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# To Make a Desert Bloom: The Israeli Agricultural Adventure and the Quest for Sustainability

ALON TAL

*This article offers an overview of the vicissitudes faced by Israeli agriculture during the past century. The Zionist pioneers who came from Europe to Palestine sought to “reclaim” the status of Jewish farmers in their homeland. This ethic translated into an extraordinary societal support for Israel’s agrarian economy and steady growth in agricultural production. Seven key factors are identified as being critical to this record of success, including a commitment to food security, water development, and technological innovation. Yet, during the past twenty years numerous changes in local and international dynamics have posed substantial challenges to Israel’s agricultural sector. In addition, while Israeli agriculture has largely halted erosion and restored desertified lands of the Negev Desert, it also produced myriad environmental side effects including water contamination and excessive pesticide usage. The article considers responses to these challenges that offer promising prospects for a sustainable agricultural future in Israel.*

ISRAEL’S EMERGENCE AS AN AGRICULTURAL country was a matter of choice. Perhaps more than any other nation, it chose to pursue a romantic, ideological agrarian vision. This dream of a rural, fertile homeland drove economic policies, launched a sociological makeover, and produced astonishing changes in an ancient landscape and a people’s

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self-image. This agricultural transformation has been manifested in breathtaking technological innovation, surprising triumphs in combating desertification, as well as devastating environmental consequences. Groundwater became contaminated; mounting dependence on herbicides and pesticides translated into a significant public health insult to residents of the rural sector; and water resources were depleted. It was not long before people raised questions about the very economic viability of Israeli agriculture.

To answer them and understand the present choices that Israel faces as it explores what a sustainable future for agriculture means, it is critical to understand the country's idiosyncratic heritage and the historic evolution of its remarkable agricultural achievement. It would seem that Israeli agriculture is in a process that will take it full circle. One hundred years ago, something akin to an "ecological impulse" galvanized an intellectual cadre of young European immigrants to redefine themselves as farmers in their "promised land." Within fifty years, a public policy that prioritized food security and exports produced an industrial model of agriculture that came to dominate the local perspective.

Ultimately, this transition in the Israeli farming sector left the agrarian sector at odds with the fundamental hydrological reality, ecosystem services of the land, and health concerns of modern farming. During the course of the twentieth century, a steady progression of institutional, physical, economic, and sociological factors converged to ultimately embrace an environmental perspective. Rather than any ecological ideology, it was fundamental pragmatism that eventually came to inform the sustainability of agricultural policy and practices in Israel. Not only the physical environment, but the political/economic drivers that initially launched the outstanding growth in Israeli agricultural production have changed.

Because it is such a small, young country, whose development has been so explosive, Israeli agricultural history offers an extreme scenario for dryland nations that seek a sustainable route for their farming sector. To review a century of eco-agricultural history in Israel might be akin to watching a fast-forwarding documentary. The story offers insights into the perils of insensitively aggressive rural development along with the possibility of ecological harmony and compatibility between food production and the environment in conditions of water scarcity.

The Jewish people, of course, were originally farmers. As embodied in the Bible's querulous ancestors Cain and Abel, pastoralism and agriculture provided the economic foundations for an Israelite society that could also support artisans, priests, kings, and scholars. These agricultural origins are woven into the very rituals of the Jewish calendar—with religious holidays to this day celebrating first fruits, final harvests, and the birthdays of trees. The numbing and prodigious minutiae of the Talmudic regulations and insights regarding agriculture in the Land of Israel, written over two thousand years ago, can compete for sheer detail with any of the encyclopedic manuals printed by the US Soil Conservation Service or Extension Service.

