THE TURKISH EXPERIENCE IN CONSOLIDATION OF IRRIGATED LAND:
PRODUCTIVITY AND EFFICIENCY IMPLICATIONS

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Paper prepared for presentation at the
“2017 WORLD BANK CONFERENCE ON LAND AND POVERTY”
Abstract

Increased population and nutritional needs worldwide make it imperative for policy makers to consider measures toward enhancing farm productivity and hence increase agricultural production from the same limited land resource base. Increasing crop yields from per unit land area can only happen by the adoption of new farm technologies and by alleviating structural deficiencies in the farming sector that impede productivity. One of the key structural constraints in the agricultural sector in Turkey is directly linked with land fragmentation. The sole remedy for land fragmentation is reversing the process via land consolidation. When applied in rainfed farming conditions, land consolidation unleashes huge economic and social benefits. When applied on irrigated land, however, economic and social benefits associated with land consolidation are amplified further due to the double effect of significant cost savings during infrastructural development and enhanced operational efficiency on the farm. One of the very important side benefits of land fragmentation is that it also helps refresh, update and complete the cadastral records which improve tenure security and increase agricultural land values.

Key Words: land consolidation, land fragmentation, efficiency, irrigation, productivity

Key Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>DSI</td>
<td>State Hydraulic Works</td>
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<tr>
<td>GDAR</td>
<td>General Directorate of Agricultural Reform</td>
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<tr>
<td>GDLRC</td>
<td>General Directorate of Land Registry and Cadastre</td>
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<tr>
<td>LC</td>
<td>Land Consolidation</td>
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<tr>
<td>LF</td>
<td>Land Fragmentation</td>
</tr>
<tr>
<td>MFAL</td>
<td>Ministry of Food Agriculture and Livestock</td>
</tr>
<tr>
<td>O&amp;M</td>
<td>Operation and Maintenance Cost</td>
</tr>
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</table>
The Turkish Experience in Consolidation of Irrigated Land: Productivity and Efficiency Implications

1. BACKGROUND

**Formal Definition of Land Consolidation:** GDAR in Turkey defines land consolidation as the process where fragmented, scattered and unfavorably shaped land parcels under private ownership are optimally rearranged and recombined in suitable geometrical shapes to facilitate modern agricultural practices and irrigation.

**Enabling Legislation:** In Turkey, land consolidation (LC) is carried out according to the provisions of two different laws, and the procedural steps of implementation are generally similar. These laws consist of the "Agricultural Reform Law on Land Rearrangement in Irrigated Areas" numbered 3083 and “Law on Soil Conservation and Land Use” numbered 5403. The Ministry of Food, Agriculture and Livestock (MFAL) is the responsible agency for all LC implementations (or projects) under the provisions of both laws referenced above. In addition to these laws, there are a few important regulations, directives and bylaws that should be cited. These are the "Regulation on Implementation of Agricultural Reform Law Regulating Land Regulation in Irrigation Areas", the "Land Consolidation Technical Directive" and "Land Consolidation Bylaws", all of which were issued in support of the Law 3083. Under MFAL, the General Directorate of Agricultural Reform (GDAR) is the authorized agency and executive arm for implementing and supervising LC projects in accordance with the Law 3083.

Regarding LC in irrigated areas, the specialized agency for irrigation development is the State Hydraulic Works (DSI) which operates under the Ministry of Forestry and Water Affairs, and which acts under delegated authority from to carry out LC under GDAR’s oversight.

**Important Distinctions for LC Applications in Turkey:** LC has a predominantly rural and agricultural character in Turkey. The urban-based land rearrangement activity (of which limited consolidation may be a part) is related to zoning and land development in the cities. LC projects in Turkey are carried out via two principal methods: compulsory and demand-driven. As stated above, LC can be implemented by GDAR (or authorized sub-agencies or entities to meet their land acquisition need in order to provide
public services) on rainfed (dry agriculture) and irrigated land (irrigated agriculture). In rainfed land, the sole lead organization is the GDAR, while on irrigated land, DSI, another government agency, is authorized to undertake LC in conjunction with irrigation development. The purpose of the paper is to highlight the importance and impact of LC on irrigated land.

2. THE BASIC MOTIVE FOR LAND CONSOLIDATION

Land consolidation is the exact opposite of land fragmentation (LF). We start by looking into what causes LF, and then reflect on why and how this could be remedied.

**Primary Causes of Land Fragmentation (LF):** GDAR identifies five major causes underlying land fragmentation in Turkey, as listed below:

- LF emanating from the civil code (inheritance),
- LF caused by building irrigation and drainage infrastructure and canals,
- LF caused by general infrastructure development (transport, network, roads, railways, etc.),
- Voluntary property subdivisions by partial sales, and
- Expropriations made by various institutions.

It is useful to elaborate further on the causes of LF and try to understand the negative consequences associated with it. As noted above, population pressure, inheritance and higher intensity of land transactions give rise to land fragmentation and spatial scattering of the fragmented land. Below is a summary of some of the negative consequences of LF.

**Why Carry Out Land Consolidation:** The basic motive for land consolidation is to be able to reverse the effects of LF, which have arisen for one reason or another. When we look closely into the negative impact of land fragmentation, the need for land consolidation on irrigated areas, in particular, emerges as a critical issue which warrants attention and intervention. Key factors that render LC inevitable consist of the following.
• Fragmented land, or more appropriately stated, fragmented land plots lead to reduction in the effective cropland area due to allowances that must be made for field boundaries, feeder roads and irrigation infrastructure (canals).

• Farming in small parcels is highly inefficient because farmers avoid planting too close to the field boundaries in order not to disable access to the fields.

• Use of farm machinery is especially inefficient when farming is practiced on small parcels of land, because a higher proportion of empty space must be allowed relative to the field sizes to maneuver the farm machinery, again leading to reduction in effective cropland area.

• Using fragmented land plots, the farmer operator usually spends a significant amount of time moving from one parcel to another which can be eliminated if the fragmented parcels are consolidated. This will offer savings in time, labor and fuel.

