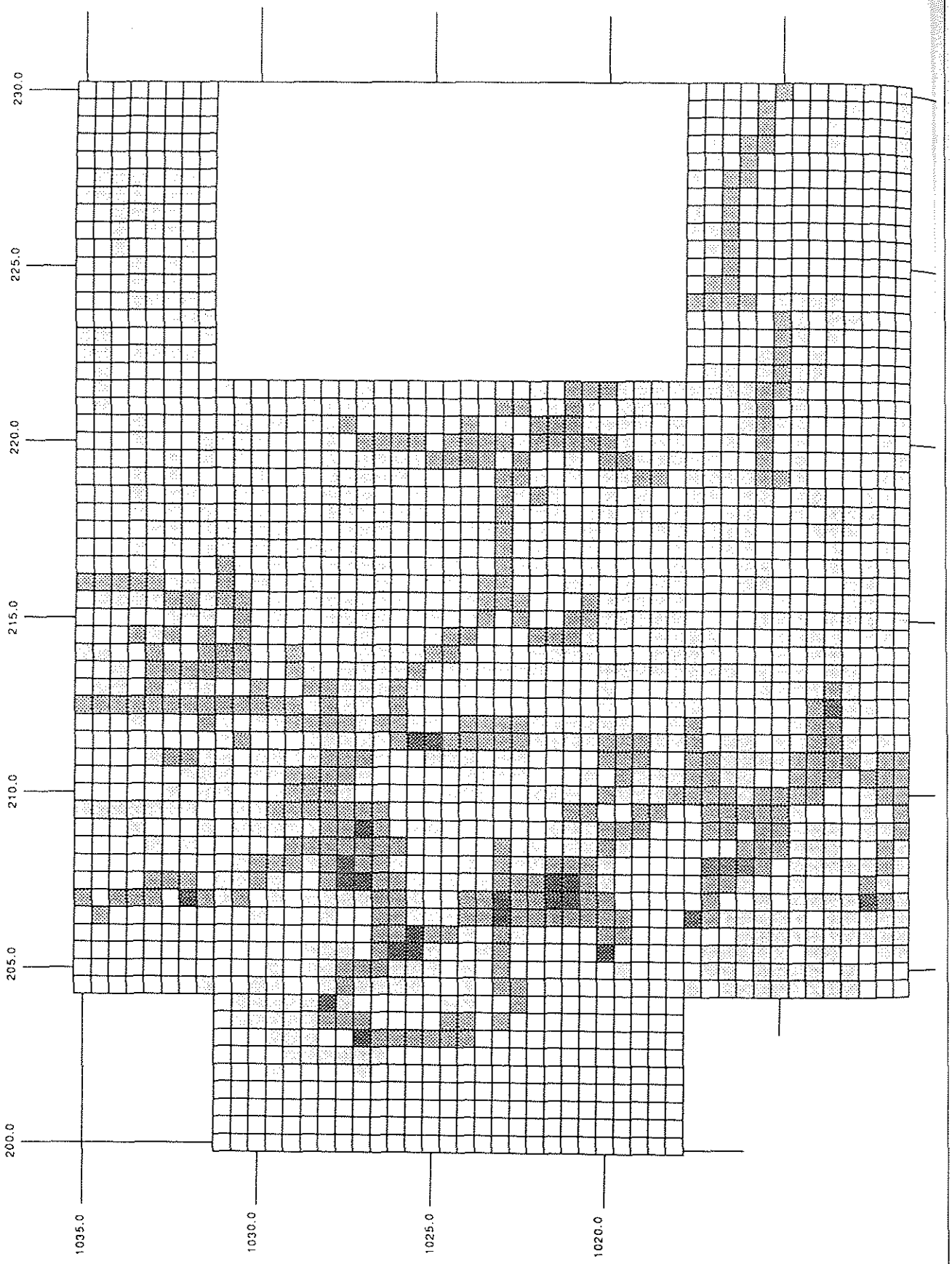


Figure C.2.12 Location of Villages and Road Network of Tafila

THE HASHEMITE KINGDOM OF JORDAN
FEASIBILITY STUDY ON AGRICULTURAL DEVELOPMENT FOR THE KARAK - TAFILA DEVELOPMENT REGION
JAPAN INTERNATIONAL COOPERATION AGENCY