But this rural status changed as the Jewish people were forced into exile with the destruction of the Temple in 70 CE. As Jewish communities adapted to minority status in their various diasporas, different professional inclinations emerged: peddlers, traders, money-lenders, physicians, and of course rabbis. Sometimes these changes of occupation were the result of intentional restriction by external authorities. For example, by the Middle Ages, governments throughout Europe prohibited Jews from owning land. By the nineteenth century both the world and the community itself had long since ceased to perceive Jews and farmers as synonymous—indeed the Jewish association with food production was as distant as any ethnic or national group in the world.<sup>1</sup>

All this changed at the end of the nineteenth century, when Jews began to think about a national renaissance in Palestine through a Zionist movement. The simple impulse was to reclaim the Jewish national birthright as an indigenous people in their promised land. Farming was a critical part of this vision. The socialist and dominant strain in the Zionist political movement used the metaphor of an “upside-down pyramid.” It perceived labor patterns and professional affiliation as indicators for the warped state of Jewish affairs. Presumably, stable pyramids need a wide base of proletariat tapering to a point of a professional class. In nineteenth-century Europe, however, the occupational breakdown was such that a small minority of workers was supporting far broader, less productive sections of the pyramid. This created an inverted Jewish sociological pyramid, dominated by disproportionate numbers of white-collars, traders, and scholars. The Zionist transformation aimed to flip this dynamic on its head and return Jewish society to a normal healthy

pyramid, with a majority of farmers at its base. This socialist impulse was strengthened by the enormous power of Tolstoy's ruralist affection for "Mother Russia" and the great author's idealization of peasant culture. These ideas resonated among Jews of his time, who sought to apply his vision of agrarian harmony in their ancestral homeland.

Aaron David Gordon was not just an influential Zionist philosopher whose writing articulated this impulse, he also personified it. After working as a bookkeeper in Russia, he moved to Palestine in 1902 at age forty-seven and redefined himself as a farmer at the first Zionist kibbutz, Degania, on the banks of the Sea of Galilee. He perceived agricultural labor as not only restoring an abandoned land, but also a damaged Jewish spirit. In his 1918 essay, *Our Tasks Ahead*, he wrote:

We Jews have developed an attitude of looking down on physical labor. . . . But labor is the only force which binds man to the soil . . . it is the basic energy for the creation of national culture. This is what we do not have, but we are not aware of missing it. . . . In my dream I come to the land. And it is barren and desolate and given over to strangers; destruction darkens its face and foreigners rule in corruption. And the land of my forefathers is distant and foreign to me and I too am distant and foreign to it. And the only link that ties my soul to her, the only reminder that I am her son and she is my mother, is that my soul is as desolate as hers.<sup>2</sup>

The back-to-the-earth ethos adopted by the Zionists can be easily understood and is hardly remarkable in the general context of the era's Romantic philosophy that sought a purer alternative to the increasingly industrial, alienating, European, urban lifestyles. What is less comprehensible and more impressive in retrospect was the phenomenal success of this comparatively small cohort of Jewish agricultural pioneers who actually implemented this philosophical formula. With practically no training, they moved halfway around the world, became farmers, and lived up to their own axiom of "conquer[ing] the wilderness."

It was hardly a hospitable land for the would-be planters. Palestine at the turn of the twentieth century bore the scars of successive waves of conquests and occupations that had more regard for the military triumph than for the associated challenges of soil stewardship. Millennia of

overgrazing, primitive subsistence farming practices, and deforestation had denuded a country whose modest precipitation leaves it almost entirely in a semi-arid/arid classification. Aerial photographs from the period confirm the resulting erosion, land degradation, and general neglect. Even without this degradation, the average organic component of soils in Israel is only 1.5 percent—literally half the 3 percent found in Europe.<sup>3</sup>

Mark Twain's famous travel log from the nineteenth century in *Innocents Abroad* offers probably as good a snapshot as any, with his description of the Judean hills a far cry from the lush landscape evoked by the Bible:

Close to it was a stream, and on its banks a great head of curious looking Syrian goats and sheep were gratefully eating gravel. I do not state this as a petrified fact—I only suppose they were eating gravel, because there did not appear to be anything else for them to eat. . . . There was hardly a tree or a shrub any where. Even the olive and the cactus, those fast friends of a worthless soil, had almost deserted the country. No landscape exists that is more tiresome to the eye than that which bounds the approaches to Jerusalem.<sup>4</sup>

