NEAR EAST AND NORTH AFRICA DIVISION

Syrian Arab Republic: Thematic study on land reclamation through de-rocking

Enabling poor rural people to overcome poverty

IFAD

Syrian Arab Republic: Thematic study on land reclamation through de-rocking

Southern Regional Agricultural Development Project (SRADP)
Jebel al Hoss Agricultural Development Project (JHADP)
Coastal/Midlands Agricultural Development Project (CMADP)
Idleb Rural Development Project (IRDP)

Near East and North Africa Division
Programme management department

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Currency equivalent

July 2007

Currency unit	=	Syrian pound (SYP)
US$1.00	=	SYP 51.50
SYP 1.00	=	US$0.0194

Weights and measures

1 kilogram (kg)	=	2.204 pounds (lb)
1,000 kg	=	1 ton (t)
1 kilometre (km)	=	0.62 mile
1 metre (m)	=	1.09 yards
1 square metre (m^2)	=	10.76 square feet
1 acre (ac)	=	0.405 hectare (ha)
1 ha	=	2.47 ac
1 dunum (du)	=	0.1 ha

Abbreviations and acronyms

ACSAD	Arab Center for the Studies of Arid Zones and Dry Lands
AEU	agricultural extension unit
ASZ	agricultural settlement (stabilization) zone
BRDP	Badia Rangelands Development Project
CAB	Agricultural Cooperative Bank
CMADP	Coastal/Midlands Agricultural Development Project
CPE	country programme evaluation
DAE	Directorate of Agricultural Extension, MAAR
FAO	Food and Agriculture Organization of the United Nations
GCSAR	General Commission for Scientific Agricultural Research, MAAR
GIS	geographical information system
GTZ	*Deutsche Gesellschaft für Technische Zusammenarbeit* (German Agency for Technical Cooperation)
GUP	General Union of Peasants
HP	horsepower
ICARDA	International Center for Agricultural Research in the Dry Areas
IRDP	Idleb Rural Development Project
JHADP	Jebel al Hoss Agricultural Development Project
KfW	*Kreditanstalt für Wiederaufbau* (German Government-owned development bank)
MAAR	Ministry of Agriculture and Agrarian Reform
M&E	monitoring and evaluation
NAPC	National Agricultural Policy Center, MAAR
NENA	Near East and North Africa
NFTP	National Fruit Tree Project
SAC	Supreme Agricultural Council
SCGIM	strategy-cum-general-identification mission
SRADP	Southern Regional Agricultural Development Project
TAG	technical assistance grant
UNDP	United Nations Development Programme
USDA	United States Department of Agriculture

I. Introduction

Context and background

IFAD's first intervention in the Syrian Arab Republic took place in 1982, with the first phase of the Southern Regional Agricultural Development Project (SRADP-I), which was cofinanced with the World Bank. To date, IFAD has supported a total of seven projects in the country, investing a sum of US$126.2 million in loans for projects with a total value of US$474.0 million. These are SRADP-I and II, the Jebel al Hoss Agricultural Development Project (JHADP), Coastal/Midlands Agricultural Development Project (CMADP), Badia Rangelands Development Project (BRDP), Idleb Rural Development Project (IRDP), and North-Eastern Region Rural Development Project (NERRDP) (see map 1 in appendix 1 and IFAD appraisal reports for each project [IFAD 1987-2006]).

Land reclamation through the removal of surface and subsurface rocks and stones by heavy equipment, known as 'de-rocking', was the main intervention funded in five of the seven projects. IFAD's objective was to assist the Government of the Syrian Arab Republic in enabling poor rural people to improve their incomes and living conditions. The organization helped poor farmers develop rainfed agriculture and manage natural resources more effectively, and promoted off-farm income-generating activities. Investments were directed towards expanding cultivable areas and increasing production through land reclamation, particularly through the de-rocking of areas with high potential for agriculture. Complementary activities such as adaptive research, extension and marketing were supported to improve productivity and increase farmers' earnings. Interventions for rural women also addressed the need to increase household incomes. By the end of the Idleb Rural Development Project over 200,000 hectares (ha) of land will have been de-rocked. This is almost half the total area of uncultivated land reclaimed through de-rocking. About 80 per cent of the de-rocked land has been planted with fruit trees – mostly concentrated in agricultural settlement zones (ASZs) 1 and 2.[1] The Ministry of Agriculture and Agrarian Reform (MAAR) has been responsible for carrying out nearly all land development operations, using large fleets of heavy earth-moving equipment.

IFAD's strategy clearly conforms to the thrust of the Government's agriculture-sector strategy. It supports de-rocking as an efficient mechanism for expanding cultivable land in ASZs 1 and 2, thus increasing production and productivity. The Government first introduced large-scale land reclamation in 1977 through the National Fruit Tree Project (NFTP), which is still an ongoing activity combined with the Ali Al Ali Fruit-Tree Planting Project (often referred to simply as the Ali Al Ali Project) launched in 1986 and funded by a loan from *Kreditanstalt für Wiederaufbau* (KfW) in six *mohafazat* (governorates).[2] A large proportion of the land reclaimed through de-rocking is located in ASZs 1 and 2 (maps 2 and 3 in appendix 1). These zones show a substantial increase in arable area of smallholdings, sometimes effectively more than doubling the size, through the application of well-tested de-rocking techniques successfully applied under completed and ongoing IFAD-funded projects.

The total area of land reclaimed with IFAD design and cofinancing support is large enough (>180,000 ha) to make a significant contribution to the Government's objective of increasing production and food security. Given the experience and expertise now present in the country, the large

1/ For policy and planning purposes, Syrian territory is divided into five major agricultural settlement zones, discussed in section II.

2/ Lattakia, Tartous, Hama, Homs, Aleppo and rural Damascus (see maps 1 and 2 in appendix 1).

fleet of heavy equipment, and the spatial distribution of the total land area reclaimed, IFAD-supported projects with land reclamation as a core activity can no longer be justified. However, after 18 years of reclamation interventions, both IFAD and the Government have expressed a need to assess the results and impact and draw lessons learned from this positive experience. In August 2001 IFAD's Office of Evaluation conducted a country programme evaluation (CPE) of this major intervention.

The CPE concluded that in terms of government objectives of increasing agricultural production in rainfed areas and halting migration to the towns, de-rocking has been an unqualified success. It is difficult to conceive of an investment in agriculture that could have had such a dramatic effect – possibly on a par with providing irrigation to dry areas. This intervention has directly brought multiple benefits to small farmers, and has undoubtedly helped reduce the poverty of many. Particular benefits were derived on small farms, where farmers went from being extremely poor workers and employees in neighbouring areas or in other sectors (both within the country and abroad) to active farmers residing on their own land with respectable incomes. Orchards have been established on some 60 per cent of the de-rocked land, which has substantially enhanced fruit production and improved the balance between annual trees and tree cropping. Nevertheless, the evaluation mission expressed a number of concerns about impact on the environment from ongoing IFAD-financed land development projects.

Regarding technical aspects, the CPE mission concluded[3] that while land development permits more efficient ploughing and seedbed preparation, as well as increasing water infiltration and retention, the process of de-rocking may also encourage some negative changes in soil quality, hydrological and erosion processes,[4] and subsequent impact on soil moisture regimes. It reported that rocks were reappearing in fields in some physiographic situations. The mission assumed that this phenomenon was the result of loss of topsoil, implying the occurrence of erosion, especially on sloping terrain. It found that environmental issues, including assessment and mitigation of possible undesirable environmental impacts, were given insufficient attention in the design and implementation of IFAD's project portfolio. It was concerned about the long-term sustainability of the flow of benefits to targeted farmers. Given the increased exposure to erosive elements, the CPE report recommended a strategy that would ensure long-term production from de-rocked areas: instigation of soil conservation measures; rehabilitation of some previously de-rocked areas; promotion of a different cropping calendar; and assistance in marketing and processing.

The following key environmental recommendations of the CPE were adopted in the agreement at completion point:

(a) Support for land reclamation through de-rocking should be preceded by a full-scale location-specific environmental assessment (EA), and environmental monitoring during implementation should be an integral part of future interventions.

(b) There is a need to assess environmental impacts of de-rocking and address any problems.

(c) MAAR is to undertake this assessment through a multidisciplinary team formed specifically for the purpose.

(d) IFAD should consider assisting this team in undertaking its assigned tasks and providing training and support as required.

3/ IFAD (2001), page xxxv, paragraph 59.

4/ The CPE mission suspected that the de-rocking process may:
- encourage accelerated surface erosion and possible changes to hydrogeology as a result of alterations in run-off patterns;
- lead to degradation of some fragile soils as evidenced on the hillsides of Sweida, Quneitra and Jabel al Hoss. Without remedial action, the significant benefits captured from land reclamation may not be considered permanent;
- lead to other changes, such as alteration to floral habitat and reduction in the variety of natural fauna, although such changes and associated impacts are unknown, as they were not assessed;
- have longer-term impacts, including more-intensified land use and increased population density. Although judged to be beneficial, the extent and impact of land development will remain unknown unless immediate action is taken to establish a monitoring mechanism;
- result in a permanent alteration of the visual landscape, including piles of stones and rows of rocks that cover 5 to 30 per cent of the surface area of cleared areas.

In respect of the above recommendations, in July 2002 IFAD commissioned an environmental assessment mission to assist the Government in evaluating the environmental effects resulting from interventions proposed in another poverty reduction/land reclamation and development project in Idleb Governorate (IRDP). Probable effects were carefully considered before, during and after implementation. The primary objective of the EA was to gauge the overall impact on the environment of the planned change in land use and the emergence of new farming systems: first, from land-clearing operations and the use of heavy earth-moving equipment; second, from land development and the establishment of new production systems; and third, after the farming systems reached maturity. The Idleb EA mission clearly identified the potential environmental impacts and proposed precise and feasible mitigation measures that were incorporated into project design.

Regarding the third CPE recommendation, MAAR undertook an assessment of the environmental impacts of de-rocking, working with a multi-disciplinary team. The study was carried out in 2005 with backstopping from the Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD) through a study contract with CMADP. This countrywide study provided more precise information and assessment of the results and impact of the de-rocking interventions carried out by all land reclamation projects, including the four IFAD-cofinanced ones.

Rationale and objectives

The evaluation studies show that IFAD-cofinanced projects focusing on land reclamation accord with the IFAD Strategic Framework 2007-2010 (IFAD 2007a). Among other things, the IFAD strategy aims to ensure that poor rural people have better access to land and water and develop improved natural resource management and conservation practices. Sharing knowledge on rural poverty eradication is one of its five key elements. It is in line with this Framework that IFAD's Near East and North Africa (NENA) Division fielded a mission[5] to undertake the present thematic study on land reclamation through de-rocking in the Syrian Arab Republic.

The objectives of the mission were (i) to contribute to implementation of the Strategic Framework through publication of a thematic study on land reclamation; and (ii) to identify project elements in the framework of pipeline development for future collaboration between IFAD and the Government.

Methodology and approach

To meet the objectives of the thematic study, the mission combined various sources of information and adopted the following approaches:

(a) **Desk review of literature and project documents**. The land area, especially in ASZs 1 and 2, had been subject to soil and land evaluation surveys and various resource management and environmental studies. Unfortunately, the documentation was hard to locate, and much of the area experience, indigenous knowledge and lessons from various projects are conserved only in the memory of senior members of the local community and project technical staff. As was demonstrated recently in the mid-term review of a technical assistance grant (TAG) programme in the Syrian Arab Republic and Morocco[6] – coordinated and managed by the International Fertilizer Development Center (IFDC) – there is an urgent need for collaborative efforts to establish a national information and knowledge management system for soils,

5/ The mission, composed of Abdelaziz Merzouk, mission leader, and Mohamed Lakhdar Jemali, irrigation engineer, visited Syria from 3 to 16 July 2007. Within the country, the mission was assisted by Basel Tello, land reclamation specialist, and Nabil Mahaini, development communication specialist and IFAD proxy field representative. Abdelhamid Abdouli, Country Programme Manager, guided the mission, participated in many meetings and accompanied the mission team on field visits.

6/ IFAD TAG 656 – Programme for the Development and Implementation of an Information and Decision Support System for Cereal Production in the NENA Region – with country case studies in the Syrian Arab Republic and Morocco (IFAD 2007b).

land suitability and reclamation. The literature review extended to IFAD-financed projects with land reclamation interventions in other NENA countries, such as the Rural Development Project for Taourirt-Taforalt in Morocco (IFAD loan 437 MA, MADRPM/ DPA-O 2005) and various experiences in other regions (Wolff, P. 1990).

(b) **Meetings with relevant staff of the IFAD-supported projects** (SRADP-II, CMADP, JHADP and IRDP). Meetings were held as well with staff of the Ali Al Ali Project, National Fruit Tree Project and other stakeholders.

(c) **Field visits and meetings with target groups**. The mission visited project areas in the southern coastal, midlands, Idleb and Jebel al Hoss areas. Field visits were organized for each project area, and the mission was accompanied by senior, experienced field staff from project management units and field units, as well as by extension agents. The mission made on-site and on-route observations. Discussions centred on targeting, technical aspects of de-rocking, and results and impact. Appendix 4 illustrates the itinerary. The mission focused on possible environmental impacts of land reclamation. The assistance of accompanying staff members aided the gathering of farmers' perceptions and opinions when possible. Digital photographic documentation was assembled to contribute to illustrating the thematic study and to knowledge management.

Through field comparison of rocky with de-rocked land (with and without a project), the mission assessed the following:

(a) environmental impact: long-term benefits and risks in relation to soil and water conservation;
(b) complementary activities required to meet the environmental and economic objectives of de-rocking, including supplementary irrigation, crop and livestock integration, and extension services;
(c) economic impact in relation to agricultural production and household income diversification;
(d) the extent to which de-rocking has succeeded in decreasing rural poverty;
(e) prerequisites of a successful de-rocking programme;
(f) sustainability of de-rocking operations at the farm level in rainfed areas; and
(g) optimum valorization of land reclamation.

II. Resources, policy, institutional context and achievement

Physiographic profile and land resources

The Syrian Arab Republic lies in the heart of the Middle East, covering a land area of 185,180 km^2, and in 2006 supported a population of some 19.5 million. The country is divided into 14 governorates or *mohafazat* and 60 districts or *manatiq*, which are further divided into subdistricts, or *nawahi* (map 2 in appendix 1).

Syria's geomorphology presents four main regions with distinct natural resource bases, constraints and suitability for agricultural development (map 3 in appendix 1).

(a) The coastal region extends north to south along the Mediterranean coast, between the mountains and the sea.

(b) The mountainous region includes the mountains and hills that run north to south along the Mediterranean. Map 3 shows the two major mountain ranges, one located mainly along the coast in the western part of the country, with altitudes of 1,300-1,800 metres (m), and the other extending south-west to north-east through the Badia, with altitudes of 900-2,700 m. Altitude plays an important role in vegetation climax.

(c) The interior region includes the Aleppo plateau and the plains of Damascus, Homs, Al Hassakeh and Daraa'a, and is located to the east of the mountainous region.

(d) The Badia is the desert plain in the south-eastern part of the country along the Jordanian and Iraqi borders.

Surface water consists of the broad Euphrates River in the east, with its Al Khabour and Al Baleakh tributaries and Lake al-Assad, and a number of small rivers and lakes in the western part of the country (Quiak, Efrean, El Sin, El Kebir El Shamali, El Kebrir El Janubi, Orantes, Barada, Al Awaj and Yarmuk Rivers and Qatene Lake) – and in the far east, there is the cross boundary Dajle River (map 3). The smaller rivers are mostly spring-fed and show strong seasonality, sometimes with ephemeral characteristics. There is a strong interaction between groundwater levels and spring flow, as indicated by dwindling flows associated with increased groundwater extraction, such as the recent disturbance of the Khabour River and the flow of its upstream springs.

The climate is Mediterranean with continental influence: cool rainy winters and warm dry summers, with relatively short spring and autumn seasons. Rainfall is concentrated between October and May and diminishes sharply as one moves eastward from the mountains paralleling the coast and southward from the Turkish border. With a large temporal and spatial variability, total annual precipitation is in the range of 100-150 mm in the north-west, 150-200 mm from the south towards the central and east-central areas, 300-600 mm in the plains and along the foothills in the west, and 800-1,000 mm along the coast, increasing to 1,400 mm in the mountains. The average annual rainfall in the country is 252 mm, giving 46.6 km^3. Recurrent drought years are not exceptional, making rainfed farming extremely risky: the country relies greatly on irrigation.

The contrasting climate and geology/lithology diversity have had a major influence on soil formation and distribution and on the geomorphic evolution of Syrian landscapes. Table 1 summarizes the major rock types and age (Technoexport, comp. 1964). Soil resources present great diversity and spatial distribution. Soil mapping at the national level has been done at scales of

1:500,000 and 1:1,000,000 (Map 6 in appendix 1). Using the United States Department of Agriculture (USDA) soil taxonomy, the soils are grouped under the five major orders described in appendix 1 and used as mapping units for the general soil map (GCSAR;[7] Ilaiwi 1983, 2001):

(a) **A: Aridisols** cover 47.5 per cent of the country. They generally occur where the annual rainfall is below 250 mm, and are thus the dominant soils in the Badia, but they also occur around Damascus. They are mostly characterized by calcic or gypsic horizons close to the soil's surface, weak structure and relatively light texture, which predisposes them to erosion.

(b) **E: Entisols** are relatively young soils, covering about 16.9 per cent of the country. They are mainly found as shallow soils over the coastal and central mountains or as alluvial soils on river terraces. They are the predominant soils in the Euphrates valley.

(c) **I: Inceptisols** are the second most extensive soils, covering about 21.7 per cent of the country. They are the prevailing soils of the rainfed areas in the north of the country and also of the areas to the east of the coastal mountains around Homs, Hama and Idleb. They are mostly characterized by calcic horizons, heavy texture and moderate-to-strong structure.

(d) **M: Mollisols** have a dark surface layer and well-developed structure, and occur over only 2 per cent of the land. They are mainly confined to the coastal region.

(e) **V: Vertisols** are heavy-textured cracking soils, which occur over only 1 per cent of the land. They mainly occur associated with the Inceptisols and are most common in the north between Aleppo and the Turkish border.

(f) Other units.

With a long history of human exploitation, land resources in the Syrian Arab Republic, as in other Mediterranean countries, have been subject to increasing pressure for thousands of years. The abundance of mountain and hilly rocky lands with shallow soils and bare rock points to processes of severe erosion and land degradation and biodiversity regression (UNDP/GEF/Ministry of Environment 1999, UNDP/Ministry of Environment 1998, Syrian Arab Republic 2006). Several natural and human-induced factors have contributed to land degradation through water and wind erosion.[8] It is estimated that 17.3 per cent of the land area is affected by some form of degradation. Water erosion affects about 9 per cent of the country.

Shallow soil depth over bedrock and the presence of cemented crust very close to the surface are major soil constraints on agricultural production and sustainable use of land resources. Shallow soils are usually found in mountainous regions and are commonly associated with steep slopes, water erosion processes, slow soil formation, and lapis conditions over basaltic surfaces. The cemented crust within the soil profile is identified as petrocalcic (accumulation of calcium carbonate) or petrogypsic horizons. Soil de-rocking has been recommended and amply demonstrated for productive and profitable land reclamation. Two major lithological formations are characterized by shallow soils and high stoniness: the rugged carbonate mountainous terrains in the western part of the country and the basalt terrains in the Jebel al Hoss undulating plateau and the southern region. In the Jebel al Hoss region, only 18 per cent of the area is free of rock. At least 27 per cent of the area has a rockiness ratio greater than 75 per cent. Figures 1 and 2 illustrate this soil constraint.