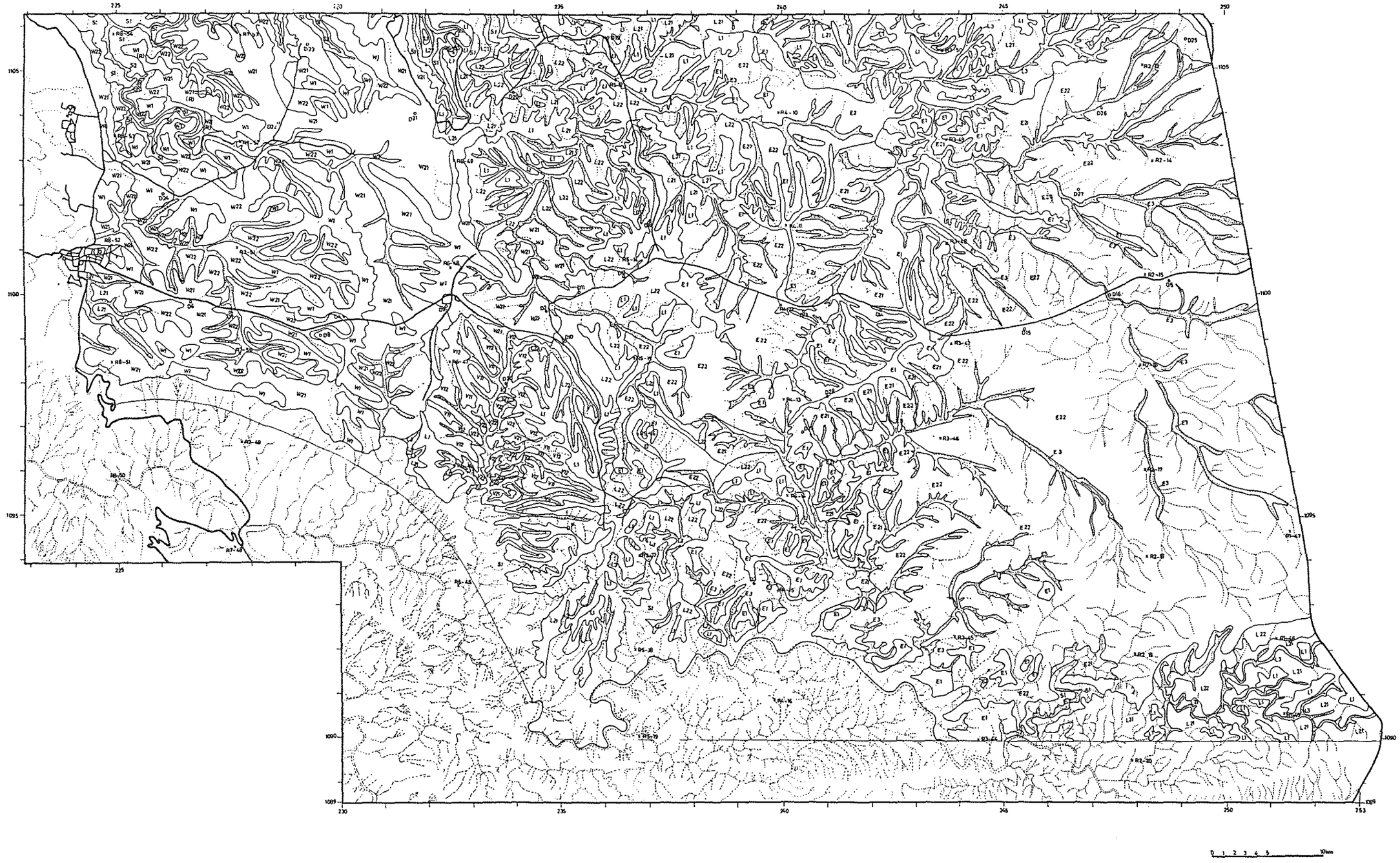


Figure C.3.1 Physiographic Soil Map of Dhiban

THE HASHEMITE KINGDOM OF JORDAN

FEASIBILITY STUDY ON AGRICULTURAL DEVELOPMENT FOR THE KARAK - TAFILA DEVELOPMENT REGION

JAPAN INTERNATIONAL COOPERATION AGENCY

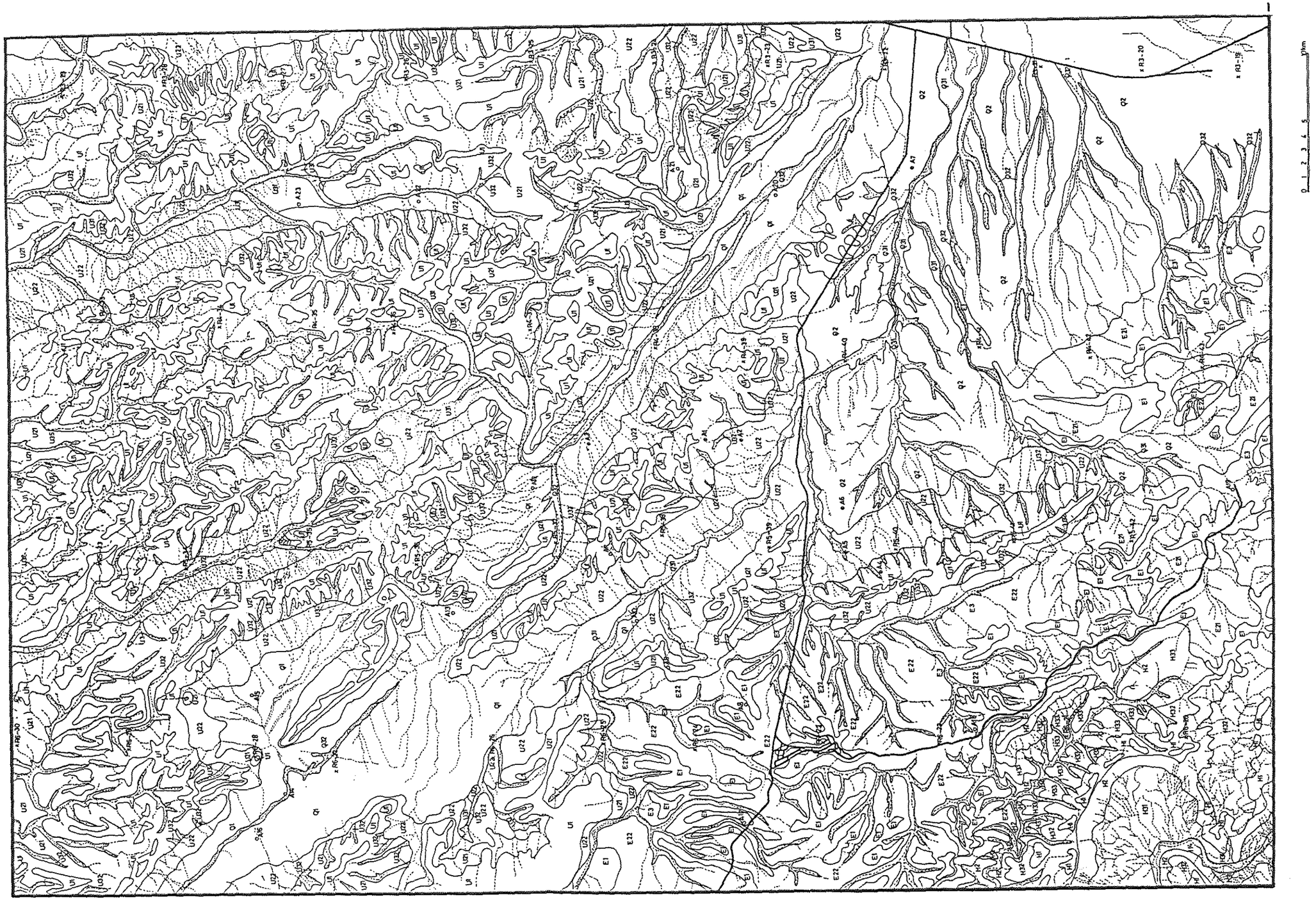


Figure C.3.2 Physiographic Soil Map of Abyad

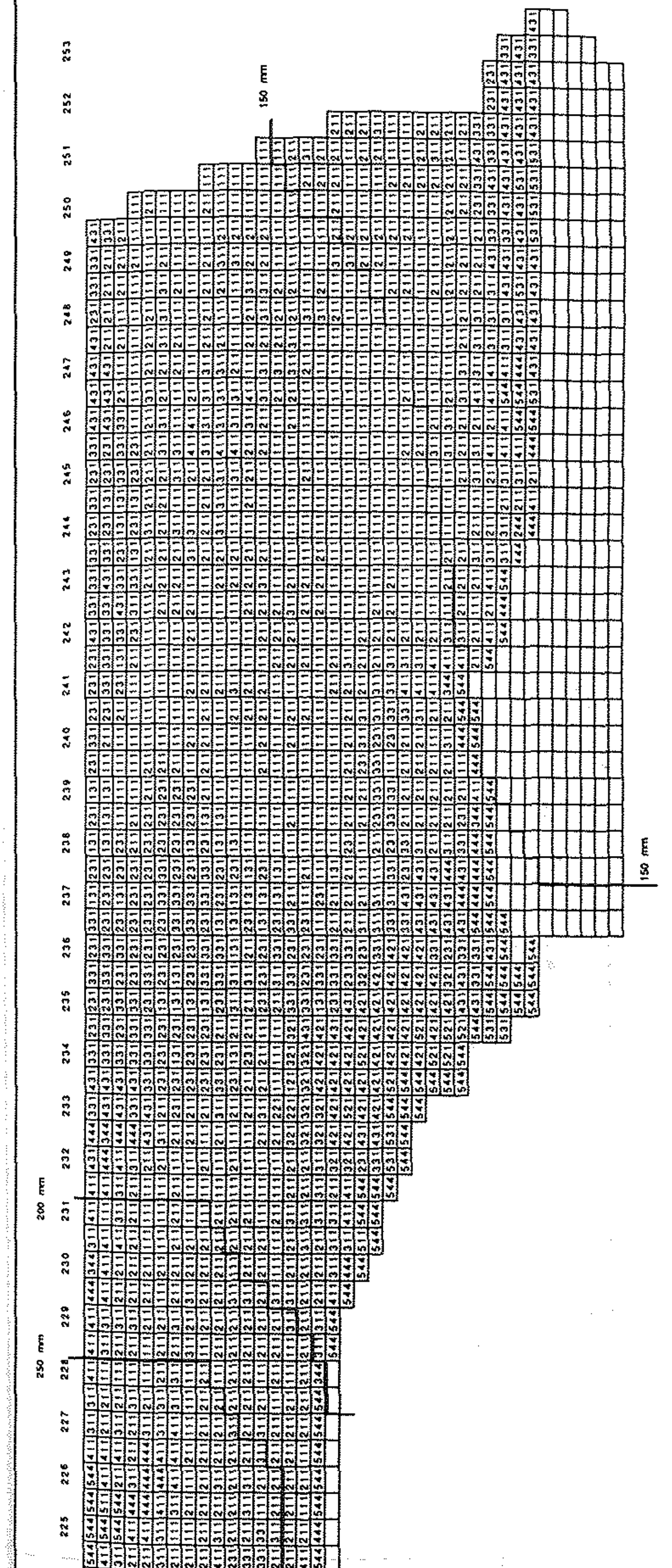
THE HASHEMITE KINGDOM OF JORDAN
FEASIBILITY STUDY ON AGRICULTURAL DEVELOPMENT FOR THE KARAK - TAFILA DEVELOPMENT REGION
JAPAN INTERNATIONAL COOPERATION AGENCY

Figure C.3.3 Physiographic Soil Map of Tafila

THE HASHEMITE KINGDOM OF JORDAN

FEASIBILITY STUDY ON AGRICULTURAL DEVELOPMENT FOR THE KARAK - TAFILA DEVELOPMENT REGION

JAPAN INTERNATIONAL COOPERATION AGENCY



RATING CRITERIA

TOPOGRAPHY
100: Flat to Almost Flat (0-4%)
200: Undulating (4-8%)
300: Rolling (8-12%)
400: Hilly (12-30%)
500: Mountainous (30% <)

SOIL DEPTH
10: Deep (100 cm <)
20: Deep to Moderately Deep (100-50 cm)
30: Moderately Deep (50-20 cm)
40: Shallow (20 cm >)

ROCKINESS
1: Non Rocky (0-10%)
2: Rocky (10-25%)
3: Very Rocky (25-50%)
4: Extremely Rocky (50% <)