Yet, the Jewish agricultural effort of the early twentieth century confounded many non-Zionist, Jewish skeptics and proved the potential fecundity of the land of Israel. The Zionist movement was adept at fundraising and much of these funds were earmarked for agriculture. Though the real estate that Arab landlords were willing to sell was largely malaria-infested swamps and wastelands, new agricultural settlements soon began to dot the map of Palestine. British land decrees limiting Jewish ownership slowed progress dramatically, but this 1940 table from the *Palestine Statistical Abstract* indicates the steady increase in Jewish agricultural activity (see Table 1). Most of the agricultural activity in the Jewish sector was situated on private lands in Palestine before 1948, but with independence, the collective kibbutz and moshav agriculture settlements became the dominant institutional framework for farming in Israel.

While the Jewish farms supported livestock and a variety of vegetables and fruits, the crop of choice for the settlers was citrus. Between

**Table 1.** Growth of Jewish Agricultural Settlements

<i>Year</i>	<i># of Jewish Settlements</i>	<i>Inhabitants</i>	<i>Land Area</i>
1899	22	5,000	300,000
1914	44	12,000	400,000
1930	107	45,000	1,050,000
1936	203	98,300	1,480,000
1939	252	137,000	1,650,000

SOURCE: *Palestine Statistical Abstract*.

1918 and 1938 Jews invested seventy-five million dollars in orange groves, and production grew seven-fold. Orange groves generated 80 percent of Palestine's export revenues and were the single greatest income generator, even though they only filled 4 percent of Palestine's eight million hectares of agricultural lands.<sup>5</sup>

The success was ostensibly due to another conscious choice by the Zionist farmers: they eschewed the existing agricultural methods and technologies of the local Palestinian peasant population—the fellahin. Theirs was to be modern, western agriculture. This dismissive attitude towards the indigenous Arab population can be seen even in Gordon's characterization of the land under Arab control as "barren and desolate." And Gordon was among the conciliatory Zionist leaders toward the Palestinian Arabs. The Zionist adage "A land without a people for a people without land" did not so much suggest that the Arab population was invisible but that their national claims and culture were less worthy. Years later, Israel's founding first Prime Minister, David Ben Gurion, a genius at languages who knew at least twelve, refused to learn Arabic on the premise that Israel could only succeed as a European nation and that learning from the locals would be a strategic mistake.<sup>6</sup>

The truth is that by the start of the twentieth century, the traditional Arab agriculture in Palestine was extremely meager for a variety of reasons. Operating in an essentially feudal context, with absentee landowners in Syria and Turkish tax collectors skimming away any possible profits, incentives (and yields) for fellahin farmers were extremely low, even by Middle Eastern standards. Agricultural tracts grew smaller and smaller as families subdivided shrinking land reserves. Production was meager. A 1937 study, for example, showed a local Palestinian Arab cow

providing 412 to 824 kilograms of milk a year (lactation) as opposed to a cow from Beirut, Lebanon, who could generate 2,000 to 3,000 kg or from Damascus, Syria, who could reach 3,500 kg. (For purposes of comparison, in 2003 Israeli cows on kibbutzim were providing an average of 8,529 kg a year, the highest rate in the world.)<sup>7</sup>

While the British Mandate government attempted modest assistance to the Arab agricultural system, through subsidized olive trees and technical assistance, these efforts were more symbolic than anything else. With no capital to support any upgrading of infrastructure, a largely illiterate farming population without extension support and with the relentless competition of an extremely ambitious and increasingly prosperous Jewish sector, indigenous Palestinian Arab farming began to fade. By the end of the British colonial period, some 64 percent of local Arabs theoretically lived off the land, but an increasingly large percentage found work within the Jewish economy or were simply destitute.<sup>8</sup>