Wind and water soil erosion, excessive soil salinity and organic matter depletion are the major land degradation processes affecting Syrian soils. These processes are described in a report prepared by the Ministry of State for Environmental Affairs (MSEA) (Syrian Arab Republic 2003).[9]

7/ GCSAR. Soil map of Syria, 1:500 000, digital soil information system. 2006.

8/ www.fao.org/docrep/006/y4890e/y4890e0d.htm and www.un.org/esa/agenda21/natlinfo/wssd/syria.pdf.

9/ www.undp.org.sy/index.php/publications/national-publications.

Table 1 **Major lithological features**

1. *Quaternary deposits*	These are recent deposits (sand, loam and clay) covering the terraces and valleys of rivers, of which the Euphrates is the most important. They are also found in the Gota of Damascus and, in some depressions, in the steppe area.
2. *Neocene rocks*	These are mainly located in the north-eastern part of the country. Gypsum is the most important rock in this group, affecting soil genesis in the area. Other rocks include marl, conglomerate and sandstone.
3. *Palaeocene rocks*	These are extensively spread in the central and south-eastern parts of the country. Major rocks are limestone, marl and chalky limestone.
4. *Cretaceous rocks*	These are spread on the Palmrides and coastal mountains and consist of limestone, dolomite, marl, and to a lesser extent, gypsum, sandstone and phosphate deposits.
5. *Triassic and Jurassic rocks*	These are mainly found in the eastern part of the coastal mountains and in the south-eastern part of the Antiliban chain. Prevailing rocks are limestone, dolomite and marl.
6. *Mesozoic metamorphic green rocks*	These are found in a limited extension in the coastal mountains north of Lattakia.
7. *Volcanic rocks*	These are of different ages and are mainly located in the south-west. In addition, they cover some locations in the central, northern and north-eastern parts of the country.

Figure 1 **Profile of shallow soil**

Profile of shallow soil formed on rugged carbonate mountains in the Lattakia Governorate, mapped as Entisols (1975 USDA Soil Taxonomy [Ilaiwi 1983] and Rendzinze-Calcimagnésique [CPCS 1967]). This soil type occurs in association with Inceptisols when the soil depth is significant and uniform, and with shallow Entisols and rock outcrops when erosion has washed away most of the topsoil. Land reclamation through de-rocking, associated with erosion control, targeted such soil covers.

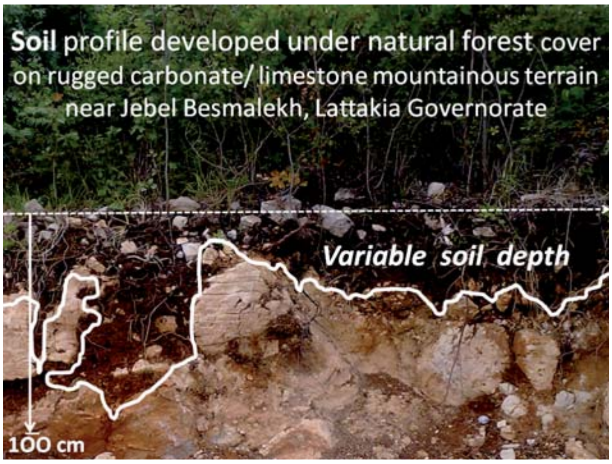


photo N. Mahaini

Figure 2 **Schematic soil profile of shallow Entisols**

Schematic soil profile of shallow Entisols formed over basaltic terrain of the Jebel al Hoss undulating plateau. The same soil profile characterizes the basaltic surface in Idleb, Sweida, Lattakia and Quneitra. This is a typical profile of the soils that were subject to de-rocking for rainfed agriculture.

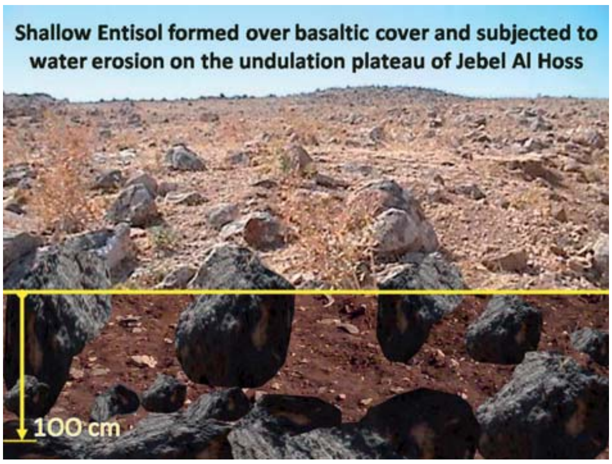
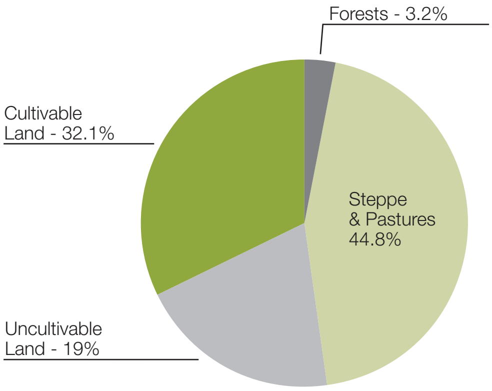


Figure 3 **Syrian land-use distribution in 2006**



Source: MAAR (2007).

Table 2 **Land-use distribution in 2006 by agricultural settlement zone (ASZ)**

ASZ	Total area		Cultivable land				Uncultivable land					
			Total		Farmed	Un-farmed	Total	Buildings and infra-structure	Rivers and lakes	Rocky and sandy	Steppe and pasture	Forest
	ha	%	ha	%								
1	2 687 683	15	1 765 136	30	1 594 071	171 065	466 323	196 552	22 882	246 889	140 633	315 591
2	2 475 130	13	1 921 256	32	1 854 670	66 586	397 826	178 860	20 642	198 324	112 928	43 120
3	1 302 550	7	875 582	15	844 985	30 597	233 354	94 616	17 543	121 195	145 023	48 591
4	1 842 039	10	963 462	16	941 473	21 989	243 427	83 977	23 591	135 859	495 290	139 860
5	10 210 569	55	424 180	7	352 274	71 906	2 336 122	103 674	69 677	2 162 771	7 396 457	53 810
Total	18 517 971	100	5 949 616	100	5 587 473	362 143	3 677 052	657 679	154 335	2 865 038	8 290 331	600 972
	Percentage		32.1%				19.9%				44.8%	3.2%

Source: MAAR (2007).

Figure 3 and table 2 show land-use distribution. In 2006,[10] cultivable land was estimated at 5.95 million ha, or 32 per cent of the total area of the country. The actual cultivated land was estimated at 5.59 million ha, which is 93.9 per cent of the cultivable area (table 3). Total land under fallow in 2006 was 0.85 million ha. Annual crops occupied 4.27 million ha, and 0.87 million ha consisted of permanent crops. Irrigated land represents 29.3 per cent (1.43 million ha) of total cultivated land. About 62 per cent of cultivated area is located in the three northern governorates – Aleppo, Reqqa and Al Hassakeh – representing only 33 per cent of the total area of the country. Almost 90 per cent of uncultivable land is represented by rocky and sandy terrain.

For policy and planning purposes, the Syrian territory is divided into five major agricultural settlement zones (ASZs) according to a number of agroecological variables, of which the most important are annual rainfall depth and probability[11] and geomorphological features. This classification system was established by decree by the early 1970s and was used in the preparation of the agricultural production plan.[12] The system, which is also referred to as agricultural

10/ *Source:* MAAR (2007), www.syrian-agriculture.org/index_ar.htm.

11/ These early ASZ studies provided the physical parameters used by planners and were verified empirically on a largely ad hoc basis by farmers. The recent climate changes that have affected most Mediterranean countries have caused a net reduction in average annual rainfall, thus shifting northward most of the isohyets, including the Badia line. Syria is undertaking the necessary updating studies of ASZ mapping.

12/ Agricultural settlement zones (ASZs) are the Syrian approach to defining land-use suitability classes, with implications for the legal position of crop farming, support services and delineation of intervention areas of government-supported projects.

Table 3 **Farmed land distribution in 2006 by governorate**

Governorate	Total farmed land	Fallow	Cultivated land									
			Total		Irrigated					Rainfed		
			Irrigated	Rainfed	Crops	Trees	Peri-meters	Nurse-ries	Peri-meters	Crops	Trees	Peri-meters
Sweida	157 098	66 657	1 452	88 989	631	775	-	43	3	55 212	33 777	-
Daraa'a	221 556	80 403	27 784	113 369	19 178	8 606	-	-	-	90 385	22 984	-
Quneitra	28 863	833	4 640	23 390	3 283	1 087	-	270	-	18 355	5 035	-
Damascus	144 605	16 522	77 363	50 720	36 868	38 502	460	1 445	88	13 194	37 378	148
Homs	344 946	40 885	56 699	247 362	30 904	24 969	24	769	33	113 948	133 414	-
Hama	359 570	49 007	74 812	235 751	58 895	15 608	-	294	15	175 898	59 853	-
Ghab	87 342	-	79 511	7 831	79 198	313	-	-	-	5 508	2 323	-
Idleb	353 309	4 144	57 109	292 056	47 665	9 301	-	141	2	160 992	131 064	-
Tartous	120 876	293	27 482	93 101	14 451	8 806	1	255	3 969	21 084	72 018	-
Lattakia	96 750	2 638	32 025	62 087	3 709	27 724	-	164	428	12 606	49 481	-
Aleppo	1 178 188	117 087	193 674	867 427	185 307	6 195	1 021	1 130	21	671 155	196 272	-
Reqqa	816 061	226 884	187 765	401 412	175 997	10 068	1 315	385	-	401 050	362	-
Deir ez-Zor	201 714	17 200	149 014	35 500	141 440	2 224	25	4 720	605	35 500	-	-
Al Hassakeh	1 476 595	222 368	432 822	821 405	431 421	1 034	151	213	3	821 319	78	8
Total	5 587 473	844 921	1 402 152	3 340 400	1 228 947	155 212	2 997	9 829	5 167	2 596 206	744 039	156

Source: MAAR (2007).

Table 4 **Syrian agricultural settlement zones (ASZs)** (see map 5, appendix 1)

ASZ 1 (14.6%)[a]	The most humid zone of the country, with annual rainfall of over 350 mm, is divided into two areas: • ASZ 1a: This region has rainfall greater than 600 mm, and rainfed crops are successfully planted. • ASZ 1b: This region receives rainfall of 350-600 mm, and not less than 300 mm in two years out of three. Thus it is possible to get two seasons every three years. The main crops are wheat, legumes and summer crops.
ASZ 2 (13.3%)[a]	A zone with annual rainfall of 250-350 mm and not less than 250 mm in two years out of three. It is best for barley, but also suitable for wheat, legumes and summer crops. The common rotation in this zone is: • On deep soil: wheat-pulses and forage legumes – a summer crop is planted if winter rain is sufficient, otherwise fallow will take the place of the summer crop. • On shallow soil: mainly barley, but part of the land is planted with cumin. Fallow is rare.
ASZ 3 (7.1%)[a]	Rainfall of 250-300 mm and greater than 250 mm in one year out of two. This zone is suitable for barley, which is the main crop, and some legumes in rotation could be planted. It is possible to get one to two seasons every three years. Fallow is practised in the case of capital shortage.
ASZ 4 (9.9%)[a]	These are marginal lands with rainfall of 200-250 mm and not less than 200 mm during half the relevant years. Lands in this zone were used for growing barley or grazing, but cultivation is very risky and thus prohibited by law. Recent agricultural policy changes have affected this area: • Formal credit is not available for crop production because cropping is considered too risky. • Fertilizer is not allocated to rainfed crops because it is considered unnecessary in this marginal zone. • Because it is a marginal production zone, not all farmers participate in the government production plan and hence do not have crop production licenses that allow them to access subsidized inputs. • Groundwater pumping for irrigating summer crops is banned.
ASZ 5 (55.1%)[a]	This is the desert and steppe region used only for grazing, with rainfall of less than 200 mm. It is broadly defined as steppe after excluding irrigated lands, and is also delineated as a Badia agroecological zone. It is a natural grazing area for sheep and camels (see demarcation line in map 5).

[a] Percentage of total land area of the country (18.5 million ha).

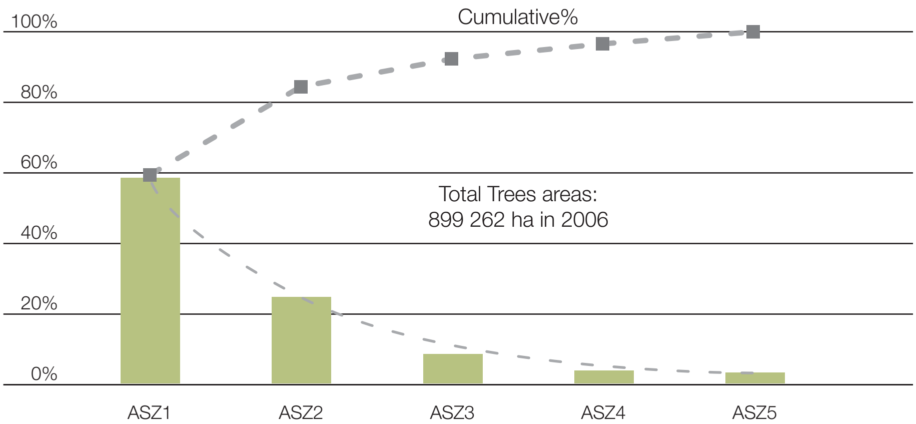
Note: The five IFAD-supported projects with land reclamation through de-rocking focused mainly on ASZs 1 and 2 and partially ASZ 3.

stabilization zones, does not take soil quality/suitability or recent climatic changes into consideration. It is currently under revision and adjustment based on the last two decades of climatological records. Average annual rainfall varies from over 600 mm in the higher areas of ASZs 1 and 2 to less than 100 mm in the extensive dryland of ASZ 5. Lands of this fifth zone, defined broadly as the Badia after excluding irrigated land, are not suitable for rainfed cultivation. The Badia includes the Syrian desert and steppe and is used as natural rangelands and to establish natural reserves. Map 5 in appendix 1 shows the ASZ boundaries with the Badia demarcation line. Table 4 presents ASZ definitions and area extent by percentage, and table 5 and figure 4 show the areas planted with fruit trees by ASZ.

Table 5 **Areas planted with fruit trees by ASZ**

	ASZ 1		ASZ 2		ASZ 3		ASZ 4		ASZ 5		Total	
Governorate	**Irrigated**	**Rainfed**	**Irrigated**	**Rainfed**	**Irrigated**	**Rainfed**	**Irrigated**	**Rainfed**	**Irrigated**	**Rainfed**	**Irrigated**	**Rainfed**
Sweida	249	15 257	505	18 429	21	91	-	-	-	-	775	33 777
Daraa'a	1 753	5 142	5 411	14 156	873	3 262	517	424	53	-	8 606	22 984
Quneitra	1 087	5 035	-	-	-	-	-	-	-	-	1 087	5 035
Damascus	10 027	6 020	6 073	12 690	4 849	7 400	5 415	7 450	12 138	3 818	38 502	37 378
City of Damascus	-	-	-	-	-	-	-	-	-	-	-	-
Homs	7 226	36 456	4 632	45 899	7 286	34 504	1 869	16 536	3 956	19	24 969	133 414
Hama	5 273	20 574	7 718	30 152	1 581	8 685	794	442	243	-	15 608	59 853
Ghab	312	2 323	-	-	-	-	-	-	-	-	312	2 323
Idleb	9 107	117 990	190	11 644	4	1 430	-	-	-	-	9 301	131 064
Tartous	8 807	72 020	-	-	-	-	-	-	-	-	8 807	72 020
Lattakia	27 724	49 482	-	-	-	-	-	-	-	-	27 724	49 482
Aleppo	4 027	125 385	1 419	65 408	616	4 967	99	509	38	-	6 199	196 270
Reqqa	-	-	374	156	244	28	2 665	-	6 783	177	10 066	361
Deir ez-Zor	-	-	-	-	-	-	-	-	2 224	-	2 224	-
Al Hassakeh	227	77	342	1	324	-	79	-	72	-	1 044	78
Subtotal	75 820	455 760	26 664	198 536	15 797	60 367	11 437	25 361	25 507	4 014	155 225	744 037
Total	531 580	59%	225 200	25%	76 164	8%	36 798	4%	29 521	3%	899 262	100%

Figure 4 **Distribution of Jebel al Hoss fruit tree area by ASZ**



The farming systems (FSs) evolved during the last two decades in response to a range of internal and external factors and household types. A study conducted by the National Agricultural Policy Center (NAPC) of MAAR[13] and supported by project GCP/SYR/006/ITA of the Food and Agriculture Organization of the United Nations (FAO) presented a detailed characterization, development and regionalization of Syrian farming systems (FAO 2003, NAPC 2006, Wattenbach, H. 2006). Table 6 presents the six dominant FSs and their characteristics.

Table 6 **Characterization of the six major Syrian farming systems**

	Total area (percentage)	Cultivated land (percentage)	Percentage of rural population	Prevailing crops
FS1: Intensive irrigated coastal	<1	1	3	Citrus, greenhouses, cucumber, irrigated tomato
FS2: Hilly and mountainous	6	10	17	Rainfed olive, rainfed cherry, rainfed apple, rainfed and irrigated tobacco
FS3: Northern and north-eastern plains	26	48	39	Cotton, rainfed and irrigated wheat, rainfed lentil, irrigated olive
FS4: Central rainfed and irrigated plains and Al-Ghab	6	14	14	Irrigated pistachio, rainfed almond, rainfed cumin, rainfed lentil, rainfed grape, irrigated potatoes, irrigated cucumber, irrigated tobacco
FS5: Southern semi-arid plains and mountains	10	8	14	Rainfed chickpea, irrigated tomato, rainfed cucumber, rainfed apple, irrigated grape
FS6: Pastoral and agropastoral farming systems of the semi-arid and arid east	55	17	8	Rainfed barley, rainfed and irrigated wheat

Government policy and agriculture-sector strategy

The Syrian Arab Republic is primarily an agricultural country. Agriculture is one of the key economic sectors in terms of contribution to GDP (25-27 per cent), employment, balance of trade, provision of food for the population, raw materials for agro-manufacturing and agro-industry, job creation and provision of production inputs. Agriculture is the second source of export earnings, after the oil sector, and its backward and forward linkages constitute the most relevant source of stimuli for industrial and commercial activities. Over the past four decades, agricultural growth has been able to respond to high population growth (3.3 per cent in the 1970s, 3.6 per cent in the 1980s, 2.7 per cent in the 1990s and 2.4 per cent in 2004), increasing the production of most food staples to the level of food self-sufficiency through price support and technological innovation. The country has also achieved significant progress in reducing poverty and improving living conditions in rural areas through infrastructure development and social services.