• It is both an inconvenience and a challenge trying to make effective use of farm inputs on small parcels which are often oddly shaped. As the number of fragmented plots decreases via consolidation, field sizes increase and their geometrical forms improve which greatly facilitate the application of agricultural inputs such as seeds, fertilizers and chemicals.

• When irrigation infrastructure is built to serve fragmented land holdings, engineering designs for roads and canals must closely follow the existing boundaries scattered and irregularly shaped parcels which entail higher investment costs during construction and higher operation and maintenance (O&M) costs during operations. Both the irrigation and transport efficiency improve significantly after land consolidation, whereby each larger and geometrically shaped parcel will now border the irrigation canal (or a line of hydrants) and the road.

**Measures to Control Land Fragmentation:** Turkey has so far taken a number of measures to prevent and control LF. These measures are the legal arrangements that aim to minimize fragmentation of agricultural lands. They are listed below.

• **Indivisible Parcel Size:** The so-called concept of “Indivisible Parcel Size” was recently introduced. This measure is intended to prevent the subdivision of special croplands and marginal agricultural lands to levels below 2 hectares, cultivated agricultural lands below 0.5 hectare and the greenhouse
agricultural lands to levels below 0.3 hectare. The sale of agricultural parcel shares whose size is under the Indivisible Parcel Size was prohibited in 2007.

- **Sale Prohibition:** As a result of investigations and detailed studies lasting more than a decade, the “Law on Soil Protection and Land Use and Revision on Turkish Civil Law” was prepared and adopted in order to prevent the fragmentation of agricultural lands in 2014.

**Why Should LC be Considered a Priority Investment:** Turkey places high priority on LC, and has allocated significant financial resources to speed up this process. Some specific justifications for urgent LC interventions are presented below.

- The incidence of land fragmentation has reached such a level that it is inhibiting the growth and productivity of farming.
- Due to land fragmentation the resulting parcels have become so small and so misshapen that carrying out the necessary agricultural development services in the field has become burdensome or impossible.
- In the existing irrigation service areas many parcels do not have direct access to service roads, irrigation and drainage infrastructure. This is giving rise to social unrest in the rural areas.
- Additional infrastructural investments, such as state highway construction, complementary irrigation canals and soil conservation measures have exacerbated the existing problems by causing further fragmentation of the parcels.
- Due to the topographical layout of the fields, land leveling must be performed without regard to legal parcel boundaries, but which is rendered impossible due to fragmented and small parcels.

We shall expand on these points in the next section with particular emphasis irrigation-related aspects.
3. IMPORTANCE OF LAND CONSOLIDATION FOR IRRIGATION

Overview: Irrigation infrastructure built without prior or accompanying land consolidation follows the existing land ownership patterns and tries to cater to farmers' needs under the existing conditions. This means that the infrastructure must follow longer and sometimes highly inefficient routes to enable farmer access to irrigation water and roads (to get the crop out of the fields) while avoiding undue social stress, which may otherwise arise due to conflicts in rights of way and inequities in accessing water. Over and above the high expropriation costs for land, infrastructure building on fragmented land parcels is wasteful, where significant efficiency must be sacrificed to be able to deliver the irrigation service to the farmers. Despite all the effort, there still may be many farmers who do not have sufficient access to the irrigation water and the roads.

Therefore, parallel to the adoption of modern irrigation technology (such as closed pressurized systems not needing land acquisitions for siting the infrastructure), land consolidation is the key measure for building more rational irrigation infrastructure and hence realizing the attendant economic and social benefits. The Turkish experience shows that if land consolidation can be implemented at the designated farming areas prior to building the irrigation infrastructures, there will be savings in the order of about 40% in both the investment and O&M costs.

At the farmer level, irrigation systems based on rational engineering design helps save money, time and labor, and hence boost productivity. In addition to these benefits, farmers have an easier time implementing other productivity enhancements, such as land leveling, drainage and construct other on-farm structures, normally excluded under general public investments.

Some Observations on the Need for LC on Irrigated Land: Factors necessitating LC on irrigated lands can be summarized as:

- Since the 1950s, a large number of irrigation projects have been completed in Turkey at various scales.
• An assessment was made of these irrigation schemes, which revealed that the irrigation ratio\(^1\) is as low as 66% for well-managed farming enterprises, and 33% for not so well-managed enterprises.
• As a result, even in well-managed farming enterprises, 34% of the irrigation infrastructure (investment) cannot be utilized, while 66% of the investment is wasted on poorly operated plants.

**Land Consolidation for Irrigation under DSI:** As already pointed out, in Turkey only two public agencies are mandated to undertake land consolidation: the State Hydraulic Works (DSI) and the General Directorate of Agricultural Reform (GDAR). Work done by DSI, however, is subject to GDAR’s oversight.

The very first land consolidation project in the country was implemented in 1961 in the Konya/Cumra locality under the General Directorate of Rural Services (GDRS - now defunct). The bulk of agricultural land consolidation was actually spearheaded by GDAR and occurred from 2007 to 2016, targeting some 3.5 million hectares of both dry and irrigated cropland.

Since 2009, DSI has been more actively involved in land consolidation. This responsibility was assigned to DSI under the Soil Conservation and Land Use Law No. 5403 and the regulation titled “Agricultural Land Conservation, Use, and Consolidation”. From 2007 to 2016, DSI implemented land consolidation projects on 540,000 ha of irrigated land in 32 provinces. The strategic focus of this massive undertaking is embodied in the agency’s strategic plan for 2015-2019.

While the average farm size is 16 hectares (ha) in the EU countries, it is only 6 ha in Turkey, implying that the average farm size of 6 ha may not be the economical operation size. Meanwhile, the average number of parcels per farm in Turkey exceeds six. Hence the average parcel size is approximately 1 ha, whereas the average parcel size varies from 1.8 to 4 ha in the EU. So far, only a small fraction of the farmland could be consolidated, leaving behind a massive agenda of unfinished work.