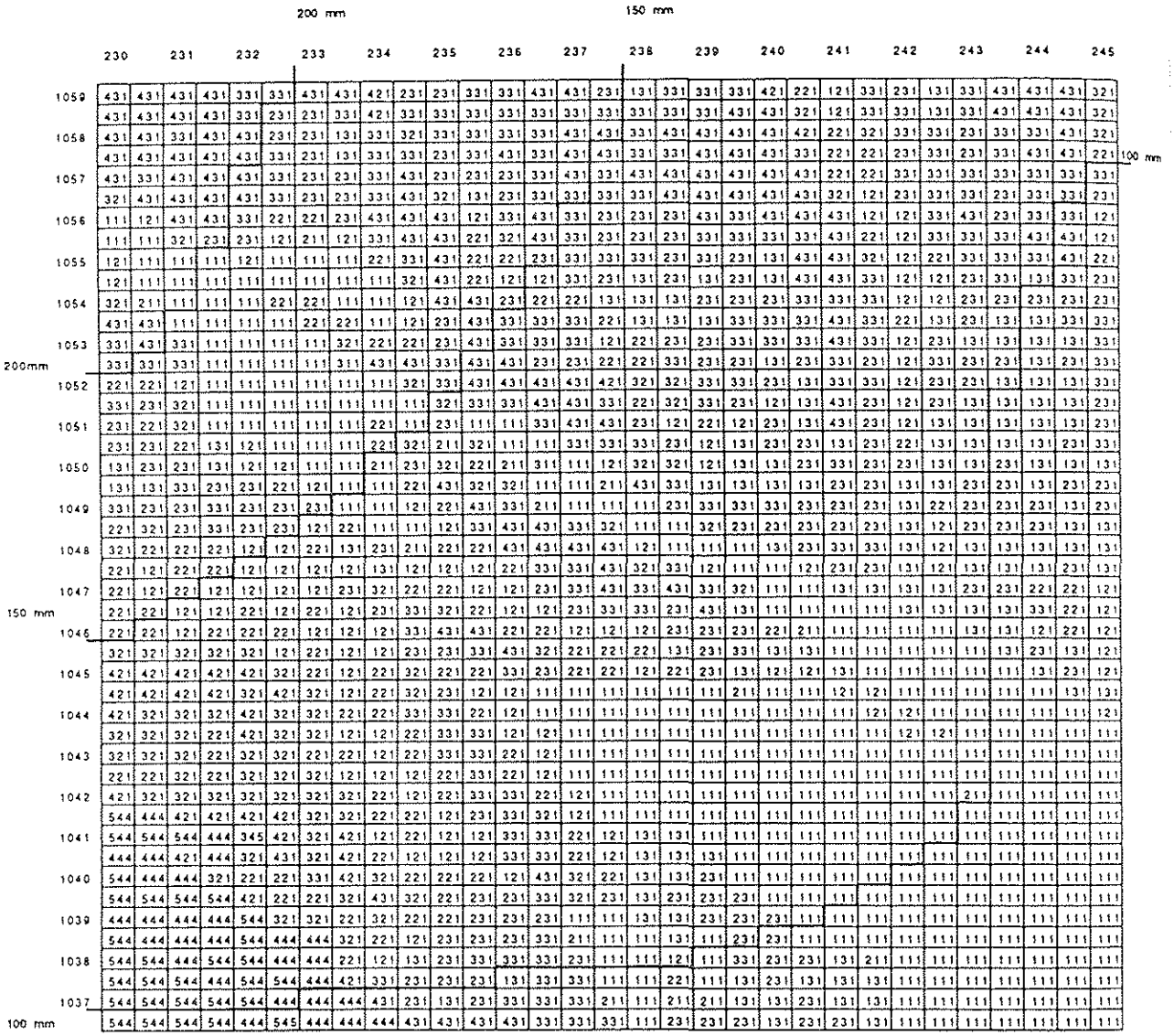
For example, 123 indicates the land class of (I) Flat to Almost Flat, (II) Deep to Moderately Deep Soils and (III) Very Rocky.

Figure C.3.4 Land Classification Map of Dhiban

THE HASHEMITE KINGDOM OF JORDAN

FEASIBILITY STUDY ON AGRICULTURAL DEVELOPMENT FOR THE KARAK - TAFILA DEVELOPMENT REGION

JAPAN INTERNATIONAL COOPERATION AGENCY



RATING CRITERIA

TOPOGRAPHY	SOIL DEPTH	ROCKINESS
100: Flat to Almost Flat (0-4%)	10: Deep (100 cm <)	1: Non Rocky (0-10%)
200: Undulating (4-8%)	20: Deep to Moderately Deep (100-50 cm)	2: Rocky (10-25%)
300: Rolling (8-12%)	30: Moderately Deep (50-20 cm)	3: Very Rocky (25-50%)
400: Hilly (12-30%)	40: Shallow (20 cm >)	4: Extremely Rocky (50% <)
500: Mountainos (30% <)		

For example, 123 indicates the land class of (i) Flat to Almost Flat, (ii) Deep to Moderately Deep Soils and (iii) Very Rocky.

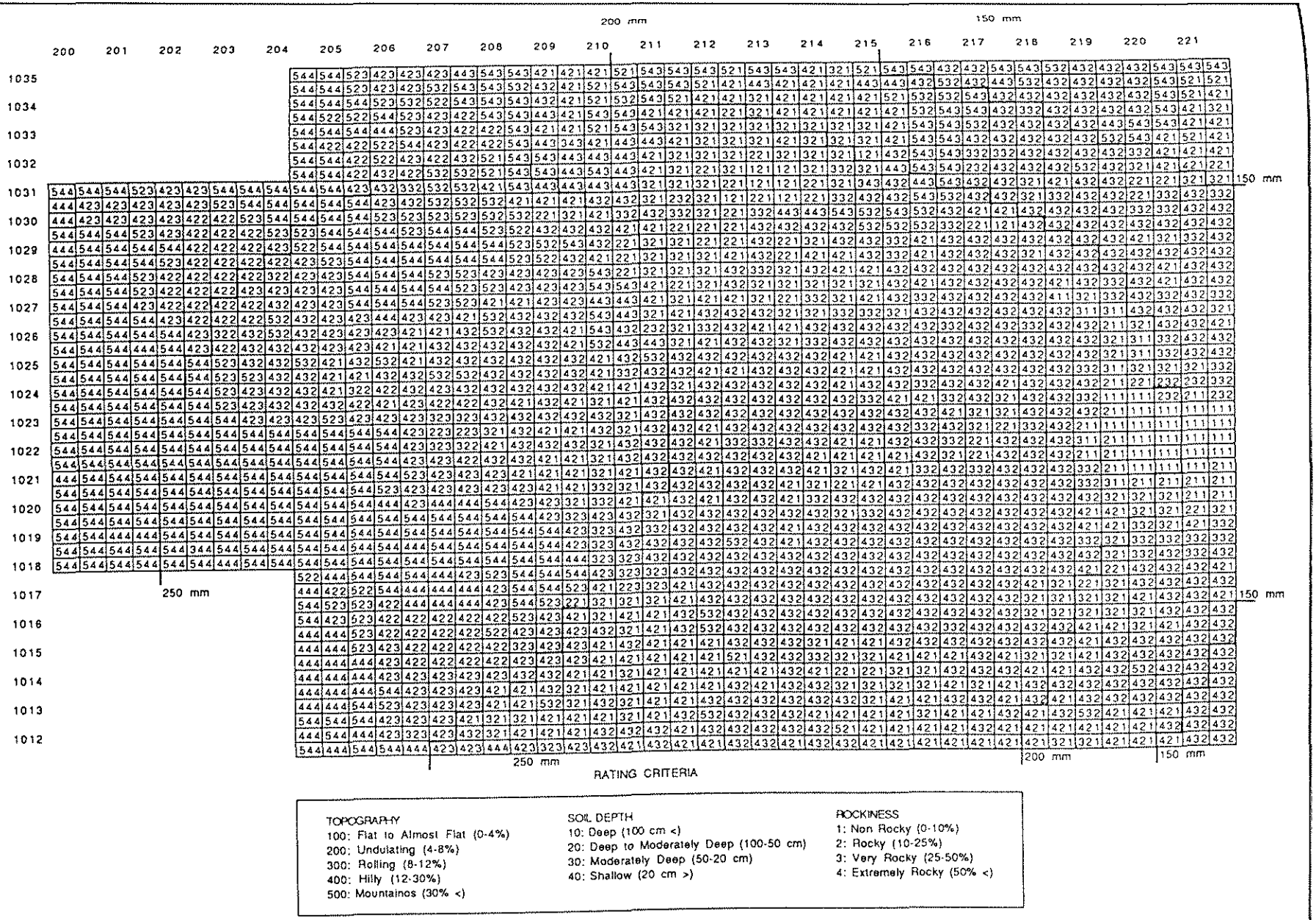
Figure C.3.5 Land Classification Map of Abyad