The agriculture sector has long been considered strategically important and operates under a controlled price regime. The Government has emphasized development and stabilization of agricultural production by expanding irrigation facilities and land reclamation. The main crops are wheat, cotton, sugar beet, barley, fruits and vegetables. The production, pricing and marketing of seven major 'strategic crops' (wheat, barley, cotton, sugar beet, tobacco, lentil and chickpea) was for many years centrally planned and government controlled. This control has gradually been relaxed, and now only wheat (hard and soft), cotton and sugar beet remain firmly within the centralized planning system. Production plans and targets for strategic crops are set annually by the Supreme Agricultural Council (SAC) and implemented by MAAR. Local authorities issue production licences to individual farmers and cooperatives, which entitle them to subsidized credit

13/ www.napcsyr.org/pubs/studies/policy_studies.htm.

and inputs. The seven strategic crops cover 75 per cent of the cultivated area, consume 89 per cent of irrigation water and contribute 60 per cent of crop subsector product. The private sector dominates the livestock subsector and has almost full control over production, pricing and marketing of non-strategic crops, fruits and vegetables. Land is largely privately owned and, following the land reform of the 1960s, farming is dominated by smallholders. This has been one of the main factors behind the continual increase in production.

The Government's policy to achieve food security, especially in wheat, resulted in rapid expansion of irrigated agriculture over the last two decades. Irrigated area rose from 0.65 million ha in 1985 through 1.12 million ha in 1996 to 1.43 million ha in 2005, of which 76 per cent (1.13 million ha) is under private-sector management. This expansion was enabled primarily by increasing groundwater irrigation, with 60 per cent of all irrigated areas using groundwater from privately developed and operated wells. Unsustainable groundwater use[14] caused overdraft (Khabour basin) and pollution in many areas, making groundwater management a key challenge for irrigated agriculture.[15]

Despite the increased importance of the irrigated sector and its overall rural output, rainfed cereal production, dryland tree crops, and range and village sheep production remain the cornerstones of the farming system and the principal determinants of the pattern of rural life, mostly in the areas of FS2, FS4 and FS5 (figure 5). IFAD (1999b) highlighted the strategic role of this subsector and its opportunities and constraints. The paradigm that better crop husbandry under rainfed and irrigated farming – rather than a horizontal expansion of irrigated areas – should result in increased agricultural production has been a constant directive in successive agricultural development and poverty reduction strategies and plans.

From the 6th five-year plan (1986-1990) to the current 10th five-year plan (2006-2010),[16] land reclamation through de-rocking for rainfed agriculture was considered a key to rural development (Syrian Arab Republic 1999, Syrian Arab Republic 2002, Syrian Arab Republic 2005). Thus regional agricultural development projects were financed with major land reclamation components to open up new areas of land for sustainable rainfed agriculture. Land reclamation in mountainous and hilly areas was associated with water harvesting and soil erosion control. With its ratification of the Convention to Combat Desertification[17] in 1997, the Syrian Government has demonstrated serious commitment to natural resources conservation and the combating of desertification.[18] Large rural development projects with land reclamation and soil and water conservation components were incorporated into the plans. They covered mountainous areas in the coastal-midlands, the southern region, the Badia, and the north-eastern region. IFAD accompanied the Government in the consolidation and implementation of its policies and strategies for optimum utilization of natural resources, improvement in rural living standards, employment generation in rural areas and improved food consumption in both rural and urban areas.

14/ Syria's water resources, estimated at about 16 billion m^3, are very limited compared with the growing need and suffer increasing drought recurrence. The overall water deficit is currently over 20 per cent of available renewable supply, varying distinctively across basins. The Government has taken several steps to meet the challenge by introducing projects to modernize traditional irrigation methods, increase efficiency and reduce demand, and is exploring various options to improve groundwater management, such as more stringent control of new well drilling, well consolidation, restricting crops with high water requirements and banning new well licenses in water deficit areas.

15/ North-Eastern Region Rural Development Project addressed this growing stress between available natural resources and a rapidly increasing population with greater demands and expectations (IFAD 2007c).

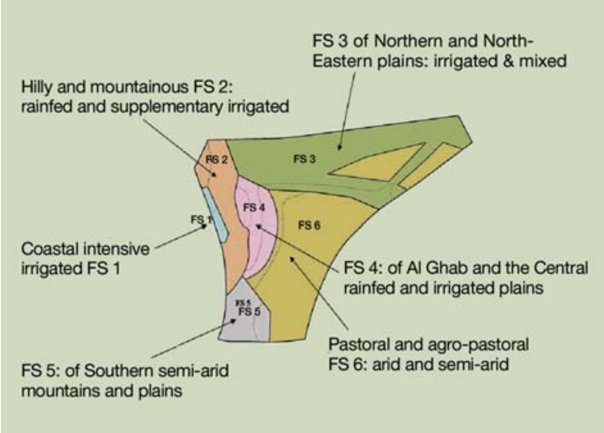
16/ The State Planning Commission prepared the 10th five-year plan in line with its social/market economy orientation, with the aim of coordinating Syrian reforms and ensuring synergies among economic, financial, investment, agricultural and social policies, having as a final target social and economic development, http://www.planning.gov.sy/files/file/FypChapter1En.pdf.

17/ United Nations Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa (UNCCD).

18/ The laws and regulations issued over the last few years have provided an important framework for carrying out the national action plan to combat desertification and for promoting sustainable development of natural resources: Environmental Law No. 50, issued in 2002; Forest Law No. 7, issued in 1994 and its recent amendments; Water Law No. 31, issued in 2005; and Transformation to Modern Irrigation Decree No. 91, also issued in 2005.

Figure 5 **Spatial distribution of the six major FSs**

Land reclamation through de-rocking was mostly located in ASZs 1 and 2, and thus involved to a large extent FS2, FS5 and FS4 on the Jebel al Hoss plateau, as well as in ASZ 3. The programmes did not concern FS3 and FS6, which are the largest in terms of area, nor FS1, which occupies the intensive irrigated coastal farming system (<1% of total area).



Source: NAPC (2006)

Key institutions involved

De-rocking has been a longstanding land reclamation practice used by Syrian farmers for thousands of years. Farmers are making significant efforts to clear their land by traditional methods, but the scope and the extent remain restricted because of limited means and outdated techniques. However, demand is still great, and thus farmers represent the first institution involved in land reclamation.

Beginning with the 6th five-year plan, the Government's agricultural development strategy supported de-rocking as an efficient mechanism for expanding cultivated land in ASZs 1 and 2, hence increasing production and productivity. For the last two decades, land reclamation through de-rocking activities was formulated and implemented as a major component of agricultural and rural development programmes. Consequently, land reclamation has been largely controlled by public institutions. Since the mid-1970s, it has been associated with fruit trees and the production of improved crops, mostly under rainfed conditions. Cleared land was also irrigated where water was available.

MAAR, the General Union of Peasants (GUP), SAC[19] and the State Planning Commission are the main institutions responsible for designing and implementing land reclamation and development programmes, as well as the related policy formulation. Other institutions, particularly the Agricultural Cooperative Bank (CAB), are crucial to the successful implementation of land reclamation and development through de-rocking.

The **Ministry of Agriculture and Agrarian Reform (MAAR)**[20] is responsible for all development activities related to agriculture, livestock, forestry and fisheries. It operates through a number of directorates at central and provincial levels, whose directors are responsible to the Deputy Minister. The central line directorates are concerned mainly with national-level policy development and the drafting of legislation; they provide only minimal technical support, monitoring and evaluation (M&E) and backstopping to provincial and field level staff. The Directorate of Agricultural Extension (DAE) provides guidance, technical advice and the transfer of new and suitable technologies to farmers, livestock owners and herders, including rural women. Field extension is organized at the provincial level, headed by a division director under the Provincial Director of Agriculture. The provincial divisions organize extension work at the village level. Field-level

19/ By late 2001, the functions of SAC were transferred to the respective ministries. Under the new arrangement, the Cabinet, presided over by the Prime Minister, adopts/approves the proposals of the sectoral ministries concerned. The consultative process, through the formal representation of political and social bodies in SAC, is now replaced by the ministries, with consultations with stakeholders at various levels. The main authority concerned with policy design and planning for all aspects of agriculture, including land reclamation, is held by the State Planning Commission, www.planning.gov.sy/en/page_id=106.

20/ See MAAR mission and organization at www.agri.gov.sy/index_ar.htm.

extension is carried out through agricultural extension units (AEUs). Agricultural research is conducted by the General Commission for Scientific Agricultural Research (GCSAR). In addition, two agricultural universities (Damascus and Aleppo), the International Center for Agricultural Research in the Dry Areas (ICARDA) and ACSAD[21] are located in the country and carry out research on subjects within their mandates.

The Directorate of Natural Resource Management at GCSAR is responsible for nationwide research on crop water requirements, land resources, on-farm water management and irrigation methods and technologies.

Under the direct supervisory responsibility of the Deputy Minister, various agricultural and rural development projects are organized as directorates: the Ali Al Ali Project, SRADP, JHADP, CMADP, IRDP, BRDP, NERRDP, and the national Al-Ghab Agricultural Development Project and Modern Irrigation Project. Most of the de-rocking programmes were carried out under the first five projects.

MAAR provides extension services to the crop and livestock subsectors and has overall responsibility for their planning, finance and administration through DAE. Field extension is organized through the Provincial Directorate of Agricultural Extension under the Provincial Directorate of Agriculture. The extension service has a total of 12,270 staff members spread across the central directorate (112), 14 provincial directorates (56), 167 district extension administrations (158), 65 extension support units (250) and 1,029 AEUs at the field level (11,700). Of the professional staff, 3,064 are agricultural engineers, roughly half of whom are women, and 517 are veterinarians. Of the technical staff, 2,145 are assistant agricultural engineers and 4,244 are assistant veterinarians. The AEU is the interface between the farmer and the extension service. About 10 per cent of the staff are women. In theory, an AEU in a rainfed area services 8,000 ha, and in an irrigation area 2,000 ha, but, in practice, an AEU may cover only 700 dunum (70 ha). An AEU generally has 10-12 staff members, but the number may exceed 20 in intensive production areas. The extension ratio (extension worker to farmer) at the field level ranges from 1:70 to 1:85, depending on the estimate of the number of farmers countrywide, and is 1:52 in relation to farm holdings.

The **Agricultural Cooperative Bank (CAB)** is the main rural financial institution and the only one in the country responsible for providing institutional credit to farmers and stockholders. With 266,000 clients (20 per cent of rural households), 106 branches, and a portfolio of US$461 million in outstanding loans (1999), CAB plays a highly important role in the domain of rural finance. It does not operate as a bank in the conventional sense, but rather as a tightly controlled channel of agricultural credit. Its primary responsibility is to ensure the provision of credit support for implementation of the Annual Agricultural Production Plan in accordance with the government-formulated Standard Schedule of Requirements, which, inter alia, sets financing terms such as loan amounts, repayment periods and due dates. In addition, CAB performs some non-credit functions. These include storage and distribution of major agricultural inputs and transfer of payments to farmers for regulated crops such as cotton, sugar beet and tobacco, which are required to be delivered to the parastatal enterprise concerned.

CAB's lending policy has been directed at achieving the production targets of specific food and industrial crops, including wheat, sugar beet and cotton. While credit is provided to all farmers, special compensation is offered to those who are members of cooperatives. Recent economic and policy changes have had and will have an impact on the way CAB conducts its business. Up to the mid-1990s, CAB was the sole provider of fertilizer and agrochemicals to farmers and cooperatives, but agrochemical commerce has since been transferred to the private sector. Farmers are not obliged to sell their produce to the bank, with the exception of wheat, cotton and tobacco. Incentives are provided for farmers who choose to export their production.

21/ Both ACSAD and ICARDA have agreements with MAAR's directorates for joint research and natural resource programmes and have provided direct technical assistance and training to agricultural development projects. ACSAD recently conducted an evaluation study on land reclamation through de-rocking for CMADP.

CAB played a major role in the implementation of various land-reclamation programmes by providing medium- and long-term credits for financing de-rocking shared costs and subsequent land development operations. However, as with all other agricultural development activities, CAB suffers from a number of problems that prevent it from truly reaching out to the Syrian rural population. Among these are: lack of adequate autonomy (i.e. lending policies and deposit rates are regulated by the Government, rather than by the bank's board of directors); an inverted interest structure (i.e. interest rates on saving deposits tend to exceed lending rates), which undermines both deposit-taking and lending; lack of a diversified portfolio and attractive loan products for various market segments; the fact that more than 81 per cent of all clients are reached through cooperatives; and the imposition of strict rules, such as those relating to collateral, that prevent it from addressing the significant portion of the rural population comprised of 'landless farmers'.

General Union of Peasants (GUP). Agricultural or peasant cooperatives have a strong presence, starting at the village level. They are vertically organized as peasant unions at governorate levels and federated as the General Union at the national level. Although Syrian cooperatives cannot be considered intermediary financial institutions at the grass-roots level because of the way in which they operate, they play a vital part in the whole system of input supply, procurement, credit disbursement, crop proceeds disbursement, dues collection and collective guarantees of repayment for farmers' groups. Thus they play an important role in the implementation of de-rocking programmes.

At present, there are 5,360 agricultural cooperatives in the country, with a membership of about 900,000. The majority (77 per cent) are multipurpose, while 13 per cent deal with animal breeding and fattening, 9 per cent with pasture improvement and the remaining 2 per cent with activities such as raising poultry, bee-keeping, and marketing. Cooperatives provide many services to members, for example low interest rates for credit from CAB, custom hire service for machinery owned by them, exemption from various taxes and fees, and entitlement to a price concession of 5 per cent from public institutions. Loan repayment is almost 100 per cent: defaulters are subject to a range of penalties including imprisonment of up to six months. Cooperatives are male-dominated institutions, with women constituting about 5 per cent of the total membership. They have a strong economic presence and involvement in the preparation and implementation of agricultural production plans, and are represented in political, economic and social committees at various levels.

Land reclamation through de-rocking: Past and present programmes

The major work of land reclamation through mechanical de-rocking began in 1977 with the NFTP, which is still being implemented in hilly and mountainous regions in ASZs 1 and 2. Despite limited capacity and expertise, the project gained farmers' trust and stimulated demand. Mechanical de-rocking was carried out using heavy machinery that did not exceed 220 horsepower (HP). To strengthen the successful start of the project and its scaling up to other governorates, the Government called for international technical assistance in 1980 through a cooperation programme with the *Deutsche Gesellschaft für Technische Zusammenarbeit* (German Agency for Technical Cooperation) (GTZ). With this assistance, Syrian engineers and field technicians developed land reclamation suitability maps and technologies for de-rocking and fruit tree development in specific areas of Rural Damascus, Homs and Aleppo Governorates. The national land reclamation efforts were enhanced in 1986 by the Ali Al Ali Project, cofinanced by KfW, which covered six governorates with the addition of Lattakia and Tartous. Further technical assistance was provided to train Syrian design and field teams for the preparation of detailed feasibility studies and adapted field operating guidelines. NFTP was the precursor of six major projects implemented by MAAR for the development of mountainous and rocky lands in the Sweida, Daraa'a, Quneitra, Rural Damascus, Homs, Hama, Tartous, Lattakia and Aleppo Governorates. The projects aimed to promote rainfed agriculture (annual and perennial crops such as cereals, legumes, fodder crops, and olive and other fruit trees) through de-rocking and through the destination of potential land and supplementary financial and technical assistance to small-scale farmers. Appendix 2 presents a brief technical note on the de-rocking process.

In total, the eight projects are: the National Fruit Tree Project, Ali Al Ali Fruit-Tree Planting Project, Green Belt Project, second Quneitra Fruit Tree Project, Southern Regional Agricultural Development Project (phases I and II), Jebel al Hoss Agricultural Development Project, Coastal/Midlands Agricultural Development Project, and Idleb Rural Development Project. Map 1 in appendix 1 shows the location of these projects.

Based on the success and farmer acceptance of NFTP, the Syrian Government and IFAD identified de-rocking as a mechanism for increasing the productivity of farms quickly and substantially and chose to use it as their main intervention in integrated agricultural projects. Even in the continuation of the Ali Al Ali Project, land reclamation through de-rocking was accompanied by the strengthening of extension services to provide small farmers with advice on sustainable agricultural production and livestock development and with inputs, through the promotion of credit, improved road access and women-in-development activities. In IFAD-supported projects, land reclamation was designed and fully integrated with other development components to mitigate constraints on agricultural development and on improved incomes for small farmers.

Table 7 presents records of areas reclaimed since 1986 by the eight projects. This table, table 8 and figures 6 and 7 show the total area reclaimed through de-rocking over the last two decades, which amounts to about 600,000 ha (10 per cent of total cultivable area). The total reclaimed area is located in ASZs 1 and 2 and part of ASZs 3 and 4. Table 7 does not show the total reclaimed areas during the 1977-1986 period for fruit tree plantation and forestry, which approached 100,000 ha. Thus the total area reclaimed through de-rocking is some 700,000 ha. This figure does not include the area reclaimed through traditional de-rocking methods or by private entrepreneurs.

As implemented in the major de-rocking projects among the eight presented below, land reclamation through de-rocking and development was coupled to more than one MAAR farmers' assistance mechanism. The most effective one was the cost-recovery process in which farmers, field extension/advisory units, land reclamation engineers and CAB credit staff worked together. There were also synergies at the village level with other programmes and donors. For example, the Rural Community Development Project, financed by the United Nations Development Programme (UNDP), was dedicated to microfinance through the innovative *sanduq* approach (see paragraph 61). It enabled many poor small farmers in the Jebel al Hoss project to finance the recovery costs of de-rocking. The same experience can be cited with World Food Programme assistance to fruit-tree planting and green belt development. [22]

Since 1977 the Government has been implementing a group of fruit-tree planting projects in mountainous rainfed areas with four major objectives: (i) reclamation and sustainable use of mountainous areas (areas of ASZs 1 and 2, mostly allocated to fruit trees, and ASZ 3 for green belt projects); (ii) reclamation of lands suitable for crops in the southern basaltic region; (iii) construction of rural roads to facilitate transportation and marketing; and (iv) generation of rural jobs and increased farmer incomes. The following projects[23] had a major de-rocking component and have been successfully implemented despite some delays.

22/ World Food Programme Syria Project WFP 2418 (WIS No. SYR 00241804), Assistance to Reforestation and Range Land Management, www.wfp.org/eb/docs/1997/2418.04~1.pdf.

23/ The MAAR/ACSAD evaluation of the Syrian de-rocking experience provides detailed information on each project and the lessons learned (MAAR/ACSAD 2005).

The **National Fruit Tree Project (NFTP)** began in 1977 with the ambitious objective of reclaiming 386,000 ha in ASZs 1 and 2 in the Daraa'a, Sweida, Quneitra, Rural Damascus, Homs, Hama, Tartous, Aleppo, Idleb and Al Hassakeh Governorates. Tables 7 and 8 show that the project cleared more than 201,310 ha from 1986 to 2006. From 1977 to 1985 it cleared almost 90,000 ha. Thus, the total area cleared was a little more than 300,000 ha, or 80 per cent of the initial target. The project started the de-rocking with seven 220-HP heavy machines, and by 1982 the fleet was composed of 193 machines (127 bulldozers, 41 tracks and 25 baggers). This fleet, with a power reaching 320 HP, is still being used by the project. Most importantly, ministry staff gained valuable technical experience and increased farmers' adhesion. The project developed an integrated-farm-unit management approach. Soil quality and erosion risks were assessed. When slope was moderate to high, the project recommended construction of stone contour walls. Project implementation was hampered by weak extension services. Land reclamation was not designed within an integrated rural development programme. Farmers faced major difficulties in mobilizing the needed financial resources to cover their contribution to the total cost of de-rocking operations. Implementation in the field lacked technical support from surveyors, researchers in the adaptation of different species and varieties of fruit trees, post-harvest technologies, and marketing. Many valuable lessons were learned in de-rocking techniques, regarding the type of machinery, and in working with small farms and with eroding slopes (5 per cent). To reduce the observed soil erosion processes that were being enhanced by land reclamation in the mountainous and rolling hills, the project adopted mitigation measures: bench terraces, supporting stone walls and waterways. The Ministry and the staff who worked on this project identify it as the first major learning experience in de-rocking.