There are over 3 million farm households in Turkey, two thirds of which have land measuring from 0.1 to 5 ha, while only a third of the agricultural households own more than 5 ha. The preponderance of small

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\(^1\) Irrigation ratio is not a universal concept. It is often used in Turkey to describe the non-use of irrigation infrastructure. It is calculated by dividing the actually irrigated area to the entire area (scheme area) for which infrastructure has been built. For instance, if farmers actually irrigate 600 ha in an irrigation scheme of 1000 ha, the irrigation ratio is 60%. 

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farms depresses farm incomes. As Turkey aspires to join the EU, productivity losses connected with fragmented land holdings emerge as a priority to be dealt with in order to prepare the country for the future. It would be possible for Turkey to compete with European countries in agriculture if only it can complete the unfinished land consolidation works and thereby enhance its farm productivity.

**Operating Constraints on Land Consolidation:** Despite pressing problems, land consolidation in Turkey is carried out on a voluntary basis. Lack of farmer cooperation and unwillingness to give up ancestral land restricts or inhibits the desired level of progress in land consolidation. In this context, a new bill was proposed to allow DSI to implement land consolidation for irrigation projects. If this bill is signed into law, land consolidation would become compulsory and up to 10% of land project areas can be taken away (expropriated) without compensation in order to provide space to establish the infrastructures.

**Priority Criteria for New Irrigation Projects:** For the last 15 years, when preparing new investment programs, DSI evaluates prospective irrigation projects according to the following criteria:

- Farmers’ demand for irrigation water;
- Land fertility together with climatic suitability;
- Water resource availability;
- Type of water supply and transmission (gravity is preferred to pumping); and
- Completion of land consolidation works.

In connection with the last bullet point, because of the high population growth and fragmentation of lands by inheritance, land consolidation receives greater attention and is being streamlined with DSI’s investment strategies. As pointed out, land consolidation allows more efficient use of modern technologies in agricultural production, and facilitates the construction of optimal irrigation and transportation networks for agricultural lands, as well as constituting a legal prohibition of further subdivision of land. DSI estimates that land consolidation generally eliminates expropriation costs and offers cost savings in the investment and O&M. Additionally, due to continuously increasing agricultural land values across the country, expropriation costs in some areas may equal or exceed the cost of the investment itself. Land consolidation accompanied by the application of modern pipeline irrigation distribution systems (providing technically and economically high standards in both new irrigation projects, as well as rehabilitation efforts), contribute to the prosperity of farmers and the national economy.
What Has So Far Been Achieved: Land consolidation works in Turkey have been ongoing since 1961, which were initiated by the GDRS (now defunct) under rather austere economic conditions and inadequate funding. Over the last half century, efforts for expanding LC implementation in Turkey have reached a certain level for which it would be useful to take stock. Below we summarize the record of achievements to date.

- As a result of land consolidation investments, in the recipient irrigation service areas, nearly 100% of the parcels are now bordering the irrigation infrastructure (canals) and roads and have direct access to surface drainage systems. In other words, each parcel can now be fully served by the road network, and irrigation and drainage infrastructure, which was not the case prior to land consolidation. This has manifested itself in spectacular performance rates: irrigation ratios have reached 90% and irrigation efficiencies\(^2\) have attained 85%.

- It has been recognized that land consolidation projects implemented concurrently and in tandem with other complementary on-farm investments - such as land leveling, soil reclamation and on-farm irrigation and drainage networks - have proved easier to plan and construct without entailing expropriation problems. Therefore, a considerable amount of savings were made in the investment costs of these projects.

- The agricultural infrastructure investments provided by the government have enabled the application of modern farming techniques and helped increase both the quantity and quality of crops. Moreover, farm input costs have decreased.

- It has become possible to carry out agriculture activities all year round by providing service road network within the irrigation areas as well as between the fields and the settlement centers. Running costs for farmers have decreased.

- In areas where land consolidation has been implemented farmers in neighboring locations observe the positive outcomes associated with the LC practice and hence express a formal demand for the service. This demonstration effect keeps LC in the foreground, enhances farmer interest and facilitates the legal process of getting farmer consent for further LC efforts in the country.

\(^2\) **Irrigation efficiency** is defined as the ratio between irrigation water actually utilized by growing crops and water diverted from a source (as a stream) in order to supply such irrigation water.
Potential for Further LC in Turkey: The total arable land in Turkey is about 24 million hectares (ha). Land suited for LC is estimated at some 14 million ha. As shown in Table 1 below, so far, LC has been completed for 5 million ha., with an unfinished balance of some 9 million ha. The bulk of the land suited for LC is irrigated land, of which some 1.88 million ha has received LC service. LC application on dry land has been about 3.12 million ha. In conclusion, Turkey is still in the process of catering for its LC needs which may take many years, where there is about 5.88 million ha of irrigated land awaiting land consolidation intervention.

Table 1: LC completed and still to be completed

<table>
<thead>
<tr>
<th>Current Status of Land Consolidation in Turkey (Million ha)</th>
<th>Dry</th>
<th>Irrigable</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Completed</td>
<td>3.12</td>
<td>1.88</td>
<td>5.00</td>
</tr>
<tr>
<td>To be Completed</td>
<td>3.13</td>
<td>5.87</td>
<td>9.00</td>
</tr>
<tr>
<td>Total</td>
<td>6.25</td>
<td>7.75</td>
<td>14.00</td>
</tr>
</tbody>
</table>

Source: DSI Real Estate and Expropriation Department

Suitability of cropland for land consolidation in Turkey (Million ha)

<table>
<thead>
<tr>
<th></th>
<th>Dry</th>
<th>Irrigable</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suited for LC</td>
<td>6.25</td>
<td>7.75</td>
<td>14.00</td>
</tr>
<tr>
<td>Uns suited for LC</td>
<td>9.25</td>
<td>0.75</td>
<td>10.00</td>
</tr>
<tr>
<td>Total</td>
<td>15.50</td>
<td>8.50</td>
<td>24.00</td>
</tr>
</tbody>
</table>

Source: DSI Real Estate and Expropriation Department

Land Consolidation on Irrigated Land - by Agency and Year (Million ha)