THE HASHEMITE KINGDOM OF JORDAN

FEASIBILITY STUDY ON AGRICULTURAL DEVELOPMENT FOR THE KARAK - TAFILA DEVELOPMENT REGION

JAPAN INTERNATIONAL COOPERATION AGENCY

Figure C.3.6 Land Classification Map of Tafila



THE HASHEMITE KINGDOM OF JORDAN
FEASIBILITY STUDY ON AGRICULTURAL DEVELOPMENT FOR THE KARAK - TAFILA DEVELOPMENT REGION
JAPAN INTERNATIONAL COOPERATION AGENCY

PROFILE DESCRIPTION (1)

GENERAL

Date	: 9th January, 1990	Climate :
Pedon No.	: D1-Dhiban	Author(s) : W. Sartawi, M. Koyama
Soil Classification	: Typic Calciorthid, clayey-skeletal, carbonatic	
Temperature Regime	: Thermic	
Moisture Regime	: Aridic, 150 mm - 200 mm	
Description Kind	: Profile pit	

SITE DESCRIPTION

Location	: 0.8 km west of Al-Rama	Elevation : El. 810 m amsl
Physiography	: Valley slope of Wadi Mujib System	Drainage :
Topography	: Hilly	
Slope		
- Slope Position	: Middle	
- Slope Shape	: Convex	
- Slope Value	: 18%	
- Slope Class	: E (moderately steep)	
Vegetation	: sparse cover of short grasses; Artemesia herba alba, Anabasis arbicnlata	
Land Use	: natural grazing	
Surface Conditions	: after rains, week crust	
Rock outcrops	: present on steep slopes and gully bottoms, < 10%	
Dominant Coarse Fragments	: gravels and cobbles of Cherts covering 20% of land surface	
Evidence of Erosion	: gully and sheet erosion	
Parent Materials	: colluvial deposits and soft limestones	
Human influence	: nil	

SOIL PROFILE DESCRIPTIONS

A 0 - 17 cm	Light yellowish brown (10YR6/4) dry, brown to dark brown (7.5YR4/4) moist; silty clay loam; weak to moderate fine subangular blocky, friable moist, slightly hard dry, slightly sticky and slightly plastic wet; evidence of many bilogical activities; many fine roots; common very fine tubular pores; moderately effervescent; clear wavy boundary;
Bca1 17 - 54 cm	Light brown (7.5YR6/4) dry, brown to dark brown (7.5YR4/4) moist; clay; moderate fine to medium subangular blocky; friable moist, hard dry, sticky and plastic wet; common fine roots; common fine to medium pores; fine distinct soft CaCO3; few small gravels (about 3% by volume); strongly effervescent; clear smooth boundry;
Bca2 54 - 100 cm +	Brown (7.5YR5/4) dry, strongly brown (7.5YR5/6) moist; clay; strongly fine to coarse subangular blocky; firm moist, hard dry, very sticky and very plastic wet; common fine roots; common fine pores; many fine to medium distinct soft CaCO3; few small gravels (about 5% by volume); strongly effervescent;

PHYSICAL AND CHEMICAL PROPERTIES

Soil Sample D1-1
Soil Sample D1-2
Soil Sample D1-3

PROFILE DESCRIPTION (2)

GENERAL

Date	: 9th January, 1990	Climate	:
Pedon No.	: D2-Dhiban	Author(s)	: W. Sartawi, M. Koyama
Soil Classification	: Typic Calciorthid, clayey-skeletal, carbonatic		
Temperature Regime	: Thermic		
Moisture Regime	: Aridic		
Description Kind	: Profile pit		

SITE DESCRIPTION

Location	: *1.0 km north of Jamail*	*Elevation*	: *El. 730 m amsl*
Physiography	: Middle slope of limestone plateau	Drainage	:
Topography	: Undulating		
Slope			
- Slope Position	: Middle		
- Slope Shape	: Concave		
- Slope Value	: 5%		
- Slope Class	: B (Gently sloping)		
Vegetation	: moderately covered by short grasses; Artemesia herba alba		
Land Use	: cereal crop production in winter		
Surface Conditions	: after rains, week crust		
Rock outcrops	: present, about 5%		
Dominant Coarse Fragments	: gravels and cobbles of Charts		
Evidence of Erosion	: gully erosion		
Parent Materials	: hard limestones		
Human influence	: *nil*		

SOIL PROFILE DESCRIPTIONS

PHYSICAL AND CHEMICAL PROPERTIES

Soil Sample D2-1
Soil Sample D2-2

PROFILE DESCRIPTION (3)

GENERAL

Date	: 9th January, 1990	Climate	:
Pedon No.	: D3-Dhiban	Author(s)	: W. Sartawi, M. Koyama
Soil Classification	: Typic Calciorthid, loamy, carbonatic		
Temperature Regime	: Thermic		
Moisture Regime	: Aridic		
Description Kind	: Profile pit		

SITE DESCRIPTION

Location	: 2.3 km south of Salia	Elevation	: El. 755 m amsl
Physiography	: Gently undulating plateau	Drainage	:
Topography	: Flat to gently undulating		
Slope			
- Slope Position	: Upper middle		
- Slope Shape	: Straight		
- Slope Value	: 4%		
- Slope Class	: B (Gently sloping)		
Vegetation	: Artemesia herba alba		
Land Use	: cereal crop production in winter, but left as fallow in considerable extent		
Surface Conditions	: after rains, week crust		
Rock outcrops	: nil		
Dominant Coarse Fragments	: nil		
Evidence of Erosion	: sheet erosion		
Parent Materials	: colluvial-alluvial deposits derived from soft limestones		
Human influence	: moderate		

SOIL PROFILE DESCRIPTIONS

A	0 - 8 cm	Very pale brown (10YR7/4) dry, strong brown (7.5YR5/6) moist; silty loam; weak very fine subangular blocky; soft dry, very friable moist, slightly sticky and slightly plastic wet; many fine roots; moderate reaction to HCl; abrupt wavy boundary;
B(w)	8 - 35 cm	Brownish yellow (10YR6/6) dry, storng brown (7.5YR5/6) moist; silty loam; strong medium to coarse subangular blocky; hard dry, firm moist, slightly sticky and slightely plastic wet; common fine roots; common fine to medium pores; fine distinct soft CaCO3 (about 2%); strong reaction to HCl; *clear wavy boundry;*
Bca	35 - 116 cm +	Brown (7.5YR5/4) dry, strongly brown (7.5YR5/6) moist; silty clay loam; strongly coarse subangular blocky; firm moist, hard dry, sticky and slightly plastic wet; presence of CaCO3 as white eye and shells in the layer; few fine pores; few fine roots; strongly effervescent;

PHYSICAL AND CHEMICAL PROPERTIES

Soil Sample D3-1
Soil Sample D3-2
Soil Sample D3-3

PROFILE DESCRIPTION (4)

GENERAL

Date	: 9th January, 1990	Climate	:
Pedon No.	: D4-Dhiban	Author(s)	: W. Sartawi, M. Koyama
Soil Classification	: Typic Calciorthid, silty, carbonatic		
Temperature Regime	: Thermic		
Moisture Regime	: Aridic		
Description Kind	: Spade hole		

SITE DESCRIPTION

Location	: 2.5 km west of Mushalfa	Elevation	: El. 780 m amsl
Physiography	: Summit of gently undulating plateau	Drainage	:
Topography	: Undulating		
Slope			
Slope Position	: Summit		
Slope Shape	: Straight		
Slope Value	: 1%		
Slope Class	: A (Flat)		
Vegetation	: *Artemesia herba alba*		
Land Use	: Fallow, cereal production in winter		
Surface Conditions	: after rains, week crust		
Rock outcrops	: nil		
Dominant Coarse Fragments	: nil		
Evidence of Erosion	: rill, sheet and wid erosion		
Parent Materials	: Soft limestones		
Human influence	: significant		