Table 7 **Areas reclaimed through de-rocking since 1986 (ha)**

Years	National Fruit Tree Project	Green Belt Project	Ali Al Ali Project	Second Quneitra Fruit Tree Project	SRADP I & IIa	JHADP[a]	CMADP[a]	IRDP[a]	Total (ha)	Cumulative
1986	13 172	2 054	630	305	4 813	-	-	-	20 974	20 974
1987	11 662	4 642	3 529	178	6 010	-	-	-	26 021	46 995
1988	13 855	6 391	5 264	222	9 881	-	-	-	35 613	82 608
1989	13 508	7 511	5 058	210	10 035	-	-	-	36 322	118 930
1990	11 413	5 797	5 695	146	8 598	-	-	-	31 649	150 579
1991	9 723	4 689	4 400	179	6 990	-	-	-	25 981	176 560
1992	11 666	5 708	4 400	133	8 010	-	-	-	29 917	206 477
1993	9 670	6 137	4 866	72	7 606	-	-	-	28 351	234 828
1994	9 937	5 823	4 686	153	5 145	-	-	-	25 744	260 572
1995	10 941	6 440	4 752	141	6 115	-	-	-	28 389	288 961
1996	11 761	6 309	4 727	302	7 568	-	-	-	30 667	319 628
1997	11 336	6 008	4 694	275	7 260	12	-	-	29 585	349 213
1998	11 335	7 097	4 815	294	6 209	131	-	-	29 881	379 094
1999	9 060	6 861	4 690	238	6 312	231	-	-	27 392	406 486
2000	8 696	5 909	4 548	212	5 497	626	-	-	25 488	431 974
2001	7 069	4 617	3 580	227	6 711	2 302	-	-	24 506	456 480
2002	7 691	3 800	4 760	305	1 706	4 121	603	-	22 986	479 466
2003	4 336	4 400	3 406	347	5 308	4 003	2 846	-	24 646	504 112
2004	5 580	5 086	2 203	293	5 230	4 063	7 845	-	30 300	534 412
2005	5 579	6 887	2 596	260	4 594	4 123	7 588	901	32 528	566 940
2006	3 320	5 225	2 953	170	3 677	4 330	6 834	1 000	27 509	594 449
Total	201 310	117 391	86 252	4 662	133 275	23 942	25 716	1 901	594 449	
Percentage	34%	20%	15%	1%	22%	4%	4%	0%	100%	

[a] IFAD-supported projects total about 185,000 ha or 31 per cent of total reclaimed area.

Table 8 **Total area reclaimed through mechanical de-rocking by major projects during the last two decades** (1986-2006) (ha)

National Fruit Tree Project	Green Belt Project	Ali Al Ali Project	Second Quneitra Fruit Tree Project	SRADP I & II[a]	JHADP[a]	CMADP[a]	IRDP[a]	Total (ha)
201 310	117 391	86 252	4 662	133 275	23 942	25 716	1 901	594 449
34%	20%	15%	1%	22%	4%	4%	0.3%	100%

[a] IFAD-supported projects total about 185,000 ha or 31 per cent of total reclaimed area.

Figure 6 **Distribution of mechanical reclamation of stony agricultural lands by project**

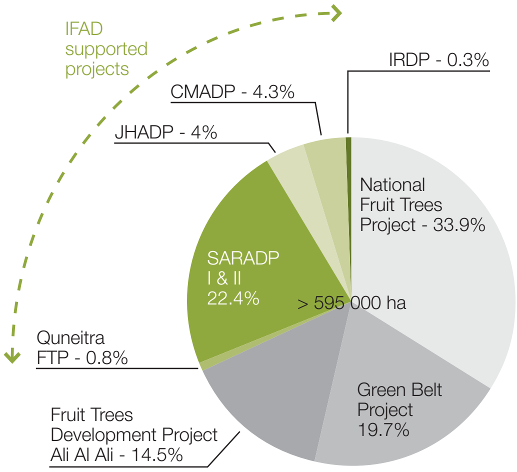
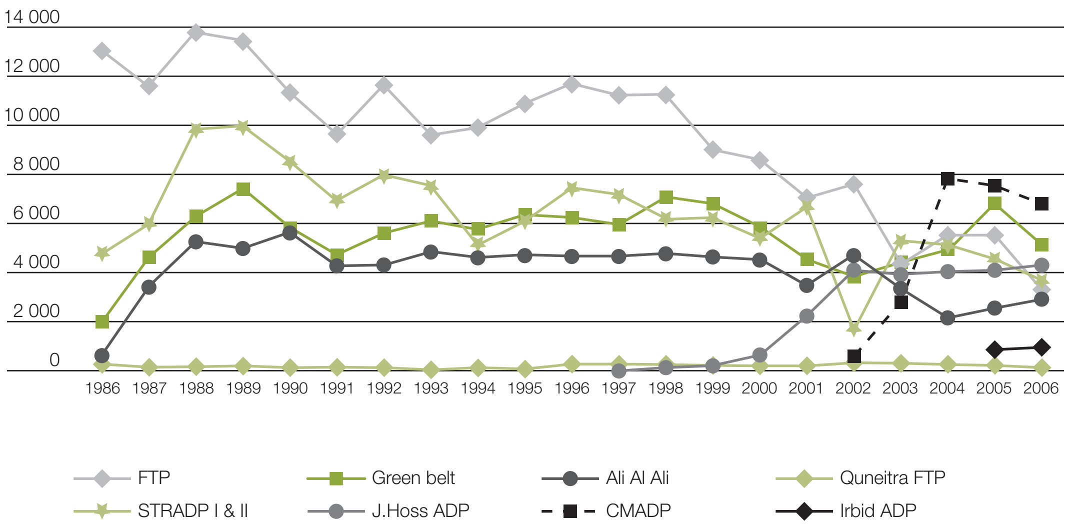


Figure 7 **Progression of total areas of land reclamation by project**



The **Green Belt Project** began in 1980 to control the land degradation processes affecting the Badia ASZ. It addressed inadequate land use through crop production, mostly barley in the 200-300 mm buffer zone. The project objectives were to:

(a) establish a green belt comprised of fruit-bearing trees (almond, pistachio, grape, fig and olive) and forest trees between the desert and inhabited areas, with a fruit-tree area of 1,100 km long by 1-20 km wide, extending from the Syrian-Turkish border in the north and the Syrian-Jordanian border in the south;

(b) establish a moderate-climate area to control desertification and relieve the degradation pressure on the Badia; and

(c) control soil erosion and floods, improve groundwater management, develop ground cover for pasture, and create balanced local environments.

The first phase (1980-1982) was designed to develop 33,000 ha in ASZ 4 in Homs, Hama and Aleppo. The project achieved about 18,882 ha because of the difficulties encountered in convincing and engaging the agropastoral communities in this land-use and production system shift. The lessons learned were applied to the second phase in 1983, which focused more on ASZ 3 and extended the project zone to Rural Damascus, Sweida, Daraa'a and Idleb). The project used heavy machinery for mechanical strip de-rocking (5 m). Table 8 above shows the total project achievement. Map 2 in appendix 1 shows the location of the project areas.

Second Quneitra Fruit Tree Project. With three Komatsu (320 HP) bulldozers and two trucks, this project served the Quneitra Governorate in the first (1978-1985) and second (1986-2006) phases. By 1997 the project was using six bulldozers (320 HP) and two trucks. The project reclaimed some 1,089 ha during phase I and 4,662 ha during the second phase, thus reaching a total of 5,751 ha.

Ali Al Ali Project. The 1980 cooperation agreement with FAO allowed the Government to develop suitability and technical guidelines for de-rocking. The most important feature of this project was the KfW-funded technical assistance programme (1980-1986).[24] Capacity-building and technical assistance yielded detailed land-quality surveys and feasibility studies, documented by soil testing results and mapping at a 1:50,000 scale. Based on these feasibility studies, KfW funded the Ali Al Ali Project in the loan amount of 96.8 million German Deutsche Marks (DEM). DEM 35.5 million of this was used by CAB to provide loans to participants for land reclamation cost-sharing. The project covered six governorates (Lattakia, Tartous, Hama, Homs, Aleppo and Rural Damascus). It began in 1986 with the objectives of land reclamation, soil and water preservation, tree planting and a shift from tobacco and other crops in low rainfall zones. It aimed to reclaim 81,577 ha and by 2006 had reclaimed more than 86,252 ha.

The project developed and adapted de-rocking schemes to different landscape and land-use units. The major discrimination parameters were the slopes (<15 per cent, 15 to 35 per cent and >35 per cent). De-rocking was disregarded for land with slopes greater than 35 per cent. Major soil erosion control was designed and mandated for every slope/soil depth combination. From the southern region in Sweida to the mountains of Lattakia, visitors are impressed by the new

24/ The first technical assistance (TA) and study programme was conducted by Atkins Inc. Another important TA project, also funded by KfW, was conducted from 1991 to 1993 by GITEC Consult GmbH and completed the first one. The objectives of this TA and feasibility study were to do as follows: i) establish detailed land capability maps based on interpretation of satellite imagery with extensive ground checks for land appraisal; ii) design an experimental de-rocking scheme and carry out subsequent tests; iii) develop de-rocking measures, including the identification and comparison of technically feasible alternatives covering risk assessment and costing of various measures; and iv) determine a programme for large-scale land reclamation. Such a programme (iv) would cover technical, socio-economic, financial and institutional elements, analysis of cereal markets and sector policies, analysis of required supporting infrastructure (feeder roads, drains, levelling, terracing), soil protection measures, heavy equipment, farm machinery and facilities. Simultaneously, possible environmental effects, farm-level economics, financial and economic analyses and the project implementation schedule should be considered.

landscape with green bench terraces and stone walls supporting contour-planted olive and fruit trees. These networks of contour terraces and walls provide an effective soil erosion control system, which is an important positive environmental impact of the mechanical reclamation of stony agricultural lands.

The Ali Al Ali Project equipped six large field units with a total of 11 bulldozers of 410-HP capacity, 13 of 310 HP, 15 bulldozers equipped with blades, 14 trucks, and 10 baggers of 75 HP. The project assisted farmers from the beginning of the de-rocking and terracing work until the planting of the adapted and accepted fruit trees and their irrigation during the first three years.

IFAD has supported seven projects in the Syrian Arab Republic since 1982, investing a total of US$126.2 million in loans for projects with a total value of US$474.0 million. Five projects out of seven had a major component of land improvement through de-rocking, with a reclaimed area from 1983 to 2006 of 185,000 ha (31 per cent of total area reclaimed). By the completion of the ongoing IRDP, the figure will exceed 200,000 ha. This will represent almost 33 per cent of the total area reclaimed since 1977. Four of the five loans have been closed, but the projects are still operating in their respective zones.

Southern Regional Agricultural Development Project. SRADP-I was the first Syrian project funded by IFAD. Its objectives were to increase production of rainfed agriculture in the underdeveloped provinces of Daraa'a, Sweida and Quneitra, and to improve poor people's access to land. The project developed an effective de-rocking technique that was a model for later operations, and it reclaimed 37,000 ha of land, an amount well beyond expectations. About 16,000 families[25] (144,000 people) have benefited from the reclamation of their unproductive or marginally productive land. Land values have skyrocketed from virtually zero to SYP 200,000 in 1991. In addition to this main benefit, about 17,000 families were able to take advantage of CAB credit in 1990, compared with 8,000 in 1985. Crop yields have increased overall, more farmers are taking advantage of extension services and, reportedly, 92 per cent of respondents have benefited from road construction.

Southern Regional Agricultural Development Project – Phase II. Based on the positive results of the first phase, SRADP-II was designed with an estimated cost of US$43.3 million and became effective in November 1992. The overall goal and objectives were improvement of farmers' incomes through land reclamation and provision of extension services and credit, improvement of the well-being of rural women through small income-generating activities; and institution-building through provision of technical assistance, and training to extension agents. The project aimed to improve the livelihoods of 17,600 households in Daraa'a, Sweida, Quneitra and Rural Damascus through increasing cultivable land by the de-rocking of 32,000 ha and improving crop and livestock production. Small producers benefited from credits from CAB and purchased dairy cattle (1 or 2 per family), sheep (10-15) and Shami dairy goats (1-3). The project also successfully established rural poultry and honey production and small-scale cheese processing.

Following the IFAD loan closing, the project has been institutionalized as the regional Directorate of SRADP, the heavy machinery is still well serviced, and the project has maintained good momentum, as shown in figure 7. The relative decline observed since 2002 is mostly due to the level of stoniness of the lands left to be de-rocked. From 1986 to 2006, SRADP-I and II reclaimed a total area of 133,275 ha (22 per cent of the total area reclaimed). The project completion report (IFAD 2002) summarizes the very important lessons learned. Technically speaking, the project was and is still considered a school for the mechanical reclamation of stony agricultural lands.

25/ The Government had estimated 10,000 families as primary beneficiaries.

Coastal/Midlands Agricultural Development Project. CMADP's primary objective was to improve the living standards of farmers and rural women in the provinces of Hama, Homs, Lattakia and Tartous through increasing the cultivable areas by de-rocking about 80,000 ha and introducing terrace cultivation. The project improved livestock and fruit production (MAAR/ACSAD 2005b). It became effective in July 1996, with an estimated cost of US$117.1 million. The project facilitated credit from CAB so that small producers could buy livestock such as dairy cattle, Shami dairy goats and honey bees. Rural women were trained to process milk by-products for sale in cities of the project area.

Jebel al Hoss Agricultural Development Project. JHADP, which began in January 1995, aimed to improve the living standards of 14,000 small farmers through the de-rocking of 22,000 ha, introduction of terrace cultivation, development of field crops in rainfed areas and fruit trees in areas with supplementary irrigation, in addition to livestock production. The project cost was estimated at US$29.1 million. In partnership with JHADP, the UNDP Rural Community Development Project in Jebel al Hoss has successfully implemented a scheme for sheep production and fattening and for rural poultry production. Small producers are using credit to purchase 10-11 sheep or fatten 30-50 lambs. JHADP trained rural women in dairy cattle production prior to the purchase of such animals in 2002. Following the IFAD loan closing, JHADP has also been institutionalized in Aleppo as the Directorate of JHADP. The completion report for JHADP (IFAD 2006) showed successful achievement of the project target for land reclamation, productivity increases and many lessons learned.

Idleb Rural Development Project. IRDP focuses on community development and land reclamation through de-rocking in the Idleb Governorate. The primary objective is to improve food security and income levels for the target group of farmers and rural women in 140 of the poorest villages. Through an innovative bottom-up process involving village development committees, people participate in their communities' development. To improve poor people's access to rural financial services, the project supports the establishment of *sanduqs*, which are informal community-based microfinance institutions. Through them, poor rural people – and particularly women – can obtain credit to cover the cost of reclaiming land for agriculture and to initiate income-generating activities. With a total cost of US$46.1 million, the project is cofinanced by IFAD (US$17.5 million), the Arab Fund for Economic and Social Development (US$18.2 million), UNDP (US$1.3 million), the Government (US$3.6 million) and beneficiaries (US$5.5 million). The project started up in November 2003, with an expected completion date of 31 December 2010. The project experienced the same problem of heavy machinery procurement delay, but by July 2007 it managed to reclaim almost 2,000 ha through de-rocking by using machines from the two neighbouring projects (JHADP and CMADP).

III. IFAD's role and intervention in land reclamation

Intended objectives and approaches

Since 1992, IFAD operations in the Syrian Arab Republic have been guided by the strategy prepared by a strategy-cum-general-identification mission (SCGIM) in that year. The strategy had five key objectives: (i) raise the productivity of land and labour; (ii) use resources better and protect the environment; (iii) improve incomes and raise the standards of living of the target groups; (iv) increase local employment and reduce urban migration; and (v) halt marginalization in areas subject to environmental deterioration. Three target groups were described: (i) small and vulnerable farmers in semi-arid and arid plains and upland, dryland farm areas; (ii) Bedouin herders who experienced loss of sheep due to drought; and (iii) small, mixed farm households in irrigated or high rainfall areas.

The goal of IFAD's operations is to enable poor rural people to improve their incomes and living conditions. To achieve that goal in this country, IFAD has focused for the last twenty years on enabling poor farmers to improve rainfed agriculture and manage natural resources more effectively, and on promoting off-farm income-generating activities. In the first four IFAD-supported projects, investments were directed mainly towards expanding cultivable areas and increasing production through land reclamation, particularly through the mechanical reclamation of stony agricultural lands in areas with a high potential for agriculture (ASZs 1 and 2).

In much of the arable land in ASZs 1, 2 and 3, a high proportion of surface and subsurface rocks of different natures (basalt, calcareous rocks or hardpan) has limited planting and the adoption of improved and mechanized techniques. This has been one of the most difficult constraints on small farmers. Thus the agricultural development strategy of the Government, supported by IFAD and other donors, embraced large-scale de-rocking as a mechanism for expanding cultivable land and productivity.

Relevance of IFAD's land-reclamation interventions to poor farmers

Nationwide surveys and poverty studies were carried out four years ago by the Government with UNDP support and independently by IFAD. They illustrated the regional dimension and supported IFAD's strategic choice to direct its attention to the needs and potential of the semi-arid eastern region, where there is a high concentration of poverty. Indeed, IFAD's Syrian strategy conforms to the Government's strategy for reducing poverty, as articulated in the last three five-year plans. IFAD has taken the lead in developing projects in integrated agricultural and rural development sectors that targeted poor people in rainfed areas.

The relevance of de-rocking as a pro-poor development strategy has been amply demonstrated by information on the profile of participants in the five supported projects and by the substantial increase in the productivity and quality of the reclaimed agricultural lands. The country programme evaluation (IFAD 2001) found that the increasing agricultural production, especially from rainfed areas, and the slowing of rural migration demonstrate that de-rocking has been an unmitigated success. The completion reports for JHADP (IFAD 2006) and SRADP-II (IFAD 2002) showed that, by and large, the design and implementation of IFAD-supported projects have been relevant to IFAD's target group and have brought substantial benefits. Given the nature and technical feasibility of de-rocking and soil conservation measures, benefits could not be limited to the poorest people, although, undeniably, more than two thirds of the participants belonged to the target group.

A 1999 survey for the mid-term evaluation of SRADP-II (IFAD 1999a) showed that 66 per cent of households had less than 2 ha developed, 21 per cent had from 2 to 4 ha and only 13 per cent had more than 4 ha developed. The completion report of JHADP (IFAD 2006) showed that some 5,000 families participated in the de-rocking programme, with an average uptake of about 4 ha per family. In the CMADP area, the average area reclaimed per household was 1.56 ha. Table 9 shows that the average uptake over all five projects was about 2.3 ha per household. As illustrated in the JHADP completion report, this is certainly an underestimation of the total number of families that benefited. The extended family factor as well as the land ownership and inheritance principles operating in the project area keep many young families living and sharing the land with their parents. Box 1 shows an example of such an extended family striving to improve their income and secure the future of their children. Haj Younes Abdelmajid considers that de-rocking of his basaltic land was the start of a new life.

To make its projects even more relevant, IFAD addressed smallholders' most limiting constraints (other than land reclamation needs) such as rural finance and access to new technologies. Complementary activities such as adaptive research, extension and marketing were included in the five projects to improve productivity and increase farmers' earnings. Specific interventions were also included for rural women, based on the need to increase household incomes and enhance women's socio-economic status.