<table>
<thead>
<tr>
<th>Key Organization</th>
<th>Period</th>
<th>Areas</th>
</tr>
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<tbody>
<tr>
<td>Toprak Su &amp; GDRS</td>
<td>1961-2005</td>
<td>0.35</td>
</tr>
<tr>
<td>GDAR</td>
<td>1983-2005</td>
<td>0.15</td>
</tr>
<tr>
<td>GDAR</td>
<td>2005-2016</td>
<td>0.88</td>
</tr>
<tr>
<td>DSI</td>
<td>2009-2016</td>
<td>0.50</td>
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</table>

<table>
<thead>
<tr>
<th>Completed to Date</th>
<th>1.88</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDAR</td>
<td>2017</td>
</tr>
<tr>
<td>DSI</td>
<td>2017</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>To be Completed</th>
<th>5.88</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unsuited for LC</td>
<td>0.75</td>
</tr>
</tbody>
</table>

Total Irrigation Area | 8.50 |

Source: DSI Real Estate and Expropriation Department
4. LAND CONSOLIDATION – IMPLEMENTATION STEPS

The procedural and implementation steps that need to be completed for LC implementation consist of:

- Creation of base maps and ownership records,
- Establishment of soil maps and soil classification maps,
- Acquisition of other supplementary base maps if needed (such as orthophotos),
- Creation of blocks on the terrain,
- Interviews with farmers to find out about their preferences,
- Creation of new parcel plans,
- Implementation of the necessary works in the field (roads, irrigation and drainage canals etc.),
- Delivery of new titles to the beneficiaries.

**Acquisition of Base Maps and Property Ownership Records:** Cadastral maps and ownership information are obtained for the targeted locations from the General Directorate of Cadastre and Land Registry (GDLRC) and are digitized if needed. Any mismatches and errors are identified during this phase, and corrective legal action is taken.

**Establishment of Soil Maps and Soil Classification Maps:** Soil specimens are taken by the agricultural engineers who specialize in soil, and soil maps are prepared after analysis in the laboratory. The soil maps are composed of index values and soil scores, and the result is a score assigned to each parcel. A fifteen-day public display follows at the project site. If there are farmers who object within this period, their objections are recorded and addressed, and the results are communicated to them in writing.

**Acquisition of Additional Mapping Material:** It is possible for the cadastral maps to exclude some key features on the terrain. These may be user roads, and fixed facilities, such as orchards, wells, buildings etc. in the consolidation area. These features are duly marked on the orthophoto or other maps.

**Creation of Farming Blocks:** Blocks are formed between the irrigation canals (constructed or to be constructed by DSI) and other landmarks such as roads, creeks etc. on the ground.

**Interviews with Farmers:** Farmer preferences are recorded during interviews with respect to the proposed blocks and soil classification maps. The farmers declare in writing where they would like to see their new consolidated parcel (or more than one parcel where appropriate). Farmers' preferences thus obtained are taken into consideration during the creation of the new parcels. During these interviews farmers can opt for a consolidation of scattered family property (under different ownership) including
spouse and children. In addition, farmers may opt for consolidation of commonly owned but geographically scattered property rights (with established rights but without specific cadastral location of the commonly held land) and may request such rights to be consolidated in a single parcel owned by a single family. Those persons who own land in the neighboring villages may request to have their new consolidated parcel located near the boundary to the neighboring village where they may be domiciled. Every village in the project area is a consolidation unit within its proper boundaries. However, boundary adjustment can also be made between the neighboring villages if and when required.

Creation of New Parcel Plans: After the issue of farmers’ preferences has been addressed, a new parceling plan is prepared according to the topography of the land, farm sizes, farmer preferences, fixed installations (wells, orchards), and current land use and soil classification maps. The new parceling plan is put on public display on site for 15 days. Written farmer objections and grievances are recorded and a new parceling plan is prepared if deemed necessary. The renewed parceling plan is also put on public display for another 15 days. If there are still objections, these are recorded and taken into account to prepare the final parceling plan. After approval by the GDAR, this final plan is sent to the General Directorate of Cadastre and Land Registry (or its regional office) for control and to be entered into the land registry for the new titles to be issued. The new parcels resulting from the LC are marked in the field.

Delivery of Titles to Farmers: After the control by the Cadastre and Land Registry, the new parceling plan is processed and the new titles are issued and distributed to the farmers.

Field Works to be Undertaken: LC process is completed by building the necessary infrastructure, which consists of the road network, irrigation and drainage systems and on-farm works (land improvement and soil reclamation, land leveling, on-farm drainage etc.).
5. INDICATORS TO MEASURE LC EFFICIENCY AND EFFECTIVENESS

There seems to be limited consensus on the performance indicators to assess the efficiency and effectiveness of LC investments. Literature review suggests that there are a few common indicators that pertain to the process (hence efficiency) and impact (hence effectiveness). Overall, we discern three groups of LC indicators being cited in the literature in Turkey. There are two categories of efficiency indicators: those related to the process (i.e., building of irrigation systems with LC incorporated on rehabilitation irrigation areas and new irrigation schemes) and those related to the immediate output of the LC investment in terms of improved field layouts. The output related indicators are intermediate indicators because they describe the systems before they are put to actual use by the farmers. Effectiveness related indicators aim to assess the impact from LC and they consist of selected irrigation system performance indicators once the LC investments have been put to actual use. Therefore, all effectiveness indicators deal with the real performance of the irrigation systems that are actually being operated.

**LC Process Related Indicators**: Key efficiency related indicators for the LC process consist of (a) time and (b) cost savings in building rehabilitation or new irrigation systems with LC being an integral part of the investment.

**LC Output Related Indicators**: Key efficiency related indicators for the LC output are: (a) consolidation ratio, (b) number of parcels with road and without road under before and after LC, (c) number of parcels bordering irrigation canals or other infrastructure (hydrants for instance) before and after LC, (d) number of regular shaped and misshapen parcels before and after LC, and (e) average parcel sizes before and after LC.