Thus, for many reasons, Zionism spawned high input, technologically based agriculture. For instance, a key to the successful land reclamation by Jewish farmers was synthetic fertilizers. Fertilizer imports jumped from 1,077 tons in 1922 to a peak of 14,698 in 1937. Years later the nitrates reappeared in high concentrations in groundwater in rural wells, but there was no way the zealous Jewish farmers in pre-World War II Palestine could have envisioned this sort of hydrological hazard.<sup>9</sup>

Technical support for the Jewish agrarian settlement initiative was quick to follow. Agricultural research and extension stations were set up by the World Zionist Organization during the 1920s, largely based on the philosophy of Yizhak Volcani, the Lithuanian agronomist who moved to Palestine in 1908 and established the country's central agricultural center, which now bears his name. Volcani's view held that the traditional agricultural methods in Palestine were unsustainable economically, and he advocated mixed farming with intense irrigation, European plows (later tractors), and diverse produce.<sup>10</sup>

Although the prevailing paradigm of Jewish agriculture was a heavily mechanized monoculture, it was largely pesticide free and soil conservation was an integral part of the program. Thus, it managed to maintain considerable environmental integrity. Walter Clay Lowdermilk, a world renowned soil scientist, was sent by the USDA just before World War II to conduct a survey of the state of soils in the ancient Levant. His report



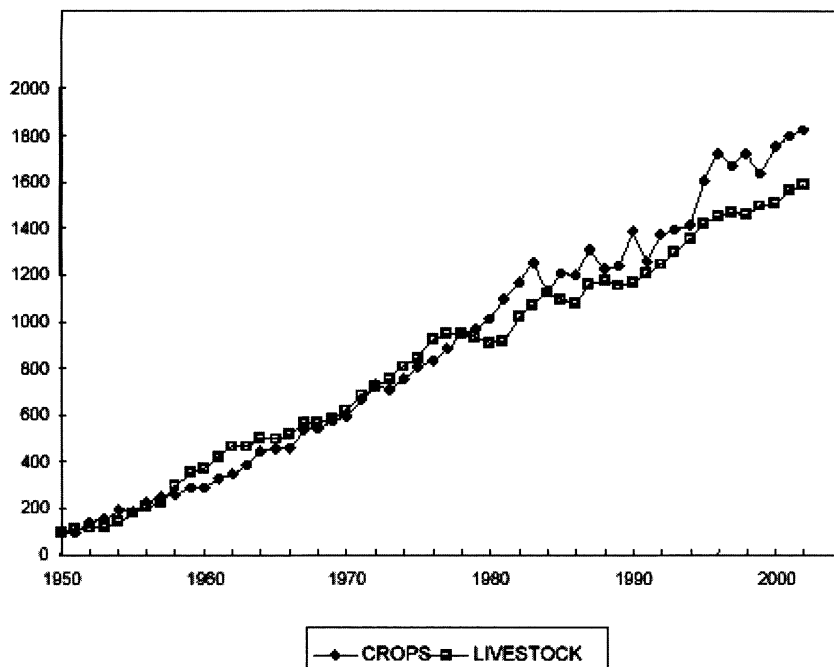
from Egypt, Tunisia, Algeria, and Morocco was bleak indeed. "Almost everywhere we saw repugnant evidences of deadly soil erosion superseding the results of skilled land use during previous centuries." His assessment of the ecological impacts of the indigenous Felah agriculture was similarly grim.

Here before our eyes the remarkable red-earth soil of Palestine was being ripped from the slopes and swept down into the coastal plain and carried out to sea, where it turned the blue of the Mediterranean to a dirty brown as far as the eye could see. We could well understand how during many centuries this type of erosion has wasted the neglected lands. It is estimated that over three feet of soil has been swept from the uplands of Palestine since the breakdown of terrace agriculture.