Table 9 presents the number of households benefiting directly from land reclamation. As shown in Table 10, land reclamation components represented almost two thirds of the total cost of the five IFAD-supported projects.

Box 1 **Haj Younes Abdelmajid and his extended family in Ghour Village, Tel Daman, Jebel al Hoss**

Haj Younes Abdelmajid (51 years) has five sons and six daughters and owns approximately 45 ha of rocky land, of which only 5 ha was cultivated with cereals. The family owned 5 ewes. Until mid-1990 Haj Younes worked in Aleppo and Beirut, and he was among the first participants in the de-rocking operation, clearing almost 20 ha over 2000-2004. With project incentives and technical supervision, he planted 200 olive trees and cultivated improved wheat varieties and cumin on the cleared land. With good rainfall conditions, Haj Younes was able to increase his yields. This resulted in rapid improvement of his family's income, enough to build new stone houses next to the old mud house for his four sons who have married and now share the land. Four of his daughters have also married. Today Haj Younes owns his own tractor, and one of his sons has bought a car and started a business. The family raises 20 ewes and has made many improvements in the quality of their lives.

Table 9 **Total direct beneficiaries of IFAD-supported de-rocking activities**

IFAD-supported projects	Implementation period	Benefiting households target	Benefiting households actual	Total reclaimed area (ha)	Ha/benefit
SRADP-I	1982-1987	10 000	16 000	54 337	2.9
SRADP-II	1992-2001	17 600	29 000	58 442	2.0
JHADP	1995-2006	14 000	5 000	24 000	4.8
CMADP	1996-2006	69 000	16 930	26 505	1.6
IRDP	2003-2006	20 000	802	1 901	2.4
Total	1982-2006	138 582	70 652	165 185	2.3

Table 10 **Summary of the key financing parameters of IFAD-supported projects**

Projects	Approved date	Project cost (US$ million)	IFAD loan (US$ million)	De-rocking US$ million	Percentage of total cost
SRADP-I	1982-1987	65.6	8.7	24.9	38
SRADP-II	1992-2001	43.3	18.0	22.9	54
JHADP	1995-2006	29.1	11.9	18.3	63
CMADP	1996-2006	117.1	20.4	98.7	84
IRDP	2003-2006	46.1	17.5	27.2	59
Total	1982-2006	300.3	76.5	192.0	64

Synthesis of project experience

Targeting

Targeting of poor rural farmers and use of the participatory approach in land reclamation evolved positively over the last two decades through the five IFAD-supported projects. The report of the country programme evaluation (IFAD 2001) described these progressive changes in project design, implementation and impact on target groups. At the time of the design of SRADP-I, targeting and participation were not a real concern: the objectives were expressed exclusively in terms of land development, extension, input supply and credit. IFAD supported the Government's policies for increasing the productivity of rainfed land and discouraging urban migration, as well as directly addressing poverty in rural areas. The completion reports of SRADP-I and II clearly show the effectiveness, first, of the thematic targeting implicit in supporting de-rocking of low-productivity and near marginal rainfed land and, second, of the geographical targeting dimension – going to the upland and semi-arid plains of the southern Daraa'a and Sweida Governorates.

By 1992 IFAD's strategy in the country had been drawn by the SCGIM, which specifically identified targeting, participatory approaches and the need to prevent outflow of resources to the better-off as key areas of project design. The design of SRADP-II was undertaken concurrently with the SCGIM, in 1992. The SCGIM report addressed targeting issues, but primarily emphasized geographical/area targeting. It also gave priority to women's development and adopted self-targeting as the preferred instrument for reaching women. In conformity with these recommendations, IFAD cofinanced JHADP and IRDP, which targeted Group A (small farmers from the semi-arid plains and upland dry farm areas), and CMADP, which targeted Group C (farmers with 1-1.5 ha of irrigated land).

Specifically for de-rocking operations in IFAD-supported projects, targeting and participatory approaches evolved positively through increasing consultation with and sensitization of target groups. This was due to improved extension programmes and innovative communication support, and, more importantly, to the persuasive impact of the first de-rocking operations in the villages.

From initial hesitation and sometimes refusal, demand and motivation of poor farmers for cost-sharing grew rapidly to exceed the project's annual capacity. In addition, project operators, as well as the farmers, who were required to attend their land clearing, gained skills and better appreciation of the land quality improvement. This was reflected in their response to the land-development appraisal target that anticipated a higher demand by farmers for the establishment of commercial tree plantations on the de-rocked land, while the rest would be planted with cereals. On the contrary, the farmers did not accept partial rock clearing for the establishment of fruit trees, preferring instead a total de-rocking of their land.

In JHADP and CMADP there was relatively less emphasis on land reclamation, and supplementary irrigation was considered on a very limited scale. However, targeting remained linked to geographical area selection and was also expressed in terms of household earnings relative to the poverty line (as opposed to national per capita average income). Both projects introduced the village approach to targeting poor farmers. Provincial project management units selected villages with a higher incidence of poverty in which to begin the sanitization and extension programme. Within a village, the selection of the specific blocks to be developed was usually made by the village leaders and farmers, represented in part by the GUP. Local field units and project coordination at the governorate level supervised and guided the selection of priority zones based on their technical feasibility. IFAD's Learning Note 2.3 used JHADP, together with three other projects in the NENA region, to draw lessons learned on best practice for project targeting (IFAD 2007d).

Field examinations confirmed the previous IFAD completion evaluation results: most of the participants in de-rocking operations were smallholders with less than 4 ha of cultivable land in ASZ 1, and less than 8 ha in ASZs 2 and 3. This confirms that, despite the clear targeting strategy from the outset of the programme, there has been no undertargeting of poorer farmers. In fact, the staff of most IFAD-supported projects understood IFAD's mission and directed resources towards those areas with a preponderance of small farmers.

Participatory approach

As with targeting, beneficiary participation evolved positively, but at a much slower pace. The concept of community participation in land reclamation, as well as in other development activities, was not adopted in the first IFAD projects. It was IRDP, which is the last IFAD-supported project with de-rocking activities, that was designed on the basis of a community participatory approach. It seeks to increase the local role in planning and managing development needs, and increase farmers' sense of ownership and responsibility for infrastructure, thereby strengthening the likelihood that development efforts will be sustainable. As a result of the implementation delay, the project is able to progress in the application of this approach. It will strengthen community empowerment by involving informal village development committees actively in land-use planning, protection and exploitation of historical sites, preserving the irreplaceable natural assets of biodiversity, and participating in the identification and resolution of local problems.

The design of the first four projects with major de-rocking components placed the responsibility for implementation with MAAR. The GUP was involved at the governorate as well as the village level. It helped organize farmers' meetings and extension training sessions where project activities such as de-rocking and fruit tree development could be explained to potential participants. More particularly, the GUP cooperative societies helped small farmers by providing security for credit from CAB and for accessing agricultural inputs and machinery. And it is clear that these same cooperative societies will play a major role in the community empowerment structures of IRDP.

Contrary to the design stage, beneficiary participation during implementation of the de-rocking operation was more effective and brought the field unit and extension agents much closer to farmers and the village community. Active participation started at the first meetings at the village level to select contiguous blocks for de-rocking with community leaders, farmers and their GUP representatives. Once convinced, farmers discussed and decided in person with the field extension and project technical staff on the areas to be de-rocked and the cost-recovery contribution. Farmers were also present during the actual de-rocking operations to certify the number of working hours and to sign for completion of the work.

As discussed in the technical note in appendix 2, the mechanical raking and levelling operations are never enough for adequate clearing of the land and its final preparation for cropping or tree planting. It is the farmer's responsibility to collect the remaining rocks from the field. Interviewed farmers indicated that when the bulldozers and trucks leave their parcel, they will still have much work to do for final clearing of smaller rocks and rearranging the piles to free more land before starting tree planting or cultivation. SRADP experience indicates that about 5 per cent of all removed rocks in field crop areas and up to 10 per cent in the tree crop areas are removed manually. Indeed, this is a direct contribution and financial contribution of the beneficiaries that was not properly estimated in terms of the number of working days for the family members and hired labour – and often the hiring of a tractor and trailer. There is of course the direct financial contribution of beneficiaries to the operating cost of the machinery, collected as recovery cost. The farmers pay it either in cash or through a loan by CAB. The subsidized rental hourly rates for each type of equipment were established by Decree No. 259 of 21 July 1994. The charge for a 320-HP bulldozer, for example, was SYP 670 per hour, while the real cost, based on capital and recurrent costs, would be about SYP 1,712 per hour. Towards the end of 2006, the Government had revised the subsidized rates. For the same example of the 320-HP bulldozer, the rate was increased to SYP 800 for land reclamation within national projects and SYP 1,200 for work outside project areas. Thus the beneficiaries were contributing about 40 to 50 per cent of the actual cost. Even though the private sector has not been much involved in de-rocking operations, the hourly rate for renting the same bulldozer would be SYP 2,000-2,200. Taking the estimated hourly rate as a proxy for other equipment, CMADP compared the unit cost per hectare for land reclamation and for different ranges of slope degree to include the extra cost for terracing. Table 11 summarizes these estimates and shows that the current government rates are about 50 per cent subsidized.

Technical considerations and biophysical information availability

From the outset of the first large-scale land reclamation of 1977, as the National Fruit Tree Project and later extended to the Ali Al Ali Project, it was understood that the operation was technically and financially feasible, but that it was also complex and called for major technical assistance and applied research. The KfW project funded such programmes and developed a more scientifically and locally validated methodology for land reclamation planning and implementation. The main objectives of the operation are to selectively remove surface and subsurface rocks to allow small farmers to substantially increase the arable area of their holdings and to promote appropriate cropping (annuals and perennials).

Table 11 **Land de-rocking unit cost in United States dollars per hectare and per degree of land slope**

De-rocking cost US$/ha		Flat area	10%	10-25%	25-50%	50-75%
Subsidized cost using	With terracing	66	240	537	754	1 176
SYP 670/hour	Without terracing	92	280	603	846	1 333
Actual cost	With terracing	169	520	1 011	1 475	2 917
@ SYP 1,712/hour	Without terracing	138	621	1 180	1 711	3 422
Cost by private enterprise	With terracing	196	631	1 137	1 667	3 333
@ SYP 2,000/hour	Without terracing	275	749	1 333	1 941	3 922

Source: MAAR/CMADP (2006).

First of all, land reclamation was to be carried out only in technically suitable areas where land slope and rockiness do not exceed 25 per cent and 65 per cent, respectively. In fact, each combination of slope range, soil depth and degree of rockiness required a different technological package and type of heavy machinery and tools. Baseline surveys and land-use mapping are needed to establish land suitability for de-rocking and to assess the impact on soil productivity and the environment. The KfW-supported project developed the tools and trained national staff in land suitability assessment and mapping. The lack of soil information at the reconnaissance level (1/50,000 to 1/100,000 scale) limited the survey and mapping to selected priority zones for fruit tree establishment. Unfortunately, the methods and knowledge generated through this technical assistance were not adequately documented in operational manuals for further scaling up and training purposes. Most knowledge and innovations were preserved only in the memory of the trained and highly skilled engineers and field technical staff. Indeed, most of them played a leading role in the design, implementation and management of IFAD-supported land reclamation projects.

The first four IFAD projects with land reclamation components (SRADP-I & II, JHADP and CMADP), had no provision for land suitability and land-use mapping. Instead, the staff used their experience and acquired skills from previous projects to carry out rapid and direct field assessment of the degree of rockiness, slope, land use and potential impact in order to convince farmers, prescribe the right de-rocking methods and plan the field unit's organization and work plans. The CPE report and various supervision missions assessed implementation progress, pointed out the weakness of the M&E of the land reclamation component and recommended improvement of the planning and M&E methodology and tools. The design of IRDP in 2002 justified the necessity of conducting a semi-detailed soil survey, land-use mapping, sub-watershed delineation and characterization, and an environmental assessment survey at project outset. The General Authority of Remote Sensing completed the sub-watershed delineation and description for the IRDP area using geomantic technology (remote sensing, global positioning system [GPS] and geographical information system [GIS]). A comprehensive physiographical database and digital thematic maps of the project zone have been compounded (Syrian Higher Council for Remote Sensing [HCRS] 2006). The most important task remains to be done, which is to train the M&E and land reclamation planning units to use this GIS-based database for their day-to-day planning, targeting and evaluation of impact.

One more important information layer in this Idleb GIS is the digital detailed soil map currently under preparation by the General Council for Scientific Agricultural Research. The Idleb GIS will also include a very important information layer as far as environmental protection is concerned – the mapping of historical, cultural and archaeological sites that any de-rocking operation should avoid disturbing. The inventory and geo-referencing of the sites have been completed at central and governorate levels by the Directorate for Ruins and Museums of the Ministry of Culture, and the project is noting all the areas recommended for exclusion from land reclamation (Ministry of Culture 2006). Once again, the concerned units of IRDP need to acquire the digital files to integrate them into the rest of the information from the Idleb GIS.

The second major level of technical considerations concerns mechanical aspects of the de-rocking process: the type of heavy machinery used for each physiographical situation, the organization and equipment of the central shops and mobile repair units. So much information and knowledge and so many innovations have been generated during the last three decades. Now they need to be organized and disseminated. The technical note presented in appendix 2 provides a quick review of these considerations.

The disposal of removed rock. The profitable disposal and use of the large volume of basaltic and calcareous rocks removed have been a major technological challenge for land development technicians, but most importantly for farmers. With an average yield of 2,000 m^3 of rocks removed per hectare, the volume to be disposed of can be enormous. Much has been written about this negative side effect of de-rocking. The farmer's major impact is the loss of farmland occupied by the rocks, which can reach up to 10 per cent. The rocks removed are piled along the borders of the parcels and sometimes in the centre (see satellite view of cleared fields in photos 1). Farmers have been complaining that the mounds of large rocks formed along the borders of their parcels make a perfect habitat for rodents, reptiles and various other wildlife and crop parasites. Another major side effect relates to the aesthetic value of the landscape, which is negatively affected by these irregular stone walls.

Farmers have been able to donate or sell limited volumes of the rocks to neighbours and local construction companies. Removed rock was also used for the construction of stonewall terraces, fencing walls, or check dams across gullies and small riverbeds (photos 2). However, all attention and hopes were guided towards the option of crushing the rocks and screening them for the production of construction sand and gravel. This could be resold for major civil works and for the construction industry's growing needs in neighbouring cities and in road projects. A preliminary study of the technical and economical feasibility of the breakdown and crushing of the removed basalt rocks was conducted in 2004 at the SRADP project management unit. The need for construction sand in the project area was estimated at 750,000 m^3/year. Using essentially locally made hydraulic breakers (25m^3/hour, 50 tons/hour) and crushers, the study concluded that the option would be economically feasible (an economic rate of return of 11.5 per cent). However, the transportation costs and the high cost of energy involved in breaking and crushing did not encourage this attractive option. If applicable, it will absorb only a small portion of the large volume of rocks that have been piled along the fields. Farmers often request support for in situ breaking of the large rocks to facilitate their arrangement and piling along the field boundaries to minimize the area loss. Small hydraulic hammer breakers are required in basaltic fields.

Very often, the de-rocking operation is not 100 per cent effective following deep uprooting with the ripper. As stated earlier, the de-rocking process will continue during the following three to five years through tillage operations, and farmers will have to pick up and remove the stones (20-40 cm in diameter) and cobbles (7-20 cm in diameter) brought to the surface. Because of the high cost of manual picking, removing and transporting of the stones, farmers criticize the efficiency of the operation and request more help with this maintenance work, following the major mechanical de-rocking work. About 2.3 man-hours per cubic metre are required for manual picking of stones. Transporting the stones to the limits of the parcels also requires renting a trailer and tractor and thus extra cost.

Implementation arrangements. MAAR has been responsible for all development activities related to land reclamation throughout the various generations of agricultural development projects, from the National Fruit Tree Project (NFTP – 1977) to IRDP (see section II.C). For the last three decades, the Ministry has directly implemented the de-rocking operation with evolving and innovative approaches and arrangements. The mechanical work was to be planned and executed by MAAR technical staff operating a large fleet of heavy machinery, thus calling for intensive and progressive capacity-building. The mechanical de-rocking has always been integrated with other agricultural development operations. But it was in IFAD-supported projects that MAAR adopted an **integrated area approach** and a long-term capacity-building programme that proved to be more effective and sustainable. All IFAD-supported projects with de-rocking components adopted a holistic approach by integrating a set of key development measures and negotiating with various village communities in this way:

- selectively removing surface and subsurface rocks to allow small farmers to increase the cropped area, mainly by planting tree crops;
- involving beneficiaries in the process of decision-making through organization, training and sensitization to the objectives of the project;
- supporting adaptive research for fodder production, tree crop adaptation, water management, livestock development and pest control;

- strengthening extension services, with particular attention to tree crop activities; supporting livestock development through improved fodder production, use and feeding practices and the introduction of special programmes for women;
- improving rural water supply through the development, on a pilot basis, of rain and floodwater harvesting and spring rehabilitation;
- providing special assistance to rural women on both an individual and community group basis through intensive training programmes;
- introducing a pest management programme in order to ensure that tree crop products are acceptable to local and international markets;
- supporting rural women's groups in the design of income-generating activities and providing credit to enable rural women to undertake such activities. The strategy followed in developing the women's component made use of the capacity of existing women-oriented programmes and institutions (for example, the General Union of Women), rather than creating new structures;
- supporting adapted credit services.

Based on the experience gained by each new project, MAAR developed its implementation arrangements involving the central and regional planning units and well-equipped field units. Land reclamation activities were carried out in technically suitable areas where (i) the soil depth is

Photos 1

Removed rocks are piled (i) along parcel boundaries as property fences or (ii) in the middle of the field – there are always far too many to remove; (iii) aerial view of area de-rocked south-west of Hallab (Jebel al Hoss).

Photos 2
Rocks are used in the construction of soil and water conservation structures (stonewall terraces, check-dams, and river embankment and protection walls).

more than 30 cm and the rockiness is from 10 to 75 per cent; (ii) there are higher concentrations of project target groups per village or land unit; and (iii) there is higher beneficiary demand and willingness to participate in and contribute to project interventions. Beneficiary implementation of de-rocking and land development measures, according to land suitability, and a firm commitment to their future maintenance were prerequisites for participation in the project.

The approach followed in developing and implementing de-rocking operations was one of **realism and flexibility**, which facilitated gradual beneficiary participation and the development of technical solutions in a participatory manner appropriate to the needs of the target group. The major cause of implementation delays was difficulty in the timely procurement of heavy machinery.

Financing mechanisms

Following successful pilot mechanical de-rocking operations in the late 1970s, the Government called on international agencies for more technical assistance (GTZ, FAO) and cofinancing through loans (KfW and IFAD). Following the KfW cofinancing of the Ali Al Ali Project (DEM 96.8 million), IFAD took the lead by cofinancing five consecutive projects focusing on land reclamation, in the amount of US$76.5 million out of a total cost of US$300 million. The de-rocking and land development were coupled with a cost-recovery mechanism designed to benefit primarily those with the least resources, so that those with more assets would be asked to make greater contributions. The unit cost charged to farmers was SYP 670 per bulldozer working hour and SYP 315 per front-loader working hour, irrespective of the task performed (i.e. clearing, ripping or raking). These charges, later augmented moderately in the light of increasing fuel costs, were not determined on the basis of actual costs but by a MAAR committee, and they reflect government policies in terms of capital subsidization to encourage farmers to remain on the land and to increase national production (table 12). Part of the loans went through subsidiary loan agreements to CAB, which played a major role in implementation of the various land reclamation programmes. CAB provided medium- and long-term credit to participants to finance de-rocking sharing costs and subsequent land development operations. Finally, the participant's contribution was essential during the major mechanical de-rocking work and in the following years, as explained earlier. Farmers were the determining factor in the success of the de-rocking operations and their sustainability.