**LC Impact Related Indicators**: Key effectiveness indicators are (a) increased irrigation ratio and irrigation efficiency, (b) cost savings directly linked with reduced time, labor and farm inputs to operate the farm after LC, (c) crop yield enhancements, (d) reduced water used in irrigation and reduced ground water abstraction or water diverted from other sources, (e) O&M cost savings for the water users’ organizations (associations, coops etc.), and (f) reduced incidence of social tension (such as reductions in court cases involving land and boundary disputes among farmers).

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3 Reduced quantities of water used in irrigation also have significant environmental implications for which a separate indicator may be needed. For instance water savings diverted to other uses, such as saved water being as municipal water would be a very pertinent indicator. However, we are making mention only of those indicators that are in current use in Turkey rather than exhaust the whole range of possible indicators for assessing LC.
Below we discuss each of the above cited indicators in connection with data and examples extracted from various sources in Turkey. Due to data limitations, we are being selective in this discussion as far as the choice of indicators.

**Example of Process Related Indicators and Analysis:** Land consolidation undertaken concurrently with the building of irrigation infrastructure (pipelines, canals and drainage systems) and service roads and on-farm works (land leveling, soil reclamation and on-farm distribution and drainage systems) generate economic savings. These economic savings (Table 2) occur in the form of cost reductions and efficiency enhancements during the investment phase.

### Table 2: Economics of land consolidation

<table>
<thead>
<tr>
<th>Descriptions</th>
<th>Units</th>
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<th>With LC</th>
<th>Increments</th>
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<tr>
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</tr>
<tr>
<td>Land Area</td>
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<tr>
<td>Land value</td>
<td>US$/ha</td>
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</tr>
<tr>
<td>Irrigation Development Cost</td>
<td>US$/ha</td>
<td>5,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Technical Parameters</strong></td>
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<tr>
<td>LC Land Deduction Practice</td>
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<td>-10%</td>
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<tr>
<td>LC Design and Implementation</td>
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<td>400</td>
<td>-400</td>
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<td>Land Needed for Expropriation</td>
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<td>Percent</td>
<td>100%</td>
<td>60%</td>
<td>40%</td>
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<td><strong>LC Design and Implementation</strong></td>
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<td></td>
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<tr>
<td><strong>Calculations</strong></td>
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<td>Unit Cost</td>
<td>US$</td>
<td>6,378</td>
<td>3,778</td>
<td>2,601</td>
</tr>
<tr>
<td><strong>Savings</strong></td>
<td>percent</td>
<td></td>
<td></td>
<td>41%</td>
</tr>
</tbody>
</table>

Source: Author’s calculations using DSI data

We use a 1000-ha hypothetical irrigation scheme being planned for irrigation rehabilitation (i.e., it is an existing irrigation scheme with no LC). Table 2 compares the with and without LC scenarios and derives some conclusions. The data part of the table provides information on the general parameters, such as land values (US$ 12,000/ha in Turkey) and irrigation development cost (US$ 5,000/ha). We assume that the engineers plan to scrap the existing open canals and replace them with a closed system (i.e., pressurized...
pipelines buried underground). If LC were to be adopted it would involve 10% deduction of land from the farmers. That is each farmer will lose 10% of his land in return for LC implementation. LC engineering design and implementation cost is US$ 400/ha. This covers consultancy costs and field works (mostly roads). If expropriation were to be practiced, this would require 7.5% of total land being taken away (at a cost to the government) from selected farmers where some farmers may end up losing a good part of their land. Experience shows that irrigation development cost on consolidated areas is estimated to be 40% lower than those areas which have not been served by LC. This is because the road and the irrigation networks are not as lengthy and elaborate as would be the case otherwise.

The conclusion is that without LC the investment cost for the 1000 ha is US$ 5.9 million against US$ 3.4 with LC. There are savings in the order of US$ 2.5 million to the government. Hence, LC application leads to an overall investment cost saving of 41%.

**Example of Output Related Indicators and Analysis:** The example shown below (Table 3) comes from the World Bank funded ARIP project Implementation Completion Report, and gives an idea how powerful LC can prove. The original table was condensed for formatting purposes by considering schemes that were more than 4000 ha in size.

**Table 3: GDAR participatory land consolidation projects (ARIP)**

<table>
<thead>
<tr>
<th>Name of Participatory Land Consolidation Sub-projects</th>
<th>Samsun - Bafra</th>
<th>Amasya - Gumusha cikoy</th>
<th>Konya - Guneyshinir, Central ve Alanoz</th>
<th>Karaman - Merkez</th>
<th>Kirklareli - Luleburgaz County</th>
<th>Aydin - Yenipazar County</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area (ha)</td>
<td>6,000</td>
<td>4,200</td>
<td>6,155</td>
<td>5,650</td>
<td>5,671</td>
<td>5,750</td>
</tr>
<tr>
<td># of parcels at the start</td>
<td>4,830</td>
<td>4,822</td>
<td>12,085</td>
<td>6,839</td>
<td>5,436</td>
<td>8,851</td>
</tr>
<tr>
<td># of parcels at the finish</td>
<td>3,500</td>
<td>3,200</td>
<td>6,050</td>
<td>3,500</td>
<td>2,500</td>
<td>4,393</td>
</tr>
<tr>
<td>Consolidation Ratio %</td>
<td>28</td>
<td>34</td>
<td>50</td>
<td>54</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Old parcels #</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parcels with road</td>
<td>1,200</td>
<td>1,500</td>
<td>4,500</td>
<td>1,800</td>
<td>1,550</td>
<td>2,400</td>
</tr>
<tr>
<td>Parcels w/o road</td>
<td>3,630</td>
<td>3,322</td>
<td>7,585</td>
<td>5,039</td>
<td>3,886</td>
<td>6,451</td>
</tr>
<tr>
<td>New parcels #</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parcels w/ road</td>
<td>3,500</td>
<td>3,200</td>
<td>6,050</td>
<td>3,500</td>
<td>2,500</td>
<td>4,393</td>
</tr>
<tr>
<td>Parcels w/o road</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Old Misshapen parcels</td>
<td>2300</td>
<td>2950</td>
<td>7851</td>
<td>4203</td>
<td>3450</td>
<td>5800</td>
</tr>
<tr>
<td>Old Regular shaped parcels</td>
<td>2,530</td>
<td>1,872</td>
<td>4,234</td>
<td>2,636</td>
<td>1,986</td>
<td>3,051</td>
</tr>
<tr>
<td>New Misshapen parcels</td>
<td>230</td>
<td>120</td>
<td>250</td>
<td>160</td>
<td>236</td>
<td>212</td>
</tr>
<tr>
<td>New Regular Shaped Parcels</td>
<td>3,270</td>
<td>3,080</td>
<td>5,800</td>
<td>3,340</td>
<td>2,264</td>
<td>4,181</td>
</tr>
</tbody>
</table>