SOIL PROFILE DESCRIPTIONS

Ap	0 - 15 cm	Very pale brown (10YR7/4) dry, brown (7.5YR5/4) moist; loam; weak medium to fine subangular blocky; friable moist, soft dry, slightly sticky and *slightly plastic wet*; *common fine roots*; *common fine pores*; *moderate* effervescent; clear smooth boundary;
B(w)	15 - 58 cm	Light brown (7.5YR4/6) dry, brown (7.5YR5/4) moist; silty clay; strong fine subangular blocky; firm moist, hard dry, sticky and slightely plastic wet; common fine roots; common fine pores; moderate effervescent; gradual smooth boundry;
Bca	58 cm +	Brown (7.5YR5/4) dry, brown-dark brown (7.5YR4/4) moist; clay; strong meduam subangular blocky; very firm moist, hard dry, very sticky and very plastic wet; CaCO3 as a white eye (about 2%); few fine pores; few fine roots; strongly effervescent;

PROFILE DESCRIPTION (5)

GENERAL

Date	: 10th January, 1990	Climate :
Pedon No.	: D5-Dhiban	Author(s) : W. Sartawi, M. Koyama
Soil Classification	: Typic Calciorthid, loamy, carbonatic	
Temperature Regime	: Thermic	
Moisture Regime	: Aridic	
Description Kind	: Spade hole	

SITE DESCRIPTION

Location	: 1.7 km west of Desert Highway	Elevation : El. 740 m amsl
Physiography	: Desert	Drainage :
Topography	: Undulating	
Slope		
- Slope Position	: Middle	
- Slope Shape	: Straight	
- Slope Value	: 5%	
- Slope Class	: B (Gently sloping)	
Vegetation	: nil	
Land Use	: barren	
Surface Conditions	: after rains, week crust of 10 mm thick	
Rock outcrops	: nil	
Dominant Coarse Fragments	: gravels and cobbles covering 3% of land surface	
Evidence of Erosion	: rill and sheet erosion	
Parent Materials	: colluvial-alluvial deposits derived from soft limestones, eolian deposits	
Human influence	: nil	

SOIL PROFILE DESCRIPTIONS

A	0 - 5 cm	Reddish yellow (7.5YR6/6) dry, strong brown (7.5YR5/6) moist; silty loam; moderately platey to week fine subangular blocky; firm moist, strongly hard dry, non-sticky and non-plastic wet; many fine roots; common fine to medium pores; crust of 10 mm thick; present of 20% gravels; moderately effervescent; abrupt smooth boundary
Bca	5 - 30 cm	Reddish yellow (7.5YR6/6) dry, strong brown (7.5YR5/6) moist; silty loam; moderate fine to medium subangular blocky; firm moist, extremely hard dry, non-sticky and non-plastic wet; common fine pores; common coarse roots; strongly effervescent; presence of cobbles (Calshe of 5 cm in diameter); abrupt smooth boundry;
Bca	30 cm +	Soft limestones of slightly weathered, Calshe

PHYSICAL AND CHEMICAL PROPERTIES

Soil Sample D5-1
Soil Sample D5-2
Soil Sample D5-3

PROFILE DESCRIPTION (6)

GENERAL

Date	: 10th January, 1990	Climate	:
Pedon No.	: A1-Abyad	Author(s)	: W. Sartawi, M. Koyama
Soil Classification	: Rocky phase (USDA), Lithosols (FAO/Unesco)		
Temperature Regime	: Thermic		
Moisture Regime	: Aridic		
Description Kind	: Surface features		

SITE DESCRIPTION

Location	: 6 km ENE of Muhei	Elevation	: El. 930 m amsl
Physiography	: Limestone hills	Drainage	:
Topography	: Hilly		
Slope			
- Slope Position	: Middle		
- Slope Shape	: Convex		
- Slope Value	: 15%		
- Slope Class	: E (moderately steep)		
Vegetation	: barren		
Land Use	: natural grazing		
Surface Conditions	: dry		
Rock outcrops	: present, > 75%		
Dominant Coarse Fragments	: stones and cobbles covering > 80% of land surface		
Evidence of Erosion	: nil		
Parent Materials	: very cherty limestones, hard limestones with fossils		
Human influence	: nil		

SOIL PROFILE DESCRIPTIONS

PROFILE DESCRIPTION (7)

GENERAL

Date	: 10th January, 1990	Climate :
Pedon No.	: A2-Abyad	Author(s) : W. Sartawi, M. Koyama
Soil Classification	: Lithic Calciorthid, silty, carbonatic, Thermic, 1% slope	
Temperature Regime	: Thermic	
Moisture Regime	: Aridic	
Description Kind	: Profile pit	

SITE DESCRIPTION

Location	: 6 km ENE of Muhei	Elevation : El. 915 m amsl
Physiography	: Lower slope of limestone hill	Drainage :
Topography	: Flat	
Slope		
- Slope Position	: Middle	
- Slope Shape	: Straight	
- Slope Value	: 1%	
- Slope Class	: A (Flat or almost flat)	
Vegetation	: moderately covered by short grasses; Artemesia herba alba	
Land Use	: natural grazing	
Surface Conditions	: after rains	
Rock outcrops	: nil	
Dominant Coarse Fragments	: cobbles of stones of 2-15 cm diameter covering 30% of land surface	
Evidence of Erosion	: rill and sheet erosion	
Parent Materials	: very charty limestones	
Human influence	: nil	

SOIL PROFILE DESCRIPTIONS

A	0 - 12 cm	Brown (7.5YR5/4) dry, storng brown (7.5YR5/6) moist; silty loam; moderate very fine angular to subangular blocky; soft dry, very friable moist, slightly sticky and slightely plastic wet; common fine roots; common very fine to coarse pores; moderate reaction to HCl; clear smooth boundry;
Bca1	12 - 55 cm	Reddish yellow (7.5YR6/6) dry, storng brown (7.5YR5/6) moist; silty loam; moderate very fine subangular blocky; slightly dry, friable moist, slightly sticky and slightely plastic wet; few fine roots; many fine to medium pores; accumulation of soft CaCO3 (about 3%); evidence of biological activities; gravel fraction of angular shape (< 5%) cobbles (30%) ; strong reaction to HCl; abrupt smooth boundry;
Cca	55 cm +	Slightly weathered limestones overlying hard limestones

PHYSICAL AND CHEMICAL PROPERTIES

Soil Sample A2-1
Soil Sample A2-2

PROFILE DESCRIPTION (8)

GENERAL

Date	: 10th January, 1990	Climate :
Pedon No.	: A3-Abyad	Author(s) : W. Sartawi, M. Koyama
Soil Classification	: Typic Calciorthid, silty, carbonatic, Thermic, 1% slope	
Temperature Regime	: Thermic	
Moisture Regime	: Aridic	
Description Kind	: Profile pit	

SITE DESCRIPTION

Location	: 6.5 km NE of Muhei	Elevation : El. 908 m amsl
Physiography	: Wabi bottom	Drainage :
Topography	: Flat, irregular microrelief	
Slope		
- Slope Position	: Bottom	
- Slope Shape	: Straight	
- Slope Value	: 1%	
- Slope Class	: A (Flat or almost flat)	
Vegetation	: moderately covered by short grasses; Artemesia herba alba	
Land Use	: natural grazing	
Surface Conditions	: after rains, very week crust	
Rock outcrops	: nil	
Dominant Coarse Fragments	: cobbles, stones < 5%	
Evidence of Erosion	: sheet erosion	
Parent Materials	: hard limestones, colluvial-alluvial deposits	
Human influence	: moderate	

SOIL PROFILE DESCRIPTIONS

A 0 - 7 cm	Brown yellow (10YR6/6) dry, strong brown (7.5YR5/6) moist; clay; loam; weak very fine platety to subangular blocky; soft dry, friable moist, non-sticky and non-slightly plastic wet; common fine to coarse roots; many fine pores; strong reaction to HCl; presence of gravels (2%); abrupt wavy boundary;
Bca1 7 - 33 cm	Reddish yellow (7.5YR7/8) dry, storng brown (7.5YR5/6) moist; silty loam; weak fine subangular blocky; slightly hard dry, firm moist, slightly sticky and slightely plastic wet; common fine to coarse roots; common fine pores; very few fine distinct soft CaCO3 (about 2%); very few gravels (< 2%); strong reaction to HCl; clear wavy boundry;
Bca2 33 - 37 cm	Gravels layer with same color as Bca1, strong reaction to HCl
Bca3 37 - 100 cm +	Strong brown (7.5YR5/6) dry, strongly brown (7.5YR5/6) moist; silty loam; moderate to strong coarse subangular blocky; very firm moist, hard dry, sticky and slightly plastic wet; presence of soft CaCO3 (> 30%); few fine pores, common coating of CaCO3 in pores; strong reaction to HCl;