Table 12 **Official subsidized rates of equipment**

Type of equipment	Make	Power (HP)	Rate (SYP/hour) as of July 1994[a]	Rate (SYP/hour) as of November 2006[b]	Rate (SYP/hour) outside land reclamation programme[c]
	Komatsu 355	420	900	1 000	1 500
	Komatsu 155	320	670	800	1 200
	Caterpillar D8K	320	670	800	1 200
Bulldozers	Caterpillar D8K	250	500	800	1 200
	International	220	440	550	825
	Fiat Alice	220	440	550	825
	Caterpillar D7F	220	440	550	825
	Caterpillar D6K	140	350	450	675
	Inter 175 S	150	370	450	675
	Track Loader – Fiat Alice 220	220	440	550	825
	Caterpillar 950	150	315	400	600
Loaders	Wheel Loader – Fiat Alice 155	155	315	400	600
	Case WB6C	194	420	500	750
	Track Loader – Caterpillar	160	370	450	675
	Track Loader – Volvo	140	315	400	600
	Case W24C	132	290	400	600
	Case B1845	45	130	150	225
	Caterpillar 50	200	430	500	750
	Mitsubishi 105	105	285	350	525
	Wheel Benati	90	260	300	450
Backhoes	Case H688	90	260	300	450
	Bobcat Clark	90	260	300	450
	Wheel	75	235	300	450
		90-110	180	210	315
Tractor		70-75	145	170	255
		45-50	100	115	175
Tankers	8-12 m^3	250	14	16	25
	16-18 m^3	300	18	23	33

[a] As per Decree No. 259 of 21 July 1994.
[b] As modified by Decree 84/IM of 28 July 2004, effective as of November 2006.
[c] Rates for tankers apply to round trip plus a surcharge of SYP 50 for 8-12 m^3 tanker and SYP 70 for 16-18m^3 tanker.

Complementary activities in relation to agricultural production

The land reclamation component was designed to be integrated with other activities for improving land productivity and farmers' livelihoods. Fruit-tree planting required assistance in introducing improved practices and water-saving technologies. The completion reports of the first four IFAD projects provide ample information and assessment of these complementary activities, such as surface and groundwater mobilization (small earth dams and ponds, spring rehabilitation for supplementary irrigation, introduction of drip irrigation technology), and market-linking infrastructure such as feeder roads and markets.

However, the most essential complementary activity in support of land reclamation was the support to extension services. Indeed, extension support was the key success factor in land reclamation. KfW- and IFAD-supported projects are commended for developing the approach and deploying well-adapted, innovative field units. In IFAD-supported projects, the design of the extension subcomponent called for establishment of a demand-driven agricultural extension service with strong links to research, using a modified 'training and visits' system having a regular programme of visits by trained extension agents to contact farmers.

Projects worked with the Directorate of Extension to reinforce and optimize extension coverage in each project zone. They provided capacity-building, adequate means for field mobility, and appropriate information on best practices. Linkage with national and international research and academic institutions was successful in providing the needed information and field demonstrations of agronomic and ecological best practice. This was not the case when the need to improve the mechanical operations of de-rocking arose. Local engineers and field technical staff had to solve problems in the workshops of the heavy fleet and innovate solutions through a trial and error approach to adapting the imported machinery and tools to specific local conditions (topographic, soil, climatic, farming system and socio-economic). Results from the extension programmes are overall satisfactory.

Monitoring and evaluation

IFAD-funded projects were designed with a special focus on M&E and a unit was always assigned to carry out M&E activities. The 2001 CPE and recent completion reports showed that M&E performance was poor. Most M&E units performed satisfactorily in the monitoring of implementation planning and progress, but only moderately in the qualitative function of evaluation. Land reclamation M&E required a special focus on the technological and physical aspects of implementation as related to landscape, soil qualities, productivity and environmental considerations. Thus not only the socio-economic aspects were to be covered.

The first GTZ/KfW technical assistance programmes designed and proposed sophisticated land and soil quality M&E parameters that were demanding on the 'very busy' technical units, and their outsourcing to research and academic institutions was not successful. Baseline soil surveys and land-use mapping were needed to establish the true impact on the environment of changes in land use. Only in this way could projects judge the sustainability of introduced farming systems or recommend measures to counter land degradation. However, IRDP is the only project carrying out a baseline soil survey through GCSAR. The proposed methodology was based on preparation of an integrated farm plan by field units in close collaboration with agricultural extension units, but it was not applied because it required data and time that simply were not available. Staff assigned to field units were not sufficiently trained to carry out the farm planning on prepared topographic maps. In fact, the entire mapping approach and means were not introduced in the land reclamation operations despite an excellent start and demonstration by the pilot phase of the Ali Al Ali Project. Also, participating farmers could not play the anticipated active role in the preparation of farm plans. The final plan would have to meet their approval, and according to field unit engineers, there was simply no time for that, given the heavy load and pressing annual programmes.

The evaluation of the land reclamation operation at project completion was based on a comparison of adjacent farmers with and without the project de-rocking intervention. Because of the simplicity of de-rocking and its sharp and drastic impact on soil quality and land productivity, many impact assessment exercises were successfully conducted with contact farmers and a good sample of participants (MAAR/ACSAD 2005a; IFAD project completion reports).

Socio-economic impact

De-rocking has a dramatic impact, similar to that of irrigation in dry areas. Farmers have seen their planting areas doubled. Their land becomes more productive and more valuable, and their incomes increase. Wheat yields have increased by 30 per cent and orchards have been planted on about 60 per cent of reclaimed land. The production of apples, almonds and olives has more than doubled in the past decade. IFAD-funded projects account for about 40 per cent of that increase. Agriculture is an important sector of the Syrian economy and a key to achieving food security. Yet only one third of the country's total area is cultivated. The barren nature of much of the land and the scarcity of water resources, including low rainfall, hinder agricultural development, underlining the utmost importance of land reclamation of almost half a million hectares.

The contribution to asset formation of the four land reclamation projects has been substantial in four regions and consists of de-rocking, fruit tree establishment, and associated actions, such as provision of improved irrigation, drinking water, and agricultural extension units. The MAAR/ACSAD (2005a) land reclamation assessment study and the information and evaluation reports provided by the project management units show that the economic impact on participants has been positive and substantial – increased agricultural productivity and surplus produce for sale, land development, supplementary irrigation, increased incomes and, to a lesser extent, income diversification.

The de-rocking impact study using M&E records of benefits and beneficiaries in selected villages showed that the operation was quite profitable for the farmer who was able to cover the cost of land reclamation in one season. The figures of production gains through land reclamation are greater than those predicted at the design stage. Soil quality was greatly improved (depth, fine particle percentage, water storage capacity, infiltration), and the value of the land increased by at least 300 per cent following de-rocking and land quality improvements. In the M&E assessment, the effects of CMADP's agronomic technology adoption raised annual agricultural production by at least 15 per cent. Project completion evaluations were unable to prepare an overall recalculation of the economic internal rate of return (EIRR), owing to the non-recording of benefits and late implementation of the major land reclamation work. MAAR/ACSAD (2005a) used the same farm models as the appraisal economic analysis, and confirmed the estimated EIRR of 22.5 per cent per annum over 30 years. The impact of the four-year delay in land reclamation has certainly altered the EIRR stability by reducing the positive effect on benefits flow of good climatic conditions.

According to M&E unit records, the MAAR/ACSAD study and the CMADP supervision report by the United Nations Office of Project Services (UNOPS), the income of beneficiaries of land reclamation has increased substantially and they have made enough of a return to improve their living conditions. Mission interviews with random beneficiaries in the four governorates confirmed the magnitude of the incremental gains. MAAR/ACSAD (2005a), in cooperation with the M&E unit, used the farm models as described by the appraisal report and updated the figures based on data collected. Three examples of farmers will illustrate this situation. They are from the village of Almoa in Hama (being the poorest area among the four areas of the project), with a land size of 1 ha or 10 dunums (table 13), and they used the de-rocking services of the project. Because the level of rockiness and slope is different in each case, the cost of land reclamation was different: (i) farmer A – SYP 8,000; (ii) farmer B – SYP 8,500; and (iii) farmer C – SYP 10,500.

These farmers are able to cover the cost of land reclamation in one season and still see a profit: (i) farmer A: 14,000/8,000*100 = 175 per cent; (ii) farmer B: 14,800/8,500*100 = 174 per cent; and (iii) farmer C: 14,500/10,500*100 = 138 per cent. The operation is quite profitable for each farmer. In the following season, profit will increase regularly and families will have savings to improve their living conditions. The mission collected even higher figures in Lattakia and Tartous – when tobacco was planted with improved soil depth and moisture regime and low stoniness, income almost doubled. In Jebel al Hoss, farmers who shifted from cereal crops to cumin following land reclamation and soil quality improvement, reported greatly increased gain and profitability (IFAD 2006). One can imagine the important impact that was foregone due to the low implementation rate of this component. Such impact involves increased income for poor farm families, expansion of agricultural land, and thus increased national agricultural patrimony, employment creation in rural areas, and reduction of migration to the cities, which will reduce demographic pressure on urban areas. There is also an increase in land values and productivity, as well as availability of agricultural products that further strengthen the country's food security.

Table 13 **Impact of land reclamation on productivity and income**

Farmers from Almoa Village	Crop	Unit	Total land reclaimed	Total expenditure	Yields in kg	Price SYP /kg	Gross revenue in SYP	Net profit in SYP
Farmer A	Rambling Vetch	Dunum	10	8 000	1 800	11	19 800	11 800
Farmer B	Barley	Dunum	10	8 500	2 300	10	23 000	14 500
Farmer C	Wheat	Dunum	10	10 500	2 000	12	24 000	13 500

Environmental impact assessment

IFAD-funded projects with a major de-rocking component have been subject to an environmental and social impact screening and scoping exercise. They have all been classified 'A' or 'B' based on the extent and magnitude of the potential adverse environmental impacts likely to result from project interventions in land reclamation, land development and change in the farming system. While most project actions were designed to improve land capability and enhance sustainable development, the design reports identified four possible negative environmental impacts and mitigation measures were prescribed: (i) land de-rocking and its subsequent soil surface disturbance risk increasing runoff and soil loss on slopes greater than 5 per cent if soil and water conservation measures are not implemented; (ii) in improving agricultural practices and cropping large areas (more than 10,000 ha) of new land, more chemicals will be used. Project extension, the promotion of agricultural best practices and establishment of erosion control measures will help mitigate this threat; (iii) changing land use and natural vegetation cover would harm natural reserves and the invaluable sources of biodiversity. Projects must implement land de-rocking on private land with prior assessment of its capability and biodiversity potential. Most of the land reclaimed was already under crops, but with very low soil quality; and (iv) archaeological, historical and cultural sites could be damaged by de-rocking operations. A full and detailed inventory and GIS-based mapping of those sites by or under the supervision of the relevant public authority is a prerequisite for the planning of land reclamation programmes. The IRDP environmental impact assessment provides the methods used and the enforcement system. For the identified potential risks and several others not cited, measured adoption of conservation-orientated methodologies and mitigation measures against possible adverse environmental impact should be prescribed and implemented.

All four projects introduced a phased process approach for land reclamation and development to ensure that: (i) only land suitable for changes in the production system according to full land evaluation parameters is developed; (ii) development is planned to fall within the guidelines set for crop suitability and farming systems; (iii) banks of plant biodiversity are located, identified, mapped and afforded in situ protection against interference; and (iv) cultural, historical and archaeological sites are identified and plotted, and perimeters demarcated to avoid damage or desecration.

Projects will introduce and promote new production system packages to farmers through extension, for both tree crops and field crops, based on conservation farming practices. These will cover a range of cultural practices, including optimization of techniques such as the use of terracing, introduction of a wide range of new soil conservation measures, and establishment of windbreaks in new orchards. Soil and water conservation works and farm management practices that have been promoted have contributed to arresting further degradation of the fragile ecosystem, restoring natural vegetation cover, reducing runoff and soil loss, and enhancing soil fertility and resistance to erosion.

Associated with the land productivity improvements, projects will promote integrated-pest-management systems, field sanitation techniques and ley farming through extension (IFAD 2002, 2006, 2007e). The introduction of these practices has the potential to significantly reduce economic losses due to pest damage, implies less reliance on fertilizers to maintain soil fertility and reduces the use of agricultural chemicals.

The installation of small on-farm cisterns for water harvesting is in conformity with and an essential part of the integrated farm plan. The project will provide technical assistance and support for site selection and appropriate design of the cisterns. Thus they should not have any significant adverse environmental impacts. The rehabilitation of existing Roman wells, which in reality are ancient versions of cisterns, will not cause significant environmental concern.

As described earlier, interventions complementary to land reclamation, such as construction of small earth dams and rehabilitation of existing *ramat* (natural or manmade collection ponds) did not show negative environmental effects. Indeed, these water mobilization and saving works were an integral part of natural resource management in the watershed/sub-catchment development plans for improved use of seasonal floodwaters through water harvesting on a pilot basis. The earth dams, although small, have a potential positive impact on flood control and groundwater recharge.

Regarding the specific environmental impact of de-rocking, IFAD (2001) raised the two major concerns about land reclamation that are illustrated below. First, it was reported in some regions that rocks were reappearing on the surface a few years after mechanical de-rocking, and second, that land reclamation is causing more soil erosion. The CPE mission reviewed the four IFAD-funded project zones with farmers and local field staff. It conducted field checks to see to what extent the two risks were real and, if so, what mitigation measures to prescribe.

- **Rocks reappearing on the surface** were not common or prevalent, and when this process was reported on some farmer's parcels, the explanation was, in fact, the limited effectiveness of the original mechanical de-rocking and of the rake type used. Indeed, with land originally highly infested with rocks on the surface as well as in the subsurface (50-75 per cent), the mechanical rake was limited to the upper 30 cm. Thus many rocks buried below 30 cm were not collected immediately. In this case, field unit staff would explain to the farmer that rocks may surface in the coming years as the soil surface (0-40 cm) becomes compacted to stable bulk density and if the farmer uses deep tillage tools (disks or chisel). It is a normal phenomenon, and the farmer should expect extra work every year following tillage operations to collect the rocks that are uprooted.
- **The concern related to soil erosion** is a real one, and if de-rocking of land with a slope greater than 5 per cent is not associated with adequate soil-erosion control measures, it will lead to severe land degradation and all its consequent disturbances (flood, silting up of reservoirs, pollution, etc.). The project design as reflected in the appraisal report was very strict regarding these risks. Any land reclamation of soil with a slope greater than 15 per cent was required to be completed with terracing or stone walls along contour lines. The 15 per cent slope limit is still too high: soil erosion measures need to be installed beginning with slopes of 6 per cent. The spectrum of soft techniques[26] is wide, and farmers can choose the most suitable for their farm. There was no soil erosion survey prior to land reclamation in the region, but the field visit did reveal some major soil erosion processes due to land reclamation. On the other hand, the extensive terracing networks that CMADP established on the slopes of hilly areas in Lattakia and Tartous make this project a typical watershed management programme. Photos 3 illustrates this reality in the field.

26/ Biological techniques and small earthworks that can be managed with normal farm machinery.


Photos 3
Establishing stonewall terraces following de-rocking on the slopes in Tartous on the left. The picture on the right illustrates the combined result of de-rocking plus terracing, which provides full protection from soil erosion, an improved soil fertility and moisture regime, and better landscape aesthetics. If conducted as recommended, de-rocking will yield major environmental protection.

Sensitization programmes and dissemination of environmental information were carried out by trained extension agents, who explained the objectives and impact of de-rocking and land development. In Lattakia and Tartous, soil erosion and local flooding with wasted runoff water are common topics that farmers discuss now, and they are aware of the benefits of soil erosion control measures. They see that the network of terraces and stone contour walls built by the project retain runoff water and create a much more agreeable landscape. Unfortunately, CMADP did not carry out an environmental impact assessment, as the project was rated category B at appraisal. Such a study could have demonstrated the positive impact of soil and water conservation measures at the watershed level, and most importantly, could have shown how much the project is contributing to the preparedness of the region and of farmers to future climate change impact on water balance and hydrological disturbances.

Extension programmes also addressed moisture and land conservation. Training/information sessions were organized for extension agents and farmers on integrated pest management and problems related to the use of organic manure. Assertions by farmers and local leaders that CMADP did not cause any major increase in the use of agrochemicals could not be confirmed by the project management unit staff in the absence of an environmental impact assessment. In any event, however, there would be no major pollution risk to groundwater given the hydrogeological features of the coastal/midlands hilly areas.

The mission visited the four governorates of CMADP, Jebel al Hoss, and the rolling plateau and mountainous region of the southern zone. It confirmed slight to moderate soil erosion processes on slopes of 5-8 per cent, considered as thresholds for surface runoff and accelerated sheet erosion. There are signs of some sheet erosion on cropped fields, but not at an alarming rate. Before this form of land degradation can spread, with up and down slope ploughing, soil erosion control measures need to be promoted for new lands with greater slopes. In the region of Homs and Hama, with mild slopes, the presence of large stones and blocks suggests use of discontinued stone contour walls that projects have already implemented. The mission proposed the use of elements of stone walls, which should be constructed in quincunxes to allow easy movement of tractors and

Photos 4
Erosion signs on de-rocked land with slopes >6 per cent and illustration of the recommended control measure adapted to the field layout.

other mechanical equipment when the parcel or field width is small, as illustrated in photos 4. Soil fertility of the new land is high, but it needs to be preserved by improving rotation (legumes and cereal crops) and by the use of organic fertilization. CMADP, for example, has succeeded in promoting better land husbandry with the implementation of integrated agricultural activities.

The mission confirmed that none of the land reclamation implemented in the region encroached on or disturbed any known historical or archaeological sites. This is a major risk that was identified in IRDP, and precise mapping was conducted in order to avoid any accidental encroachment. A similar assessment was conducted for natural biodiversity in the region. The only concern was the de-rocking and cultivation of natural forest or ecological reserves. Indeed, in Lattakia, some private farmers who owned land with natural cover (forest or shrubs) converted part of it to fruit tree plantation. In this case, as can be seen in photos 5, land reclamation was conducted under sound soil and water conservation measures (strip cropping, terracing, lateral drainage, waterways, etc.). To conserve natural vegetation, farmers and project staff conserved strips of natural plants, which can even be used intensively to collect medicinal, aromatic and ornamental plants.

Another evident positive impact of the project was improvement of the quality of life and health of thousands of households that benefited from the village water supply.

Photos 5
Land reclamation with biodiversity conservation in mountain areas: terraces built after de-rocking in Lattakia, showing strip cropping with natural vegetation to conserve biodiversity. With improved soil quality and moisture retention, medicinal and aromatic plants are thriving, with positive impact.

IV. Lessons learned

The successful implementation of four IFAD-funded projects with land reclamation components clearly indicates that the Government has the capacity to effectively conduct de-rocking operations on smallholder farms. Indications are that machinery can be used well after project completion, thus adding considerably to projected benefits and sustainability. Indeed, the key element is the truly admirable technical capacity developed in diverse regions to maintain motorized equipment of all kinds, using it for durations that are far in excess of designed machine lifetimes.