Source: The World Bank ICR Agricultural Reform Implementation Program, November 2009
This table introduces a new concept, which we call the consolidation ratio. This ratio captures the degree of reduction in the number of parcels as compared to the situation without LC. For instance, in Samsun Bafra, the number of parcels at the start was 4830. After land consolidation the number of parcels was 3500. The reduction was 1330 parcels, which is divided by 4830 to yield 0.28 or 28% in consolidation ratio. The comparisons of parcels with road and reduction in the misshapen parcels are rather self-explanatory. As would be noticed, after LC, all parcels gain access to the roads. Likewise, the number of misshapen parcels is drastically reduced as a result of LC application.

Another example (Table 4) comes from an individual case cited by Kusek (ex-GDAR general Director), where he calculates a much higher consolidation rate for a small project area with three villages involving some 6051 ha project area where LC was implemented. Here the consolidation rate is 62%, and average parcel size has more than doubled.

Table 4: LC efficiency parameters – another illustrative case

<table>
<thead>
<tr>
<th>Description</th>
<th>Units</th>
<th>Without LC</th>
<th>With LC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of village</td>
<td>Number</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Project area (ha)</td>
<td>ha</td>
<td>6,051</td>
<td></td>
</tr>
<tr>
<td>Number of farmers</td>
<td>Person</td>
<td>543</td>
<td></td>
</tr>
<tr>
<td>Population</td>
<td>Person</td>
<td>3309</td>
<td></td>
</tr>
<tr>
<td>Number of parcels before the project</td>
<td>Parcel</td>
<td>3125</td>
<td>1188</td>
</tr>
<tr>
<td>Average size of the parcels before the project (Ha)</td>
<td>ha</td>
<td>1.94</td>
<td>5.09</td>
</tr>
<tr>
<td>Consolidation Rate</td>
<td></td>
<td>62%</td>
<td></td>
</tr>
</tbody>
</table>

Source: Land Consolidation Projects in Turkey MFAL, GDAR, Presentation by Gürsel KUSEK (PhD) 2010

Example of Impact Related Indicators and Analysis: Following LC, there will be reduced costs of production to individual farmers as well savings in operation and maintenance (O&M) costs of irrigation infrastructure and service roads for the public service providers (DSI, water users associations and irrigation coops). In Table 5, we try to illustrate a case which involves savings to farmers only.

These savings are time and fuel savings which are directly connected with LC accruing to individual farmers. It is estimated by the GDAR that some 50 liters of fuel would be saved per hectare as a result of reduced transport costs, better road conditions and mechanization economies. This would correspond to some US$ 66 in savings to the farmers.
Table 5: Farm management savings

<table>
<thead>
<tr>
<th>Items</th>
<th>Units</th>
<th>Level of Savings</th>
<th>Savings (Benefits)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport - Farm to Parcel Time</td>
<td>liter/ha/year</td>
<td>25</td>
<td>33</td>
</tr>
<tr>
<td>Transport - Road Quality Effect</td>
<td>liter/ha/year</td>
<td>15</td>
<td>20</td>
</tr>
<tr>
<td>Mechanization - Parcel Shape Effect</td>
<td>liter/ha/year</td>
<td>10</td>
<td>13</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>liter/ha/year</td>
<td><strong>50</strong></td>
<td><strong>66</strong></td>
</tr>
</tbody>
</table>

Source: Land Consolidation Projects in Turkey, MFAL, GDAR, Gursel Kusek Presentation, 2010

As an additional example, Table 6 below portrays another real case from Karaman, where closed and pressurized irrigation systems accompanied by land consolidation have jointly resulted in 64% water savings for an irrigation coop. It is seen that the apportioned contribution of LC (45%) is greater than that of modern technology (34%). This level of savings has cost implications as far as energy use and as far as the environmental benefits in terms of avoided water use and possible pollution.

Table 6: Karaman Merkez Kisecik sub-district LC and irrigation project

<table>
<thead>
<tr>
<th>Year</th>
<th>Project Area 2,750 ha</th>
<th>Wells Discharge</th>
<th>Annual Operation Time</th>
<th>Water Abstraction</th>
<th>Savings Rate percent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>number</td>
<td>liter/sec</td>
<td>hours</td>
<td>m³/year</td>
<td></td>
</tr>
<tr>
<td>1999</td>
<td>Open Canal Irrigation System</td>
<td>45</td>
<td>2,365</td>
<td>74,273</td>
<td>14,583,022</td>
</tr>
<tr>
<td>2009</td>
<td>Pressurized Pipeline System</td>
<td>46</td>
<td>1,725</td>
<td>68,416</td>
<td>9,681,290</td>
</tr>
<tr>
<td>2010</td>
<td>LC + Pressurized Pipeline</td>
<td>44</td>
<td>1,635</td>
<td>35,064</td>
<td>5,253,177</td>
</tr>
<tr>
<td></td>
<td>Total water saving by LC and closed irrigation pipeline</td>
<td></td>
<td></td>
<td></td>
<td>64</td>
</tr>
</tbody>
</table>

Source: 3rd National Irrigation Systems Symposium, October 2015 Ankara

**LC Visuals:** To conclude this section, below we provide three charts: Figures 1, 2 and 3. Figure 1 illustrates a real case from the Biga district of Canakkale province of a single farmer who has four parcels (colored red) of land before LC. After LC he has a single parcel (colored purple). Figure 2 compares and contrasts a situation with and without LC on rural land. Numerous small parcels have been consolidated into larger ones in the diagram to the right. Likewise, figure 3 provides a contrast for situations with and without LC for agricultural fields near a settlement for more than one farmer using different colors.
(yellow, red and blue) to highlight how the LC process has worked in reducing the number of small and scattered parcels.