PHYSICAL AND CHEMICAL PROPERTIES

Soil Sample A3-1
Soil Sample A3-2
Soil Sample A3-4

PROFILE DESCRIPTION (9)

GENERAL

Date	: 11th January, 1990	Climate :
Pedon No.	: A4-Abyad	Author(s) : W. Sartawi, M. Koyama
Soil Classification	: Lithic Calciorthid, silty, carbonatic, Thermic, 14% slope	
Temperature Regime	: Thermic	
Moisture Regime	: Aridic	
Description Kind	: Auger hole	

SITE DESCRIPTION

Location	: 3.5 km east of Muhei	Elevation : El. 1,000 m amsl
Physiography	: Upper slope of limestone hill	Drainage :
Topography	: Hilly	
Slope		
Slope Position	: Upper	
Slope Shape	: Straight to convex	
Slope Value	: 14%	
Slope Class	: E (moderately steep)	
Vegetation	: Sparsely covered by Artemesia herba alba	
Land Use	: natural grazing	
Surface Conditions	: after rains	
Rock outcrops	: nil	
Dominant Coarse Fragments	: Cobbles and stones, > 50% of land surface	
Evidence of Erosion	: Sheet erosion	
Parent Materials	: Very cherty limestones, Calishe	
Human influence	: nil	

SOIL PROFILE DESCRIPTIONS

A	0 - 20 cm	Reddish yellow (7.5YR6/6) dry, strong brown (7.5YR5/6) moist; silty loam; platety (0-2 cm) and weak fine subangular blocky; friable moist, soft dry, slightly sticky and slightly plastic wet; many fine to medium roots; many fine pores; strongly effervescent; gradual smooth boundary;
Bca1	20 - 37 cm	Light brown (7.5YR4/6) dry, reddish brown (7.5YR6/6) moist; silty loamy; very weak fine subangular blocky; friable moist, soft dry, sticky and slightely plastic wet; few coarse roots; few fine pores; strong reaction to HCl; clear smooth boundry;
Bca	37 cm +	Hard pan of chert, calishe mixed, discontinuous layer strong meduam subangular blocky; very firm moist, hard dry, very sticky and very plastic wet; CaCO3 as a white eye (about 2%); few fine pores; few fine roots; strongly effervescent;

PROFILE DESCRIPTION (10)

GENERAL

Date	: 11th January, 1990	Climate :
Pedon No.	: A5-Abyad	Author(s) : W. Sartawi, M. Koyama
Soil Classification	: Typic Calciorthid, silty, carbonatic, Thermic, 2% slope	
Temperature Regime	: Thermic	
Moisture Regime	: Aridic	
Description Kind	: Profile pit	

SITE DESCRIPTION

Location	: 3.5 km east of Muhei	Elevation : El. 900 m amsl
Physiography	: Pediment of limestone hill	Drainage :
Topography	: Gentle slope	
Slope		
- Slope Position	: Middle to lower	
- Slope Shape	: Straight	
- Slope Value	: 2%	
- Slope Class	: A (Flat to almost flat)	
Vegetation	: nil	
Land Use	: Wheat, lentil	
Surface Conditions	: after rains, moderately developed crust	
Rock outcrops	: nil	
Dominant Coarse Fragments	: stones and cobbles covering > 30% of land surface	
Evidence of Erosion	: rill and sheet erosion	
Parent Materials	: colluvial-alluvial deposits derived from cherty limestones	
Human influence	: significant	

SOIL PROFILE DESCRIPTIONS

A 0 - 17 cm	Reddish yellow (7.5YR7/8) dry, strong brown (7.5YR5/6) moist; silty loam; moderately platey to weak fine subangular blocky; very friable moist, soft dry, non-sticky and non-plastic wet; many fine roots; common fine pores; crust of 10 mm thick; present of 3% gravels; moderate reaction to HCl; gradual smooth boundary
B(w) 17 - 37 cm	Reddish yellow (7.5YR6/6) dry, brown to dark brown (7.5YR4/4) moist; silty clay; weak to moderate medium subangular blocky; friable moist, slightly hard dry, slightly sticky and slightly plastic wet; common medium pores; common fine roots; strong reactio to HCl; secondary calcium accumulation; presence of few fine gravels (2%); clear wavy boundry;
B(ca) 37 - 70 cm +	Reddish yellow (7.5YR7/8) dry, brown to dark brown (7.5YR4/4) moist; silty loam; moderate medium subangular blocky; friable moist, slightly hard dry, slightly sticky and slightly plastic wet; common medium to coarse pores; few fine roots; strong reactio to HCl; secondary sofy CaCO3 accumulation (2%); clear wavy boundry;

PHYSICAL AND CHEMICAL PROPERTIES

Soil Sample A5-1
Soil Sample A5-2
Soil Sample A5-3

PROFILE DESCRIPTION (11)

GENERAL

Date	: 11th January, 1990	Climate :
Pedon No.	: A6-Abyad	Author(s) : W. Sartawi, M. Koyama
Soil Classification	: Typic Cambiorthid, silty, carbonatic, Thermic, 1% slope	
Temperature Regime	: Thermic	
Moisture Regime	: Aridic	
Description Kind	: Profile pit	

SITE DESCRIPTION

Location	: 3.5 km east of Muhei	Elevation : El. 900 m amsl
Physiography	: Wadi bottom	Drainage :
Topography	: Gently sloping	
Slope		
- Slope Position	: Bottom	
- Slope Shape	: Straight	
- Slope Value	: 1%	
- Slope Class	: A (Flat to almost flat)	
Vegetation	: nil	
Land Use	: Wheat, lentil	
Surface Conditions	: after rains, moderately developed crust	
Rock outcrops	: nil	
Dominant Coarse Fragments	: nil	
Evidence of Erosion	: rill and sheet erosion, active wind erosion	
Parent Materials	: colluvial-alluvial deposits derived from cherty limestones	
Human influence	: very significant	

SOIL PROFILE DESCRIPTIONS

A	0 - 16 cm	Brownish yellow (10YR6/6) dry, reddish yellow (7.5YR6/6) moist; silty loam; week platey to strong fine subangular blocky; very friable moist, soft dry, non-sticky and non-plastic wet; many fine to medium roots; many very fine pores; moderate reaction to HCl; abrupt smooth boundary;
B(w)	16 - 120 cm	Strong brown (7.5YR5/6) dry, brown to dark brown (7.5YR4/4) moist; silty loam; strong fine subangular blocky; firm moist, hard dry, non-sticky and non-plastic wet; common fine to medium pores; common fine to coarse roots; few small gravels (3%); evidence of biological activities;
Bca	120 cm +	Reddish yellow (7.5YR7/8) dry, brown to dark brown (7.5YR4/4) moist; A layer of stone chert, calishe

PHYSICAL AND CHEMICAL PROPERTIES

Soil Sample A6-1
Soil Sample A6-2

PROFILE DESCRIPTION (12)

GENERAL

Date	: 11th January, 1990	Climate :
Pedon No.	: A7-Abyad	Author(s) : W. Sartawi, M. Koyama
Soil Classification	: Typic Calciorthid, silty, carbonatic, Thermic, 1% slope	
Temperature Regime	: Thermic	
Moisture Regime	: Aridic	
Description Kind	: *Profile pit*	

SITE DESCRIPTION

Location	: 0.5 km east of railway roads	Elevation : El. 900 m amsl
Physiography	: Desert	Drainage :
Topography	: Flat to almost flat	
Slope		
- *Slope Position*	: -	
- Slope Shape	: Straight	
- Slope Value	: 1%	
- Slope Class	: A (Flat to almost flat)	
Vegetation	: nil	
Land Use	: Quarry site, road construction materials (hard limestones)	
Surface Conditions	: after rains, moderately to strongly developed crust	
Rock outcrops	: *nil*	
Dominant Coarse Fragments	: chert of flint angular shape covering land surface	
Evidence of Erosion	: rill and sheet erosion	
Parent Materials	: colluvial-alluvial deposits derived from cherty limestones	
Human influence	: significant	