In contrast, he saw the soil conservation efforts of the Zionist farmers, who at the time controlled only 6 percent of the lands, as sensational:

We were astonished to find about three hundred colonies defying great hardships and applying the principles of co-operation and soil conservation to the old Land of Israel. . . . Here in one corner of the vast Near East, thoroughgoing work is in progress to rebuild the fertility of land instead of condemning it by neglect to further destruction and decay. . . . The country is emerging from a backward low-yield agricultural economy, dependent chiefly on grains and olives, and is evolving towards a modern, scientifically directed and richly diversified economy with fruits, vegetables, poultry and dairy products playing an ever greater role. The wooden plow is yielding to the tractor, the flail to the threshing machine. Rural Palestine is becoming less and less like Trans-Jordan, Syria and Iraq, and more like Denmark, Holland and parts of the United States.<sup>11</sup>

Once Israel was established in 1948 and the Zionist settlement agencies were freed of the constraints of British land and water proscriptions, the new Jewish State set out to expand agricultural production. In five years during the 1950s, cultivated lands increased by 150 percent—with the percentage increase of irrigated plots even higher. Soon after, the



**Figure 1.** Quantity Index of Agricultural Production, Crops, and Livestock. Source: Ayal Kimhi, "The Rise and Fall of Israeli Agriculture: Technology, Markets and Policy," paper presented at Sung Kyun Kwan University, 2004.

Israeli government amended its National Planning and Building Law so that the default zoning for open spaces was for "agricultural usage." Changing the classification of farmlands required approval of a committee dominated by agricultural interests. During this period, agricultural settlement actually doubled, with the number of Jewish farming communities increasing from three hundred to six hundred. Areas that had been written off for millennia as desert reemerged as arable lands, as the ideological fervor that characterized the pioneer spirit was given a state-supported framework that both deified and subsidized agriculture. During the 1960s, over 30 percent of exports came from the agricultural sector. Figure 1 shows the continuous expansion of agricultural production in Israel since the founding of the state.<sup>12</sup>

The steady growth in yields has continued to the present, even as the breaking of new agricultural land has leveled off. Today, Israeli farmers produce over 3.3 billion dollars worth of produce, 20 percent of which is

**Table 2.** Land Use in Israel

<i>Land</i>	<i>Thousands of Hectares</i>	<i>Percentage of Total Lands</i>
Total area of Israel	2,245,000	100
Built Areas	200,000	8.9
Non-Agricultural Open Spaces	1,146,000	51
Natural Reserves and Forests	347,000	15.5
Pasture	141,000	6.3
Arable Lands	411,000	18.3

SOURCE: Ministry of Agriculture, 2001.

exported. Table 2 indicates that roughly a quarter of land in Israel is being utilized for agricultural production, and this rate is fairly steady. This proportion is extremely high considering that most of the country is arid or semi-arid in its precipitation levels.<sup>13</sup>

As to the composition of Israeli agriculture, Table 3 provides a general breakdown of present production according to land use. As would be expected given the climatic conditions, the majority of agricultural lands are irrigated. Roughly a quarter of agricultural lands are dedicated to orchards, with citrus still comprising a major component of local fruits, even as the groves have migrated south to the northern Negev. Flowers and ornamental plants, intensively raised in greenhouses, provide revenues far greater than their 1.6 percent of land space. In general, some 1,456 hectares of land are utilized as green or “hot” houses.

In contrast with the success of Jews and Jewish agriculture in Israel, the 150,000 Arabs who remained in Israel after the War of Independence fared poorly. Most Palestinian Arabs fled the country during the fighting for a variety of reasons. The new Jewish government was not interested in rebuilding the fellahin communities that had frequently been hostile. In many cases, Arab farmers were not allowed to return to their homes. Under the 1950 Absentee Property Act they were paid compensation that fell far short of the land’s actual value.