Figure 1: Canakkale Biga – Derekoy – before (top) and after (bottom) the project
Source: DSI, Real Estate and Expropriation Department
Figure 2: Field layout before and after land consolidation (all rural)
Source: DSI, Real Estate and Expropriation Department

Figure 3: Field layout before and after land consolidation (near a settlement)
Source: DSI, Real Estate and Expropriation Department
6. OVERALL ECONOMIC, SOCIAL AND TECHNICAL IMPACTS OF LAND CONSOLIDATION

Economic Impact: In order to site the infrastructure, i.e., build the drainage canals, main irrigation canals, secondary and tertiary pipelines and feeder roads land will be required. This requirement will be satisfied by deducting 10% of all land at the project site without resorting to expropriation. If expropriation had been practiced, this would imply an added cost outlay amounting to at least two-thirds of the cost of building a modern closed irrigation system, and sometimes even exceeding the cost of the investment itself. Stated in other words, every time the government builds five irrigation schemes using land consolidation, it will have sufficient funds saved to build two additional schemes at no cost, simply because no funds would have to be paid for expropriations.

As a result of concurrent application of land consolidation and irrigation, crop productivity will be greatly enhanced. Cropping on consolidated irrigated land will result in yields improvements by 149% in cereals, 233% in legumes, 96% in sugar beets, 245% in cotton, 481% in corn, 129% in fruit, 129% in citrus and 143% in vegetables.

When moving from dry to irrigated agriculture, farmers also tend to switch to higher value crops: sunflower, corn, sugar beet, vegetables, etc. Land consolidation simply amplifies the regular expected impact of irrigation and makes it even more remunerative.

After LC, water is being used more economically. Modern irrigation systems such as sprinklers and drips provide significant savings in farm inputs while increasing productivity. Research shows that modern irrigation systems save water by 30-80% depending on the irrigation method and irrigated crop characteristics, while saving 40% on energy, 50% on fertilizer use and 30% on the use of farm chemicals.

Switching from open and trapezoidal irrigation canals (located on ground surface), to closed pressurized pipeline systems (located beneath the ground) frees up the land occupied by infrastructure and minimizes loss of cropland.

When farming on consolidated land, the total fuel consumption decreases and pollution is reduced. In the past, farmers who had to travel on average of, say, 8500 meters to reach 6 different parcels of land would now have to travel only an average of 1350 meters to visit the single and larger consolidated land parcel after LC. There will also be significant savings in the most important categories of farm inputs: labor,
fuel, fertilizer, spraying, seed and actual application of irrigation (heavy in labor requirements, because water use must be closely monitored).

When irrigation projects are designed and eventually built, irrigation routes following cadastral parcel boundaries are significantly reduced in length via land consolidation. Concurrently, technical fragmentation brought about by the irrigation lines crossing and dividing the parcels is also avoided. As a consequence, land consolidation in irrigation investments can save up to 40% in investment costs.

Since parcel shapes will be more suited for agricultural mechanization, labor will be reduced in planting, harvesting and marketing operations, hence saving time. Fuel expenditures will likewise decrease.

Following LC, farmland appreciates in value within a year or two by about 25% to 40%. Even the staunchest opponents of land consolidation become avid supporters as they come to recognize the immediate value added by land consolidation.

Farmers who currently irrigate by pumping water from the streams and from deep wells will see their costs reduced by 60% after land consolidation. Some farmers would no longer need to operate the deep wells (water savings) and save on energy costs.

Social Impact: When and consolidation is utilized, expropriation will be avoided. This means there will be no farmers losing a good part of their land, and hence become landless. Hence, there will be no urge for any farmer to collect the cash proceeds from expropriation and be tempted to move in the urban areas, deserting farming as business. Research has shown that people migrating from rural to urban areas cannot adapt and find employment. They end up working in marginal business lines, and are generally unhappy. Meanwhile, a large part of the expropriation proceeds, which they have received in return for their land, has already been exhausted in a short period of time without new business prospects.

Land consolidation will reduce the total length of the field boundaries (i.e., the length of perimeters combined) by 60%. In the absence of land consolidation, the number of parcels bordering other people’s property will be on average 4 to 5 (i.e. 4 to 5 neighbors). However, after consolidation, the same farmer will end up with only two neighbors. This situation will greatly reduce land disputes related to property boundaries, hence help minimize legal cases filed and help build a more congenial farming community.

In the absence of land consolidation, it is impossible for every parcel to border the irrigation canal (or be in the vicinity of a hydrant etc.) and the road. There will be incessant disputes between those farmers
bordering the irrigation infrastructure and roads, and other farmers deprived of these advantages. The
disadvantaged farmers can go to court if disputes cannot be settled amicably. Without land consolidation,
the irrigation canals or pipelines will have to be built lengthier because the infrastructure will have to
follow the existing property boundaries, without being able to touch all parcels. With this approach, on
average, while 40% of parcels can be irrigated, the remaining 60% of parcels cannot be properly irrigated.

There are also social benefits associated with land consolidation, such as respect of inheritance rights of
women, establishment of family business, prevention of rural to urban migration and the development of
a culture conducive to practicing irrigation.

Land consolidation projects are social projects. Initially, voluntary land consolidation is carried out only if
51% of the beneficiaries provide written consent. In the first series of LC projects that DSI has
implemented, a consent rate of 85-90% was reached. The soil classification maps are prepared with the
participation of two elected members from the application area. The beneficiaries preserve the right to
appeal to the soil classification map. The beneficiaries also have the right to ask for interviews to
determine their preferences as to where their properties would be grouped. The re-allotment plan that is
prepared is also subject to objection or to ultimate formal appeal at courts. This practice is reminiscent of
the appeals by land owners to urban zoning plans, with an option to resort to formal legal pursuit.