SOIL PROFILE DESCRIPTIONS

A 0 - 23 cm	Reddish yellow (7.5YR7/8) dry, strong brown (7.5YR5/6) moist; silty loam; moderately platey to weak fine subangular blocky; very friable moist, soft dry, non-sticky and non-plastic wet; many fine roots; common fine pores; crust of 10 mm thick; present of 3% gravels; moderate reaction to HCl; gradual smooth boundary
B(w) *23 - 140 cm*	*Reddish yellow (7.5YR6/6) dry, brown to dark brown (7.5YR4/4) moist;* silty clay; weak to moderate medium subangular blocky; friable moist, slightly hard dry, slightly sticky and slightly plastic wet; common medium pores; common fine roots; strong reactio to HCl; secondary calcium accumulation; presence of few fine gravels (2%); clear wavy boundry;
B(ca) 140 - 190 cm +	Reddish yellow (7.5YR7/8) dry, brown to dark brown (7.5YR4/4) moist; *silty loam; moderate medium subangular blocky; friable moist, slightly hard* dry, slightly sticky and slightly plastic wet; common medium to coarse pores; few fine roots; strong reactio to HCl; secondary sofy CaCO3 accumulation (2%); clear wavy boundry;

PHYSICAL AND CHEMICAL PROPERTIES

Soil Sample A7-1
Soil Sample A7-2
Soil Sample A7-3

PROFILE DESCRIPTION (13)

GENERAL

Date	: 13th January, 1990	Climate :
Pedon No.	: T1-Tafila	Author(s) : W. Sartawi, M. Koyama
Soil Classification	: Typic Calciorthid, loamy, carbonatic, Xeric, 2% slope	
Temperature Regime	: Thermic	
Moisture Regime	: Xeric	
Description Kind	: Profile pit	

SITE DESCRIPTION

Location	: 3.5 km southeast of Alais	Elevation : El. 1,220 m amsl
Physiography	: Valley bottom	Drainage :
Topography	: undulating	
Slope		
- Slope Position	: lower	
- Slope Shape	: straight	
- Slope Value	: 2%	
- Slope Class	: A (Flat to almost flat)	
Vegetation	: moderately covered by short grasses; Artemesia herba alba	
Land Use	: Fallow after cereals or legumes	
Surface Conditions	: after rains, unploughed	
Rock outcrops	: nil	
Dominant Coarse Fragments	: stones and cobbles of cherts covering > 30% of land surface	
Evidence of Erosion	: rill and sheet erosion	
Parent Materials	: colluvial deposits derived from cherty limestones	
Human influence	: nil	

SOIL PROFILE DESCRIPTIONS

PROFILE DESCRIPTION (14)

GENERAL

Date	: 13th January, 1990	Climate :
Pedon No.	: T2-Tafila	Author(s) : W. Sartawi, M. Koyama
Soil Classification	: Typic Calciorthid, loamy, carbonatic,	Xeric, 25% slope
Temperature Regime	: Thermic	
Moisture Regime	: Xeric	
Description Kind	: Profile pit	

SITE DESCRIPTION

Location	: 2 km east of Twana	Elevation : El. 1,210 m amsl
Physiography	: Plateau	Drainage :
Topography	: Almost flat	
Slope		
- Slope Position	: lower	
- Slope Shape	: straight	
- Slope Value	: 2%	
- Slope Class	: A (Flat to almost flat)	
Vegetation	: moderately covered by short grasses; Artemesia herba alba and Atriplex hailiur	
Land Use	: Fallow after cereals or legumes	
Surface Conditions	: after rains, unploughed, weak crust	
Rock outcrops	: nil	
Dominant Coarse Fragments	: gravels and cobbles of cherts covering < 5%% of land surface	
Evidence of Erosion	: Sheet erosion	
Parent Materials	: Cherty limestones	
Human influence	: significant	

SOIL PROFILE DESCRIPTIONS

Ap 0 - 13 cm	Reddish yellow (7.5YR6/6) dry, storng brown (7.5YR5/6) moist; silty loam; weak very fine subangular blocky; soft dry, friable moist, non-sticky and non-plastic wet; common fine roots; common fine coarse pores; weathered basalt gravels < 5%; strong reaction to HCl; clear smooth boundry;
B(w) 13 - 50 cm	Reddish yellow (7.5YR6/6) dry, storng brown (7.5YR5/6) moist; silty loam; moderate fine subangular blocky; hard dry, firm moist, non-sticky and non-plastic wet; common fine to medium roots; common fine to medium pores; presence of gravels, cobbles of basalt and soft limestones > 5%; strong reaction to HCl; gradual smooth boundry;
Bca1 50 - 155 cm +	Reddish yellow (7.5YR6/6) dry, storng brown (7.5YR5/6) moist; silty clay loam; strong fine to coarse subangular blocky; exteremly hard dry, very firm moist, sticky and plastic wet; common fine roots; common fine to medium pores; strong reaction to HCl; soft accumulation of carbonate about 30%; presence of gravels of angular shape 10 - 15%;

PHYSICAL AND CHEMICAL PROPERTIES

Soil Sample T2-1
Soil Sample T2-2
Soil Sample T2-3

PROFILE DESCRIPTION (15)

GENERAL

Date	: 13th January, 1990	Climate	:
Pedon No.	: T3-Tafila	Author(s)	: W. Sartawi, M. Koyama
Soil Classification	: Typic Calciorthid, loamy, carbonatic, Xeric, 5% slope		
Temperature Regime	: Thermic		
Moisture Regime	: Xeric		
Description Kind	: *Profile pit*		

SITE DESCRIPTION

Location	: 3.5 km northeast of Alais	Elevation	: El. 1,210 m amsl
Physiography	: Summit of undulating plateau	Drainage	:
Topography	: Gently sloping		
Slope			
- Slope Position	: summit		
- Slope Shape	: straight		
- Slope Value	: 5%		
- Slope Class	: B (Gently sloping)		
Vegetation	: sparse cover by short grasses; Artemesia herba alba Centauren sp.		
Land Use	: Fallow after cereals or legumes		
Surface Conditions	: after rains, unploughed, weak crust		
Rock outcrops	: nil		
Dominant Coarse Fragments	: nil		
Evidence of Erosion	: Sheet erosion		
Parent Materials	: Cherty limestones		
Human influence	: significant		

SOIL PROFILE DESCRIPTIONS

Ap 0 - 14 cm	Reddish yellow (7.5YR6/6) dry, storng brown (7.5YR5/6) moist; loam; weak fine subangular blocky; soft dry, friable moist, slightly sticky and slightly plastic wet; many fine roots; many fine pores; moderate reaction to HCl; clear smooth boundry;
Bca1 14 - 42 cm	Strong brown (7.5YR5/6) dry and moist; clay loam; moderate fine subangular blocky; extremely hard dry, very firm moist, sticky and plastic wet; common fine to medium roots; common fine to medium pores; presence of gravels of chert 2%; accumu;lation of soft carbonate about 5%; strong reaction to HCl; gradual smooth
Bca2 42 cm +	Brown to dark brown (7.5YR4/4) dry and moist; clay loam; strong fine to coarse subangular blocky; exteremly hard dry, very firm moist, sticky and plastic wet; common fine to medium roots; few fine to medium pores; strong reaction to HCl; accumulation of soft carbonate about 30%; *presence of gravels of angular shape* 2%;

PHYSICAL AND CHEMICAL PROPERTIES

Soil Sample T3-1
Soil Sample T3-2
Soil Sample T3-3

PROFILE DESCRIPTION (16)

GENERAL

Date	: 13th January, 1990	Climate :
Pedon No.	: T4-Tafila	Author(s) : W. Sartawi, M. Koyama
Soil Classification	: Typic Calciorthid, loamy, carbonatic, Xeric, 2% slope	
Temperature Regime	: Thermic	
Moisture Regime	: Xeric	
Description Kind	: Profile pit	

SITE DESCRIPTION

Location	: 2.5 km west of Ainbida	Elevation : El. 1,460 m amsl
Physiography	: Summit of undulating plateau	Drainage :
Topography	: Gently sloping	
Slope		
- Slope Position	: summit	
- Slope Shape	: straight	
- Slope Value	: 2%	
- Slope Class	: A (Almost flat)	
Vegetation	: sparse cover by short grasses; Artemesia herba alba Centauren sp.	
Land Use	: Fallow after cereals or legumes	
Surface Conditions	: after rains, unploughed, weak crust	
Rock outcrops	: nil	
Dominant Coarse Fragments	: nil	
Evidence of Erosion	: Sheet erosion	
Parent Materials	: basalt and limestones	
Human influence	: significant	