Land reclamation through de-rocking has a positive and sustainable impact on farmers' incomes and livelihoods only when the reclaimed land is effectively used. Improved farming systems were developed – mainly of orchards with supplementary irrigation or other cash crops such as cumin or tobacco.

Land reclamation, if conducted as prescribed, has a positive impact on the environment and biodiversity.

Adaptive research and extension systems played major roles in the success of land reclamation.

The following lessons learned from workshops and field units will be given due consideration in future project design:

(a) Komatsu bulldozers averaged nearly 2,200 hours annually over an average working period of 11 years. Thus up to 2,500 hours could be reasonably expected per year over the first six years of operation.

(b) Spare part needs have been clarified through experience, with more emphasis placed on hydraulics, the undercarriage and gearbox.

(c) Genuine manufacturers' spare parts should be used.

(d) Five or six bulldozers are appropriate in a field unit that is organized along the lines of SRADP-I.

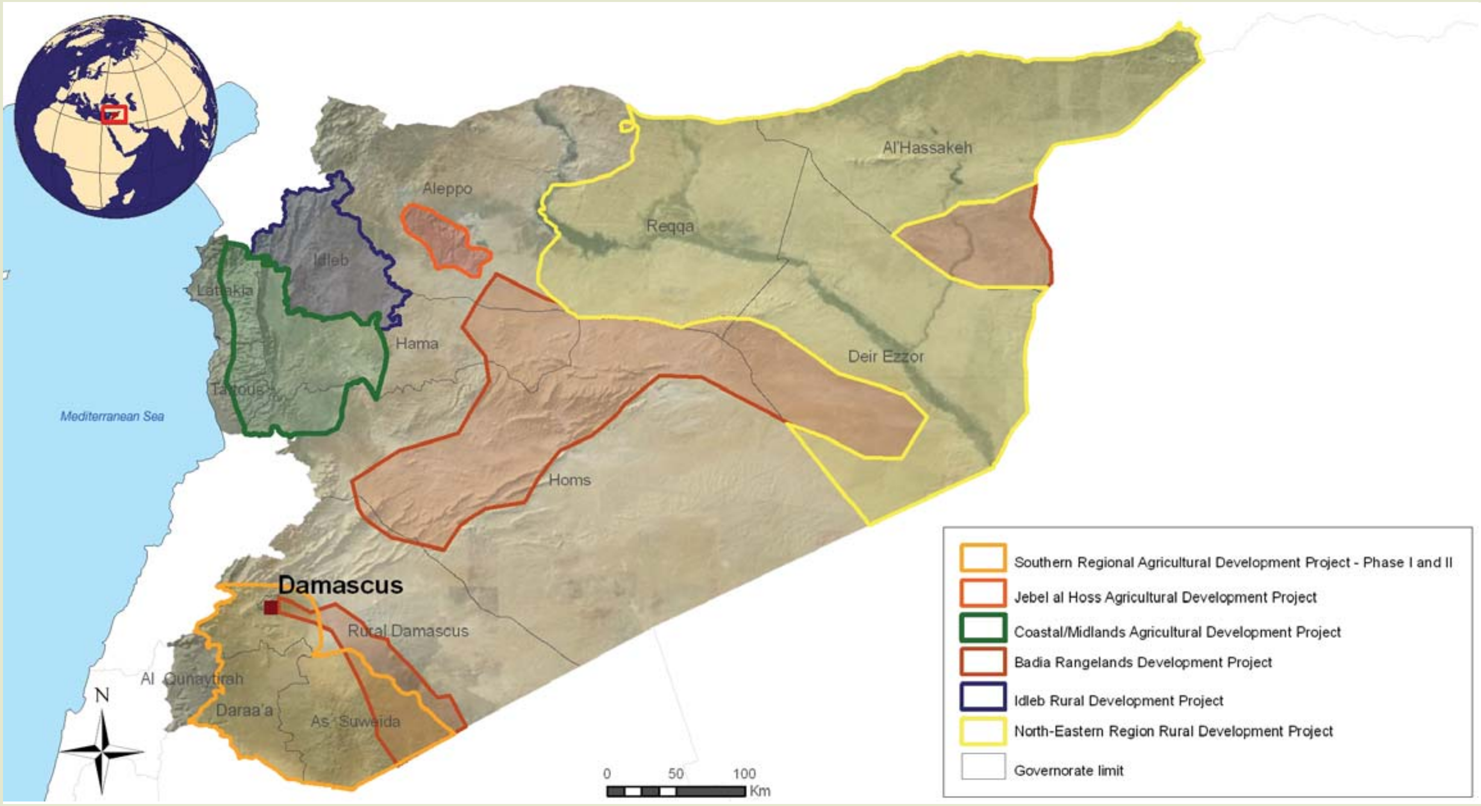
(e) Because the raking operation is more sensitive to soil conditions than are clearing, terracing or ripping, there should be sufficient operational flexibility to allow concentration on raking when conditions are suitable. Flexibility can be achieved through the provision of interchangeable blades and rakes.

(f) Larger bulldozers (400 HP) are justified for ripping purposes, particularly in situations with very large rocks or with layers of solid rock.

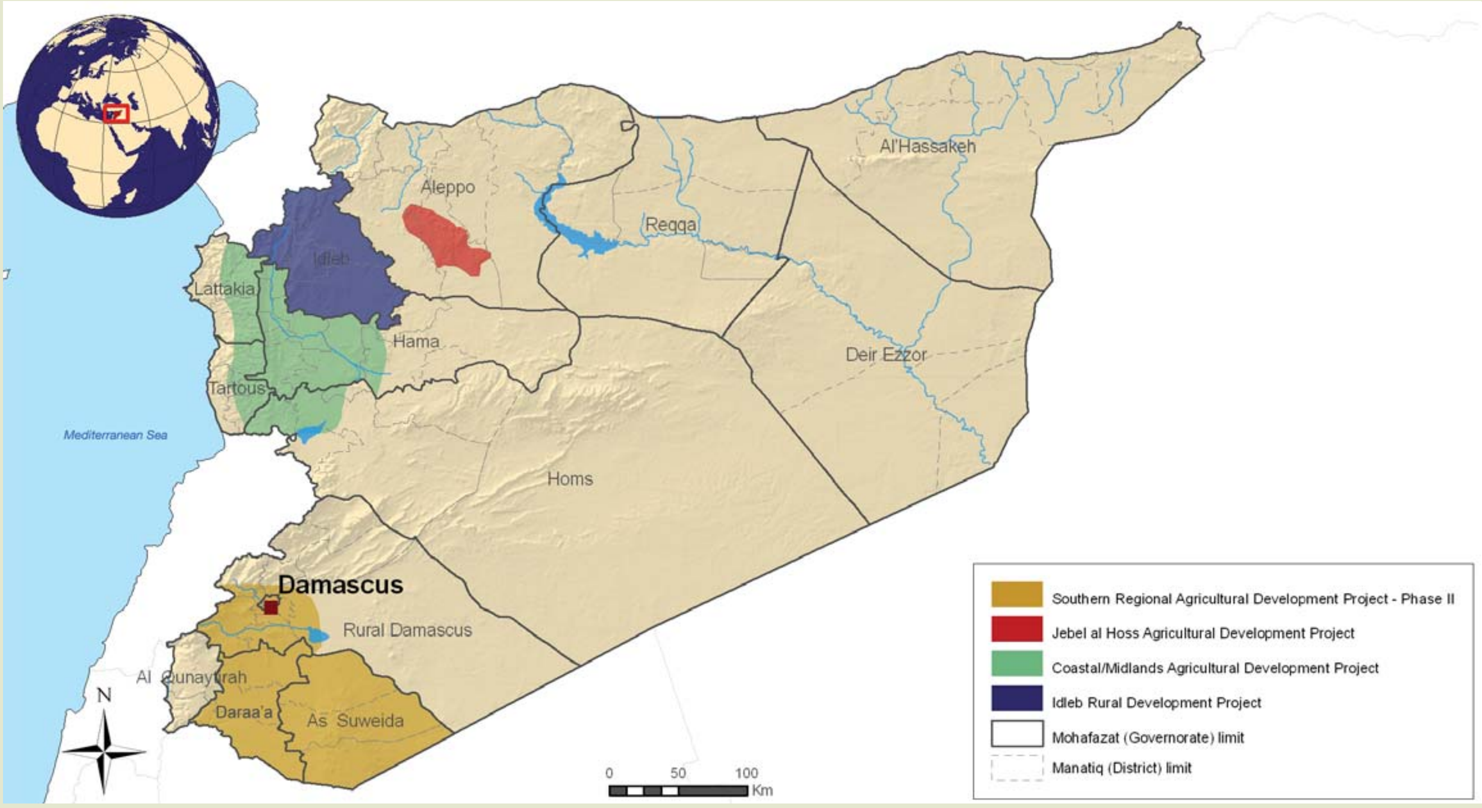
(g) Komatsu bulldozers showed adaptability superior to Caterpillars under the specific conditions of the Syrian landscape.

Appendix 1
Thematic maps

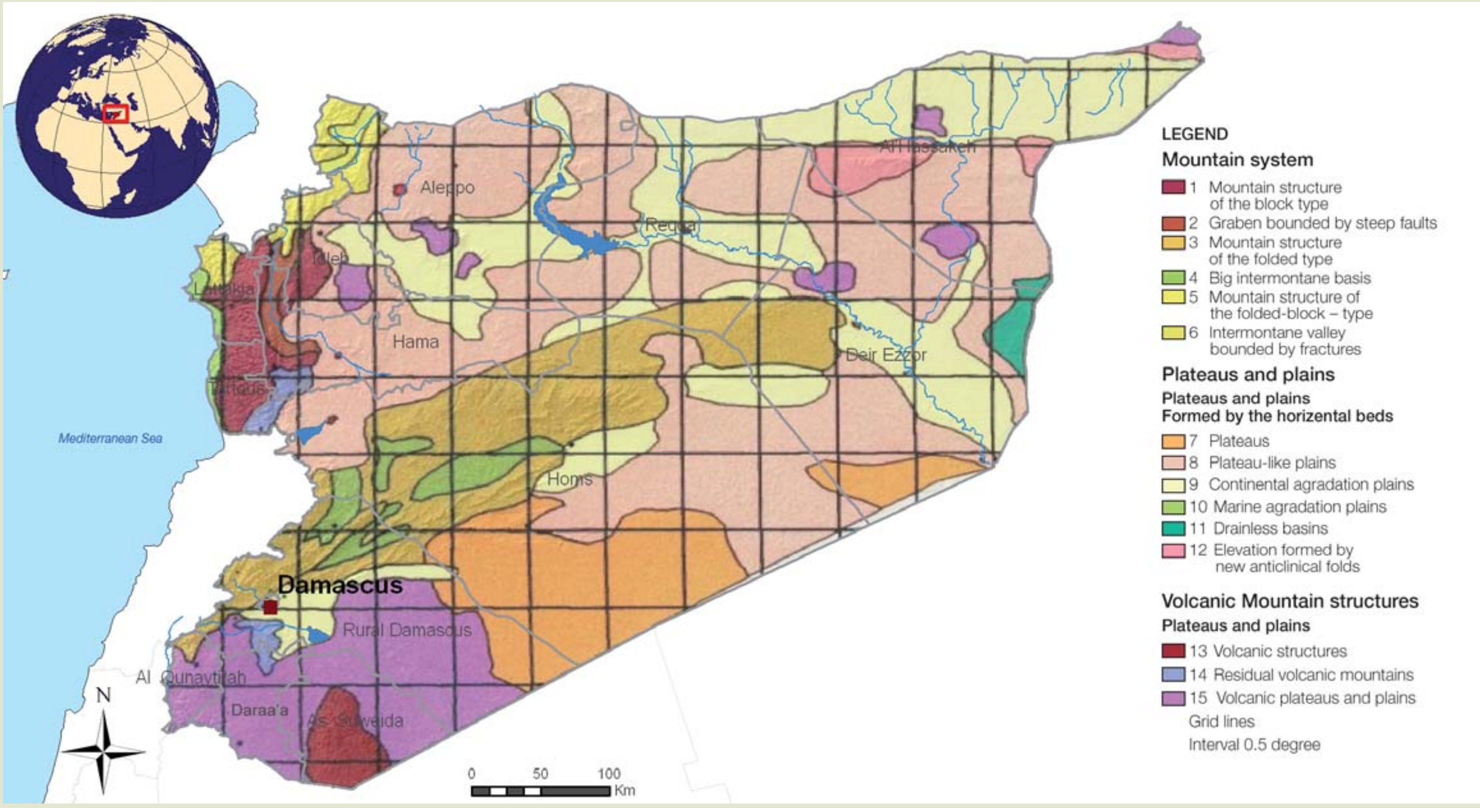
Map 1 **Administrative map – governorates and project areas**



Map 2 Location of IFAD-cofinanced projects with a major land reclamation component

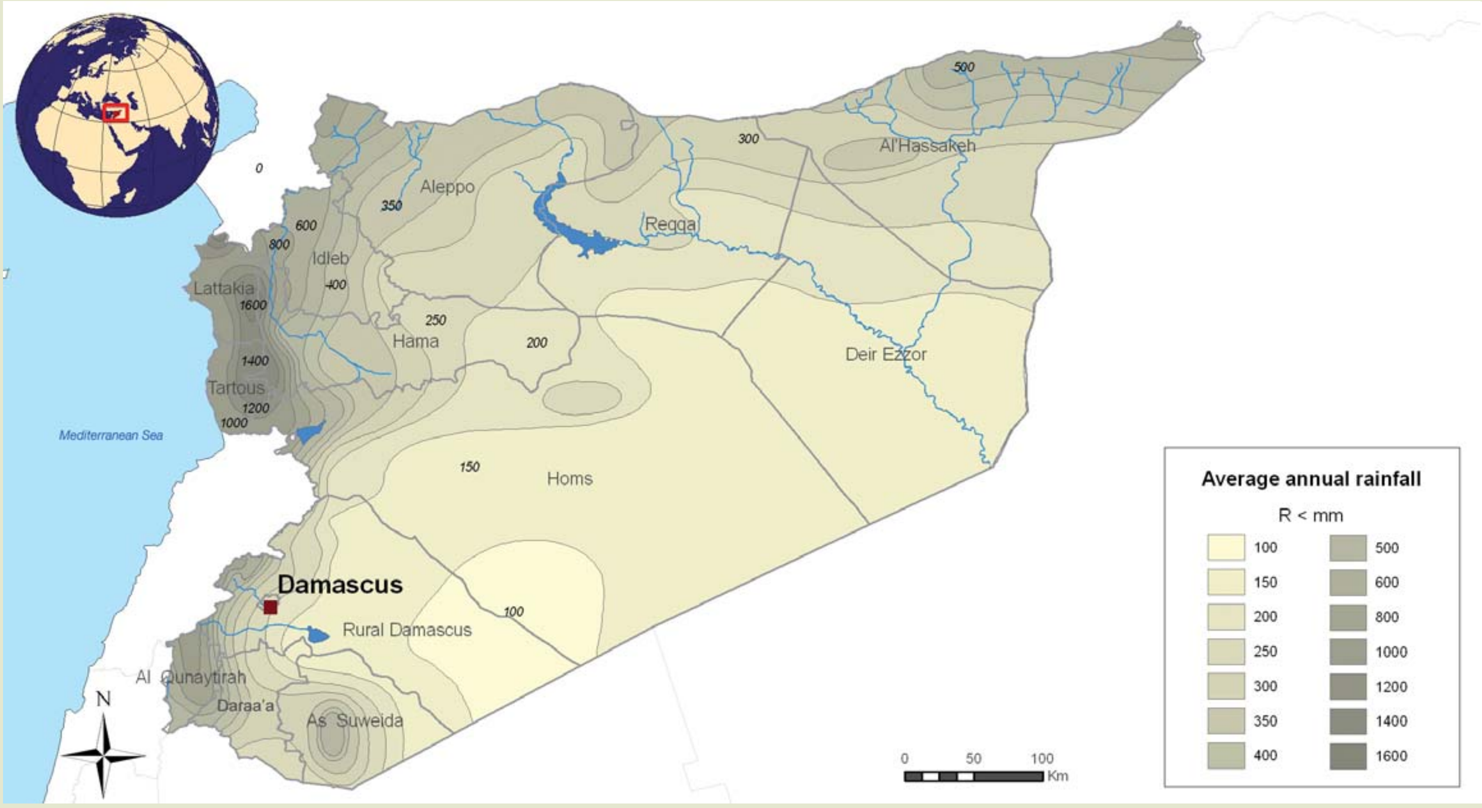


Map 3 **Geomorphological map**



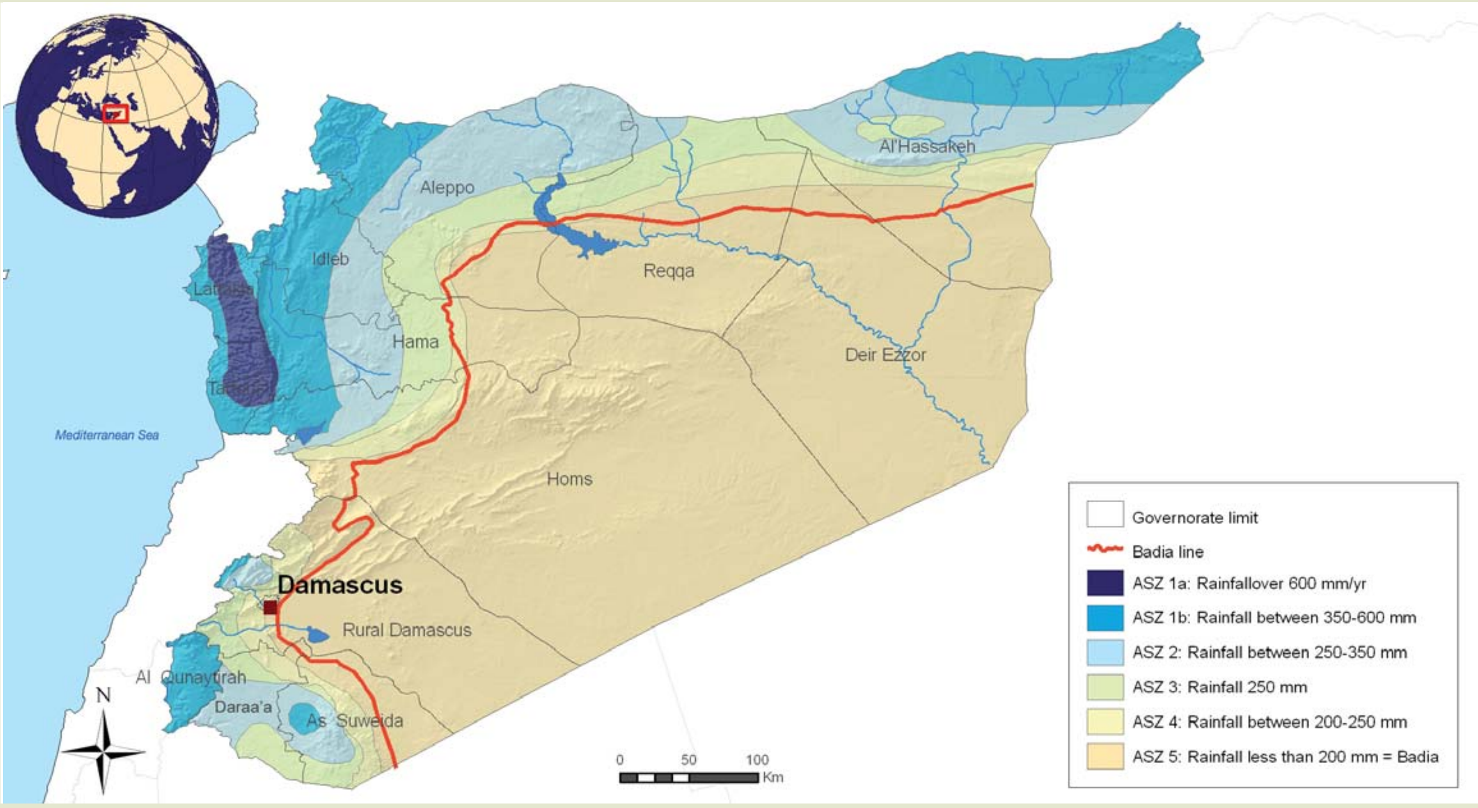
Source: FAO Gateway to land and water informations and the Syrian Ministry of Agriculture and Agrarian Reform (MAAR) – 2006.