About 40 percent of private Arab land resources were confiscated during this period, and today Arabs—who are 20 percent of the population—own only 3.4 percent of the land. This shift in landownership was certainly not an objective of the young Jewish State during its military conflict with five Arab armies and the local Palestinian Arab militias,

**Table 3.** Uses of Agricultural Land in Israel

<i>Type of Cropland</i>	<i>Thousands of Hectares</i>	<i>% of Total Lands</i>
<b>All Cropland</b>	<b>382.2</b>	<b>100</b>
Irrigated	192.3	58.6
Rainwatered	136.9	41.4
<b>Orchards</b>	84.8	25.8
Citrus	25.3	7.7
<b>Vegetables</b>	55.1	16.8
<b>Flowers and Plants</b>	5.2	1.6
<b>Field Crops</b>	183	55.8
Cotton	29	8.8
Wheat	86	26.2

SOURCE: Ministry of Agriculture, 2001.

but it was an undeniable outcome. With the loss of most of its lands, the already beleaguered fellah economy went into free fall. Already, it could not really compete with the highly mechanized Jewish agricultural sector. By the 1990s only 8 percent of Arab-Israelis made a living in agriculture. Historians Baruch Kimmerling and Joel Migdal summarize the process:

Even where they held onto their plots, the Arabs found it difficult to stay in farming. The state severely limited their water and electricity quotas, particularly when compared to the more productive neighboring Jewish communal and cooperative farms (kibbutzim and moshavim). And the Arabs found themselves excluded from the country's powerful marketing, credit, and purchasing cooperatives. Arab-owned citrus groves all but disappeared; in the 1950s, the fellaheen fell back on subsistence production, with supplemental marketing of olive oil. It is thus not surprising that many Israeli Arabs abandoned agriculture altogether . . . in Zureik's terms, they underwent a process of depeasantification. The land became the domain of those with the machinery to exploit. By the 1960s and 1970s, Arab agriculture in Israel would undergo significant mechanization and cash cropping, Israeli research organizations speaking of a shift from fellah to farmer.<sup>14</sup>

Despite the problems of this ethnic group, agricultural production at the national level grew exponentially. When broken down to its con-

stituent parts, the phenomenal success of Israeli agriculture during the past fifty-seven years can be attributed to seven factors: commitment to food security; extraordinary water development; innovative technological development; steady increase in available work force; a unity of purpose in Israel's agricultural settlement movements; unconditional political/economic support; and the growing availability of export markets.

Yet, in the more recent past, many of the very factors that created such agricultural prosperity have changed—from agriculture's perspective—not for the better. Indeed, there is a wide perception among Israelis that agriculture in Israel has lost its luster, comparative advantage, and most importantly, its future. While agriculture provided 30 percent of the national GNP during the 1950s, today's 3.2 billion dollars in annual production is only 1.6 percent of GDP. The trends in each of the seven key factors raise serious questions about the sustainability of Israel's present agricultural economy.<sup>15</sup>

Israel's initial years were characterized by chronic shortages of food. As the nascent State of Israel was absorbing hundreds of thousands of refugees from Arab lands, it faced a boycott from its Muslim neighbors. Domestic food production was inadequate, and proteins in particular were in short supply. Strict rationing of basic food supplies by the central government spawned a black market for a variety of staples. This period of collective hardship, known locally as the *Tsenah*, left an imprint on the national psyche.<sup>16</sup>

The residual effect of this trauma was a national commitment to agricultural self-reliance that has survived for fifty years. As agricultural researcher Elaine Solowey recalls:

On Kibbutz Matsuva during the fifties, the choice for a protein course during a meal was between ten olives and one egg. This memory drives the feeling that Israel needs its own milk, eggs, etc. Rationing was very strict and many kibbutzim, like Scarlet O'Hara, declared they were never going to be hungry again and started up an amazing variety of projects from raising guinea fowl to growing mushrooms.

Today, however, Israeli supermarkets offer a cornucopia of domestic and imported products that is as plentiful as any in the world. This

bounty has led many Israelis to grow more confident about the country's long-term ability to import food, notwithstanding its tenuous international stature in much of the world.<sup>17</sup>