SOIL PROFILE DESCRIPTIONS

Ap 0 - 32 cm	Brown (7.5YR5/4) dry, brown to dark brown (7.5YR5/6) moist; silty clay loam; weak fine subangular blocky; slightly hard dry, very friable moist, slightly sticky and non-plastic wet; many fine to coarse roots; many fine pores; strong reaction to HCl; clear smooth boundry;
Bca 32 - 45 cm	Strong brown (7.5YR5/6) dry and moist; clay ; moderate to strong subangular blocky; hard dry, firm moist, sticky and slightly plastic wet; common fine to coarse roots; many fine pores; presence of gravels,cobbles of weathered limestone; accumulation of soft carbonate (white eyes) frequent > 20%; strong reaction to HCl; abrupt smooth boundry;
Cca 45 cm +	Alternation of weathered basalt and limestones

PHYSICAL AND CHEMICAL PROPERTIES

Soil Sample T4-1
Soil Sample T4-2

PROFILE DESCRIPTION (17)

GENERAL

Date	: 11th January, 1990	Climate :
Pedon No.	: A5-Abyad	Author(s) : W. Sartawi, M. Koyama
Soil Classification	: Typic Calciorthid, silty, carbonatic, Thermic, 2% slope	
Temperature Regime	: Aridic	
Moisture Regime	: Thermic	
Description Kind	: Profile pit	

SITE DESCRIPTION

Location	: 3.5 km east of Muhei	Elevation : El. 900 m amsl
Physiography	: Pediment of limestone hill	Drainage :
Topography	: Gentle slope	
Slope		
- Slope Position	: Middle to lower	
- Slope Shape	: Straight	
- Slope Value	: 2%	
- Slope Class	: A (Flat to almost flat)	
Vegetation	: nil	
Land Use	: Wheat, lentil	
Surface Conditions	: after rains, moderately developed crust	
Rock outcrops	: nil	
Dominant Coarse Fragments	: stones and cobbles covering > 30% of land surface	
Evidence of Erosion	: rill and sheet erosion	
Parent Materials	: colluvial-alluvial deposits derived from cherty limestones	
Human influence	: significant	

SOIL PROFILE DESCRIPTIONS

Ap 0 - 30 cm	Brown (7.5YR5/3) dry, yellowish brown (7.5YR5/4) moist; silty clay loam; weak medium subangular blocky; soft dry, friable moist, sticky and plastic wet; many fine to medium roots; common fine pores; medium reaction to HCl; presence of gravels 3%; clear smooth boundry;
B(w)ca 30 - 80 cm +	Brown (7.5YR5/4) dry, brown to dark brown (7.5YR4/4) moist; clay loam; strong fine to coarse subangular blocky; hard to very hard dry, firm moist, very sticky and plastic wet; many fine roots; common moderate fine pores; accumulation of soft carbonate (white eyes) 2%; strong reaction to HCl; presence of gravels 5%;

PHYSICAL AND CHEMICAL PROPERTIES

Soil Sample T5-1
Soil Sample T5-1

RESULTS OF LABORATORY TESTS

Lab. No.	Location	Depth (cm)	pH(ext)	EC(ext)	CaCO3 %	OM	P ppm	K ppm	Sand %	Silt %	Clay %	Texture	Fe ppm	Zn ppm	Cu ppm	Mn ppm
900316	A 2	0 - 12	7.7	1.0	26.6	1.97	10.0	350	31.20	37.81	30.99	Clay Loam	3.2	0.42	1.0	3.0
900317	A 2	12 - 30	7.8	3.4	29.4		2.7	190	24.14	37.92	37.93	Clay Loam	3.4	0.22	1.2	1.6
900318	A 3	0 - 7	7.8	0.7	29.7	1.67	15.0	320	31.50	37.70	30.80	Clay Loam	3.0	0.44	1.0	2.0
900319	A 3	7 - 33	7.9	1.1	28.0		6.0	260	24.40	41.24	34.36	Clay Loam	3.0	0.42	1.4	1.9
900320	A 3	33 - 100	7.4	13.2	30.4		10.0	80	16.00	31.50	52.50	Clay	3.0	0.52	0.8	1.0
900321	A 5	0 - 7	8.0	0.8	23.8	2.20	11.0	330	27.34	51.90	20.76	Silty Loam	2.0	0.80	1.1	2.4
900322	A 5	7 - 37	7.8	4.1	22.7		4.5	130	23.88	41.52	34.60	Clay Loam	3.8	0.40	1.0	2.6
900323	A 5	37 - 70	7.7	6.7	20.3		19.0	140	17.30	43.97	38.73	Silty Clay Loam	3.0	0.51	1.0	1.8
900324	A 6	0 - 16	8.0	0.6	21.0	0.17	8.5	300	25.30	39.12	35.58	Clay Loam	1.6	0.36	1.0	1.4
900325	A 6	16 - 120	7.3	14.5	26.2		6.0	110	23.35	31.36	45.29	Clay	3.0	0.38	1.0	1.2
900326	A 7	0 - 23	8.0	1.0	21.0	0.90	7.0	310	33.10	35.30	31.60	Clay Loam	3.0	0.42	1.0	1.2
900327	A 7	23 - 140	8.0	1.2	34.0		17.5	130	23.35	41.81	34.84	Clay Loam	3.0	0.50	1.0	3.4
900328	A 7	140 - 190	7.7	3.6	30.4		16.0	90	17.53	34.36	48.10	Clay	3.2	0.42	0.8	2.0
900329	D 1	0 - 17	7.7	0.5	19.6	3.80	7.5	280	25.99	40.71	33.30	Clay Loam	3.8	0.68	1.2	1.8
900330	D 1	17 - 54	8.0	0.7	22.8		4.0	160	15.76	35.10	49.14	Clay	3.4	0.51	1.0	1.4
900331	D 1	54 - 100	7.6	5.0	29.8		5.5	100	31.80	33.80	34.40	Clay Loam	3.2	0.42	1.4	3.4
900332	D 2	0 - 20	8.0	0.4	25.5		5.0	190					4.2	0.22	1.2	3.4
900333	D 2	20 - 58	8.0	1.5	28.7	1.70	4.0	180					4.2	0.36	1.2	2.6
900334	D 3	0 - 8	7.7	0.5	22.7	3.70	7.5	580	19.02	45.77	35.21	Silty Clay Loam	3.2	0.62	1.2	3.2
900335	D 3	8 - 30	7.8	0.5	27.6		8.0	360	8.29	38.80	52.91	Clay	4.0	0.68	1.4	3.8
900336	D 3	30 - 116	7.5	1.0	33.2		10.0	140	14.60	32.02	53.38	Clay	3.0	0.38	1.0	1.8
900337	D 5	0 - 5	8.0	6.0	25.5	1.25	46.0	880	5.11	32.85	62.04	Clay	3.2	0.70	1.0	3.0
900338	D 5	5 - 30	7.3	25.0	28.7		26.0	570	29.83	38.60	31.57	Clay Loam	2.2	1.00	1.2	2.0
900339	D 5	30 -	7.2	20.5	22.7		9.0	70	23.08	38.46	38.46	Clay Loam	3.8	1.20	2.2	4.8
900340	T 2	0 - 13	7.9	0.6	27.6	1.62	15.0	310	21.43	42.86	35.71	Clay Loam	2.4	0.42	1.4	2.4
900341	T 2	13 - 50	7.9	0.3	33.2		40.0	140	16.67	34.72	48.61	Clay	3.0	0.32	2.0	1.4
900342	T 2	50 - 115	7.7	3.0	30.1		2.5	150	23.92	43.48	32.60	Clay Loam	3.0	0.40	1.8	1.0
900343	T 3	0 - 14	7.8	0.4	44.4	1.57	7.5	260	28.58	39.28	32.14	Clay Loam	3.0	0.38	1.2	1.0
900344	T 3	14 - 42	7.9	0.2	26.9		4.0	160					3.0	0.50	1.3	1.8
900345	T 3	42 - 110	7.7	0.3	31.5		3.9	145					4.2	0.40	1.2	2.6
900346	T 4	0 - 32	7.7	0.4	19.9	1.82	10.0	240					4.2	0.38	1.4	1.0
900347	T 4	32 -	7.7	0.3	23.4		5.0	160					3.2	0.38	1.4	1.0

Laboratory: NCARTT