Map 4 **Rainfall distribution**



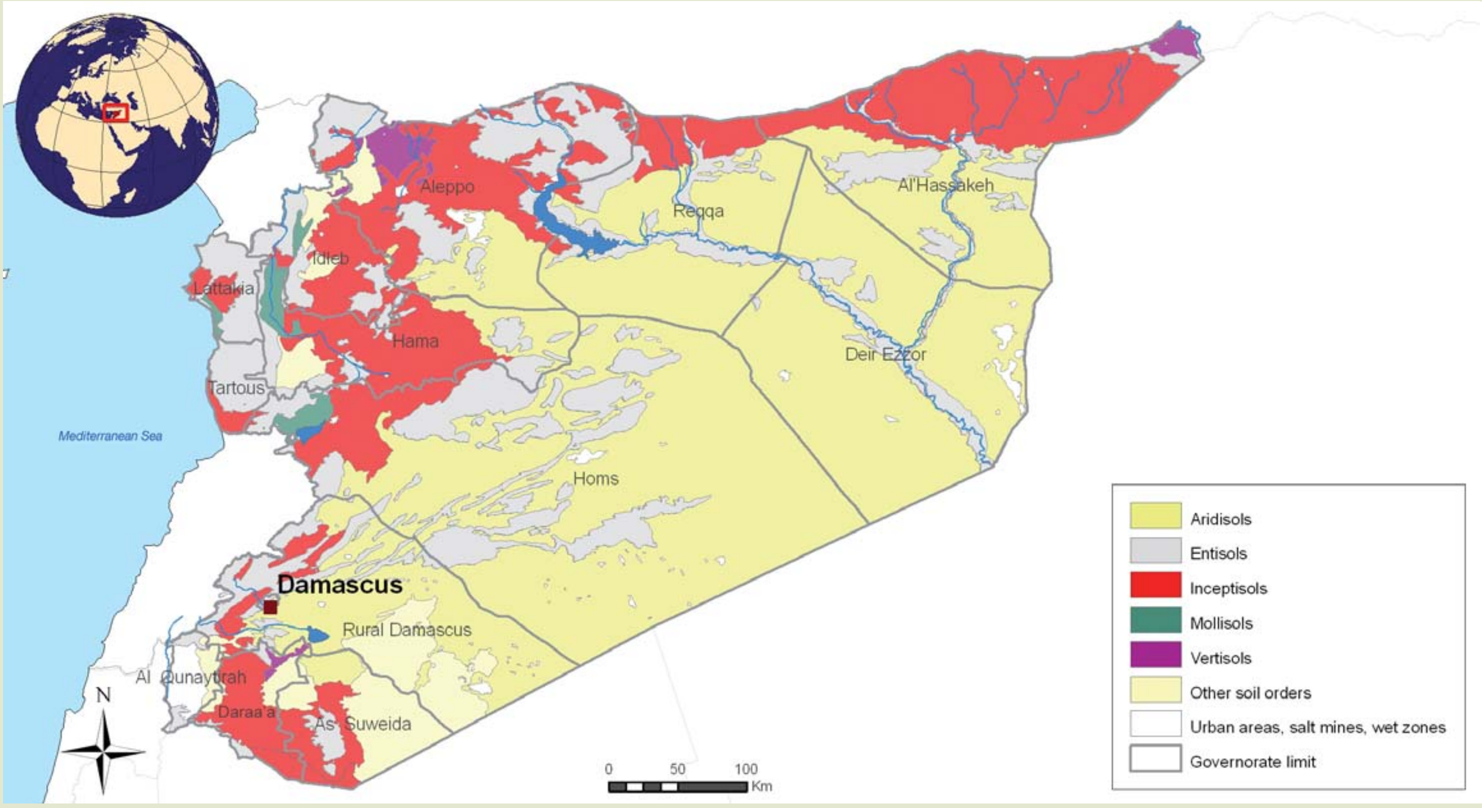
Source: MAAR/GCSAR – 2006.

Map 5 **Agricultural settlement zones (ASZs)**



Source: MAAR/GCSAR – 2006.

Map 6 **Soils map (published at 1:500,000, GCSAR – Damascus)**



Legend

Soils are spread over the following five orders of the 1975 USDA Soil Taxonomy (Ilaiwi 1983).

Aridisols: Are the most extensive soils in the country. As a general rule, they occur when the annual rainfall drops below 250 mm. They cover about 50 per cent of the country. The following suborders are formed:

- **Calcids:** Dominate the largest part of the soil with an aridic moisture regime. They cover about 20 per cent of the total area. Their main occurrence is in the south-eastern part of the country, including the Syrian part of the Hamad plateau and most of the Syrian desert. They also dominate some units within Mesopotamia, the Bichri Mountains and the Resafah desert.
- **Gypsids:** Is the second important suborder within the Aridisols. They also cover about 20 per cent of the total area. Their occurrence as dominant soils is due rather to the composition of the parent rock. Syrian Gypsids are usually characterized by high gypsum content. They dominate the central and southern parts of Mesopotamia, including the Euphrates and Khabour terraces, the northern part of the Syrian desert and a large part of the Bichri Mountains.
- **Cambids:** Dominate a few intermountain valleys and depressions in the south-west. Their main occurrence is as associated soils with the Calciorthids. They are estimated to cover about 3 per cent of the country.
- **Salids:** Dominate some desertic depressions with shallow saline groundwater. They also occur as associated soils with the Entisols of the Euphrates and Khabour valleys.

Entisols: They are mainly represented by the Torrifluvents, Torriorthents and Xerorthents. The Torrifluvents cover the Euphrates and Khabour lower terrances; they also occur in some desertic plateaux.
- The Torriorthents are mostly represented by the lithic subgroups; they occupy about 7 per cent of the country, dominating large parts of the Antiliban and Palmyrian Mountains. Fifty per cent of them are also found as major associations with the Calclorthids of the Hamad plateau and the Syrian desert.
- Lithic Xerorthents cover about 6 per cent of the total area. They are chiefly confined to the western mountains. They are also found along the Euphrates River near the Turkish border and in Jabal Abd el-Aziz.

Inceptisols: Are the second most extensive order. Apart from a few volcanic ash soils in the south-west, they are entirely represented by the Xerepts.
- The Xerepts are the most extensive suborder, covering about 25 per cent of the total area. They occur along the northern border with Turkey and east of the coastal mountains in the west.
- Calcixerepts and Haploxerepts represent the Xerepts. Calcixerepts have the largest extension. The distribution of this great group is mainly related to the amount of rainfall.

Mollisols: Occur in areas receiving the highest rainfall, dominating about 2 per cent of the country. They are mostly represented by the Haploxerolls, of which the lithic subgroup is the most common.

Vertisols: Cover about 1 per cent of the total area and are mainly represented by the Haploxererts. Haplotorrerts dominate only the Balikh Valley. The Chromoxererts develop typically at a rainfall amount of 500 to 600 mm. They dominate three units in the north. They also occur in major and minor association with the Xerepts.

Source: MAAR/GCSAR – 2006.

Appendix 2

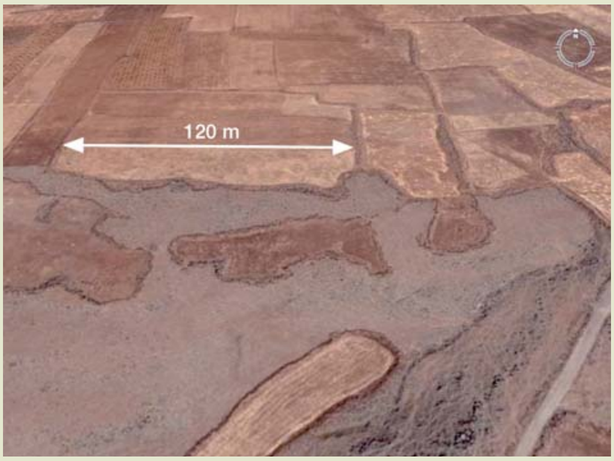
Technical note on the de-rocking process

Based on lessons learned from successive land reclamation projects, de-rocking methods and practices had been established and scaled up. A large number of field unit managers and technicians were highly trained in the planning and conduction of different operations of the process. The technical methodology has proved very successful, and operations have been undertaken to a high standard.

The process developed and used in IFAD-supported projects consisted of the three major operations described below. However, the mechanical field operations have to be preceded by two major tasks; the land capability and suitability assessment for de-rocking and the socio-economic feasibility survey. Each of these prerequisite steps, numbered '0' below, deserves a technical manual to collect and document the information and knowledge generated by projects. It is also important to note that the final land clearing and its development through improved farming systems is crucial to the profitability and sustainability of the land reclamation process. All IFAD-supported projects developed an effective extension system and complementary activities in relation to agricultural production on the reclaimed land. The KfW-supported project invested much effort and funding in technical assistance and applied research to develop a specific knowledge base and innovations. Unfortunately, this was not accompanied by an effective system for capitalizing on the knowledge management plans and exit strategy. Most of the knowledge and innovations generated by these land reclamation projects remain in the memory of the managers, field engineers, extension agents and farmers. Most of the learning was technician-to-technician and farmer-to-farmer.

Step 0 Land evaluation and farmers’ engagement

De-rocking rationalization, planning and impact assessment require semi-detailed land surveys (at least at the 1:50 000 level) which were not available in the rainfed zones. Land capability mapping and soil surveying started in the 1950s at general reconnaissance levels. KfW supported a de-rocking programme associated with the Ali Al Ali Project, developed the methodology and applied it to priority zones. IRDP mandated and funded surveying and mapping of soil types and qualities, including degree of rockiness and land reclamation needs. This programme is being carried out by the GCSAR soil survey team. The recent development of GIS and high-resolution satellite remote sensing makes the survey faster, more precise and inexpensive. Surface rockiness is assessed and mapped using six classes, combining percentage surface coverage by rocks, average dimension or size (cm), average distance between rocks and the degree of difficulty in conducting agricultural operations. Class I is for soils with surface rocks of less than 2 per cent; Class II surface rockiness is high enough to limit some agricultural operations, but still allows crop cultivation, 2-10 per cent; Class III, with 10-25 per cent rockiness, is high enough to limit cultivation – land can only be used for improved rangelands; Class IV is for rocky land of 25-35 per cent – no agricultural mechanization is possible; Class V is for very rocky land with shallow soil surface horizon – no cultivation is possible; and Class VI, with over 90 per cent surface rockiness, is reserved for rock outcroppings with no soil.



Soil surface showing precise delineation of high surface rockiness (>60 per cent), as viewed by Ikonos Satellite.

Source: Google Earth.

Step 1 **Clearing**

Initial clearing of loose rocks and boulders to a depth of about 20 cm if the land is not to be terraced. Where terracing is required (slope >15 per cent), the land is terraced and cleared of surface rocks in one operation. This clearing is done using a front-mounted bulldozer blade, usually a so-called Semi-U blade fitted to a 300-HP bulldozer. These blades are 3.2 m wide, slightly concave in shape and can be raised, lowered and tilted sideways. Wheeled loaders, because of their much greater speed in comparison with track-tractors,[a] are useful in assisting with clearing operations in areas with loose surface rocks. The usefulness, however, is limited where stones are partly but firmly embedded in the soil. In such situations, bulldozers with blades need to be used.

[a] Track-tractors will be referred to as bulldozers in this report. Horse power (HP) ratings are approximate; for instance 300 HP would mean 310 and 320 HP in the cases of Caterpillar D9ss or Komatsu respectively.

Step 2 **Ripping**

Ripping to about 90 cm depth to bring rocks to the surface. The same bulldozers used above are fitted with rear-mounted three-shank rippers operated hydraulically. In SRADP and JHADP, the rippers operate at 60-70 cm for field crop areas and 70-90 cm for fruit tree areas. Where the rocks are not excessively large or consist of fragmented pieces, the ripper shanks are able to get underneath them, thus making the rock-loosening operation relatively fast.

In situations where very large rocks or solid slabs of rocks predominate, the operation is much slower and single-shank 'giant' rippers are advantageous, preferably fitted to bulldozers with greater power (400 HP).

This is the case with calcareous formations, where the bulldozer could be standing on the same block the ripper is trying to uproot. The Ali Al Ali Project was the first to justify and demonstrate the efficiency of the 400 HP bulldozer equipped with a single-shank ripper for ripping purposes in basaltic or solid calcareous surface formations.

Step 3 Raking

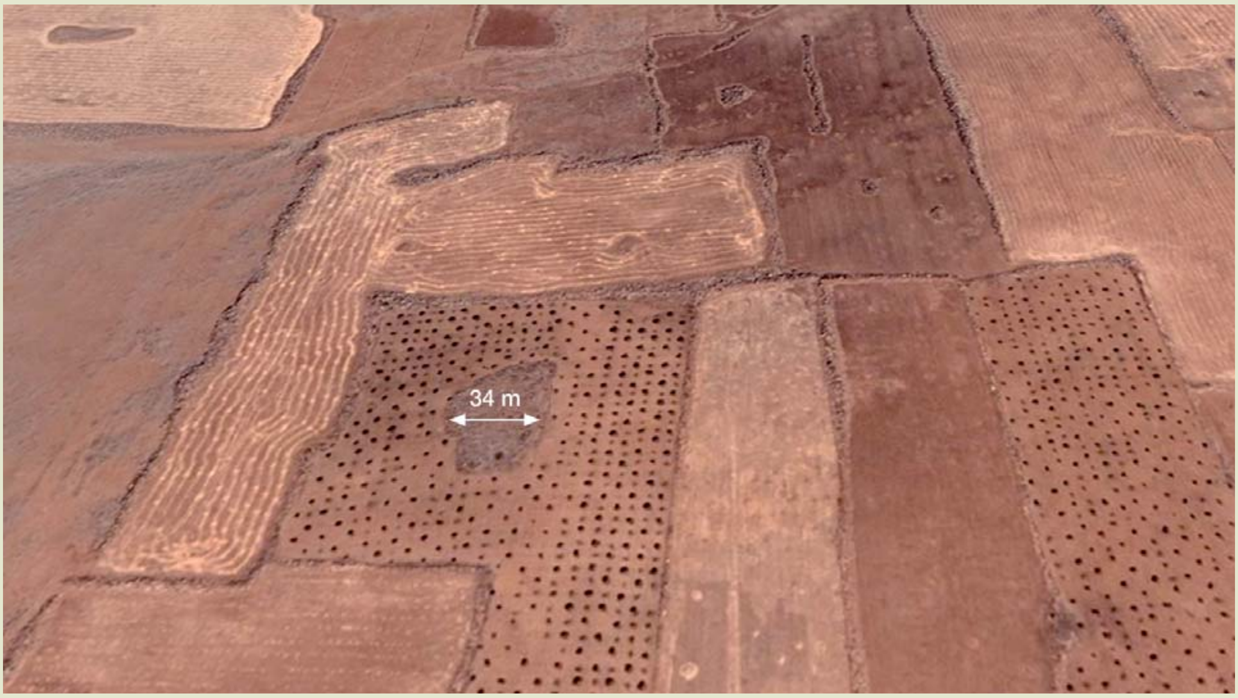
Raking rocks of over 30 cm in diameter and levelling the land, using a medium bulldozer (200 or 320 HP) with a front-mounted toothed rake blade. This operation removes rocks, but leaves the soil. In most cases, the rake operates at a depth of 30-40 cm in field crop areas and 30-50 cm in tree crop situations. The rake blade is 3.25 m in length, with 11 rake rods spaced 30 cm apart, which collect rocks of over about 25 cm in diameter. It took a lot of thinking, trial and error, and innovation by the field units and repair shops to adjust and propose a well-adapted rake for basaltic and other solid slabs. This last operation was very critical, because it was usually supervised closely by the participants. It was shown that soil moisture conditions are critical, because if the soil is not sufficiently dry, it tends to bind and accumulate with the rocks to be removed, resulting in a bulldozing action rather than a raking movement. Removal of topsoil is undesirable. Bucket loaders (equipped with 2.3 m^3 buckets or larger) are used to assist in the final clearing processes, particularly when rocks accumulated by rakes have to be moved some distance. With farmers' approval and suggestions, the rocks are piled along the parcel limits or somewhere in the middle when they are not removed to a distance if there is a waterway or area with no surface soil.

No precise data was collected on the volume of rocks removed from a unit hectare or dunum. SRADP reported an average volume of 100-150 m^3 of rocks per hectare to be removed in field crop areas and 150-250 m^3 where tree crops were to be grown. The volume would vary with the initial level of rockiness, the lithology of the land and the de-rocking process. If the average volumes reported for the CMADP appraisal mission area are relatively low, a recent study by a MAAR technical committee on the feasibility of breaking and using the removed rocks, used an average volume of 2,000 m^3/ha (MAAR 2005). A recent field survey for the impact study of a similar de-rocking operation in Morocco under calcareous formations suggested an average volume of 1,200 m^3 (MADRPM/DPA-O 2005). In all of the reclaimed land areas visited by the mission, the rocks were piled along three borders of the parcel and the cross section of the piles was from 2 to 3 m^2. Aerial photography and high resolution satellite views (see Ikonos satellite views of JHADP area) show the magnitude and various dispositions of the removed rocks in the field.

Photos © N.R. Mahaini and CMADP

Raking (cont.d)

A small percentage of the volume of rocks removed is used for the construction of houses, donated or sold. More than 90 per cent is used to construct stone walls around the parcels or is left piled in the middle of the field. A feasibility study showed that volcanic rocks can be crushed mechanically and sold as gravel and sand for the construction industry and civil engineering works. In the field, farmers are still complaining about the large size of some rocks removed (>100 cm). The use of a mechanical crusher (hydraulic hammer) can break down large rocks to facilitate their removal and use in the construction of well-shaped fencing walls, construction or masonry.



Photos © N.R. Mahaini, 2007

Jebel al Hoss area: Land initially with a high degree of rockiness (50-75 per cent) yielding more than 2,000 m^3 of rocks to be piled in the middle of the field or disposed along the border of each parcel.

Ikonos Satellite view. Source: Google Earth.

Step 4 Terracing

Clearing and land preparation for agricultural production

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Cover:
Civil Engineer Ahmen Aldahi and farmer Hilah Alosh discuss the soil in an olive grove in Quinetre. The land has been cleared of volcanic rock by the project.
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International Fund for
Agricultural Development
Via Paolo di Dono, 44
00142 Rome, Italy
Telephone: +39 06 54591
Facsimile: +39 06 5043463
E-mail: ifad@ifad.org
www.ifad.org
www.ruralpovertyportal.org