**Technical Matters:** Prior to LC, the number of parcels in rectangular form is around 15-20%. Following
LC application, misshapen, small and elongated land parcels are transformed at a rate of 95% into regular
rectangular form (much more conducive to farming and mechanization). After LC, farming families can
effectively create large family estates in contiguous tracks of land and promote family businesses that
bring family members together if they express such a need during the LC related interviews. LC is a
process that creates an opportunity to rectify errors originating from the land registry and cadaster, which
otherwise might take years to settle in courts. Land consolidation is an integral part of on-farm
infrastructure development process. River training, building of on-farm roads, irrigation ditches, drainage
canals, land reclamation and leveling, stone removal and similar endeavors can accompany or follow LC
and can make an important contribution to rural development.

To be able to implement the LC projects, contactors prepare land and soil classification maps which are
also shared with the beneficiary farmers. Farmers equipped with such maps can access a higher degree of
farm supports from the government. While the number of parcels with road access before LC is only
around 20-30% of the total parcels, after LC all parcels border the road which enables farmers with all-
season access to the fields. The success of a land consolidation project depends on the community ownership of the project. LC projects are human-focused projects too. When the so-called automatic parcel re-allotments (a faster technique used in Turkey) are being made, consolidation is carried out around those parcels containing the farmstead, olive grove, fruit orchard, and other fixed installations (wells for drinking water instance) in order to form the blocks. Other criteria are also used to address the needs of the farmers. Under the automatic parcel re-allotments, about 60-70% of the farmers will be able to end up with their first preferences as revealed in the interviews.

In the initial stages, LC efforts mainly sought to bring scattered parcels together and increase efficiency of labor and agricultural production. This was done mostly with a technical focus. However, over the last few decades, LC has evolved into a critical tool for sustainable development and it is being rapidly mainstreamed with the overall social policy and environmental sensitivity in the country. There is now growing consensus that LC is a necessary infrastructural development that benefits the entire farming community and contribute to a healthy living environment in the rural areas. The only issue and challenge is to be able to complete the outstanding LC work as soon as possible.

**Recap on LC Impact – Economic, Social and Technical Dimensions:** LC is a prerequisite for efficient use of water in irrigation projects whereby each parcel gains direct access to irrigation facilities and roads, which in turn improves both the irrigation efficiency (more water reaching the plant root zone) and irrigation ratios (greater use of irrigation infrastructure via expanded irrigation areas due to elimination of operational barriers). Turkey’s experience provides a solid case and massive body of evidence on the undeniable catalytical role of LC, which elevates and enhances the benefits from conventional irrigation, while improving land and ownership records. Since the need for land expropriations will be eliminated, there will be significant savings for the government in the form of avoided expenditures. The concurrent investment in irrigation and land consolidation will amortize itself due to massive value added streams within the next 5 years. There will be positive impact on global warming too, because fuel consumption for farming will be reduced. Transformation of agricultural areas into urban and industrial areas will effectively be avoided, because farmers will not need to move into the city for lack of opportunities in the village. Water resources will be used more economically, producing more and better quality crops. Marketing of crops will be facilitated using the extensive network of feeder roads that accompany irrigation and LC application. In connection with LC, there will be reduced boundary related land disputes and while property values appreciate reflecting the enhanced productivity and ease of operation of the newly allocated land parcels.
7. SUMMARY AND CONCLUSIONS

Farm restructuring through large-scale land consolidation has recently become a major policy undertaking in Turkey. Reduced fragmentation of farmland has already been improving land use, with potential benefits for agricultural productivity and natural resource management, including water resources, which are becoming scarcer. Reduced land fragmentation also has very positive repercussions on land tenure, land administration and land management.

This paper provides an overview of the Turkish experience in irrigated agricultural land consolidation and highlights the achievements to date as well as discuss the challenges, shortcomings and the outstanding agenda.

Land consolidation is more than a simple reallocation of parcels to remove effects of fragmentation. It enables and facilitates broader social and economic reforms, as we have demonstrated in this paper. Within the context of irrigated agriculture in Turkey, efforts for consolidation of parcels have sought to enlarge individual land holdings to assist with the building and operation of more efficient irrigation and drainage infrastructure. These efforts have invariably led to significant cost savings during the investment phase of the infrastructure (both irrigation systems and roads), and in later stages, resulted in reduced O&M and cost of production, enhanced crop productivity, improved water management and increased ability to provide for other ancillary needs such as land levelling and soil improvement.

Setting aside urbanization prospects, speculative uses and associated expectations, the value of agricultural land in Turkey largely depends upon its productivity, location and proximity to various sites of interest, such the road, the river or center of town etc. Productivity is by far the most important determinant of land values. As discussed, land consolidation in Turkey is a process whereby farmers voluntarily agree to swap fragmented pieces of land with larger pieces of land of equivalent productivity or intrinsic value, but not necessarily of equivalent size. Therefore, land consolidation goes hand in hand with two basic public functions consisting of land administration and land management. In fact, land consolidation is one of the rare instances where both functions converge to create additional value and generate benefits. Stated in other words, land consolidation is a process whereby the outcome can be characterized as one of “the whole is greater than the sum of its parts”.

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In terms of land administration, the process of land consolidation requires renewing ownership and cadastral records to reflect changes in property ownership. The necessary service organization for land administration in Turkey is the General Directorate of Land Registry and Cadastre, with which an excellent record of cooperation exists. The second aspect concerns land management which focuses on exchanging land for land, whereby all participating farmers agree to put their fragmented land holdings in a pool, and agree to the outcome of being apportioned larger pieces of land which are equivalent to what they have given up not in terms of size, but in terms of productivity and any other criterion that would be associated with proximity. This function is largely fulfilled by DSI on irrigated land consolidation.

It is interesting to note that while creation of rent and value in urban land is premised upon fragmentation as a result of splitting of large cadastral parcels into smaller urban development parcels, in the rural areas it is just the opposite process that has been creating value, whereby consolidated agricultural land appreciates in value due to its higher productivity and ease of management.
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Regulations:
DSI, Renewal Notice (Yenileme Önergesi)
DSI Land Consolidation Technical Specification (Arazi Toplulaştırma Teknik Şartnamesi)

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