The need for irrigation has been as historically important in Israel as the desire for food self-sufficiency. In anything beyond a subsistence economy, agriculture in semi-arid and arid climates cannot rely on rainfall as its water source. The impressive achievements in agricultural production reached prior to Israel's independence were made possible due to a coordinated water development program in the Jewish sector. This was coordinated by Mekorot, a public company that essentially became the national water utility when the state was created. Israel's founding political socialist leaders, almost all of whom came from the agricultural sector, perceived water as the engine that would fuel the incipient nation's rural economic development. The initial estimate for establishing a national water carrier at the start of the 1950s was fifteen million dollars a year for the first eight years of the project. Considering that Israel's entire foreign currency earnings during this period did not exceed twenty million dollars, the decision to push ahead with the infrastructure project constituted an astonishing commitment to Israel's agricultural communities. (During Israel's first decade, some 80 percent of investment in water infrastructure went into national water carriers.) Fifteen years after the War of Independence ended, the country had put in place a massive system for redistributing the naturally asymmetrical hydrological allocation.<sup>18</sup>

Despite the protestation of its Arab neighbors, Israel's National Water Carrier to this day takes water from the relatively rainy Galilee and the Kinneret Lake (Sea of Galilee) in the North and carries it down through a grid to irrigate semi-arid plots in the center of the country and the southern Negev Desert. Then, as during most of Israel's history, water was highly subsidized. It was hydrological socialism, and the results did not disappoint. With state incentives to open new spigots, for Israel's first thirty years, agricultural production could burgeon.

Of course, there were significant environmental ramifications to this aggressive water exploitation policy. The relatively saline waters of the Kinneret exacerbated groundwater contamination when used for irrigation, salinating the soil. As early as the 1950s water resources had already begun to deteriorate due to overpumping of the country's largest

aquifer to support new agricultural settlements along the coast. The results were quickly manifested in seawater intrusion and increased salinity levels. By the 1950s wells were closed. A decade later, when Israel found yet another new source for irrigation, recycling a substantial percentage of its sewage, an additional stream of contamination was added.<sup>19</sup>

The Israeli experience with wastewater recycling is unique and instructive. Israel was the first country on earth to make effluent recycling a central component of its water management strategy, setting standards for reuse and designing a national blueprint. When the state framed the original master plan in 1956, it originally envisioned the ultimate recycling of 150 million cubic meters—all going to agriculture. Today almost three times that level is recycled—a total of over 60 percent of sewage, generally considered the highest percentage of any nation in the world. By the beginning of the twenty-first century, effluents contributed roughly a fifth of Israel's water supply, and 50 percent of the irrigation supplied for agriculture.<sup>20</sup>

Concern, however, about the quality of water reused for irrigation has emerged, given its poor pretreatment, inadequate oversight, and the leniency of the standards. Epidemiological studies during the 1970s established that there were no discernible occupational health effects among Israeli farmers who irrigated with effluents. But it took another decade for the full hydrological impact of massive wastewater recycling to be assessed, and even longer for the country to set sufficiently stringent treatment standards to ensure groundwater and stream integrity. Thus, while Israeli agricultural water policy and irrigation resourcefulness facilitated increased production and expanded water resources, there was an indisputable ecological downside. This legacy includes high nitrate concentrations in aquifers, periodic bacterial episodes in urban drinking water sources, a steady increase in the levels of salt in aquifers, and even contamination by industrial solvents in rural regions, making dozens of wells unfit even for agricultural utilization.<sup>21</sup>

Other aspects of Israeli high-tech agriculture have come with both benefits and costs. When a popular daily newspaper surveyed Israelis, looking back after fifty years of statehood about the country's contribution to the world's technology, they voted drip irrigation as the country's most important invention. It even came ahead of the legendary

epi-lady hair removal system and ICQ software. Developed by the kibbutz-based Netafim Corporation, drip irrigation has created a world-wide revolution in farming for water-scarce regions. Other farmers in more humid regions have come to understand the benefits of bringing water, in precise quantities, with optimal fertilizer concentrations, directly to the root zones of plants, and they have embraced the technology; for example, the Florida citrus industry and the Northern California marijuana growers. Health hazards of drift from wastewater irrigation are also prevented by this system, and bacteria are neutralized on route. Computers run the entire operation.<sup>22</sup>

In Israel drip irrigation became ubiquitous, with over half of irrigated lands in Israel today under such micro-irrigation. It is the primary reason why water delivery efficiency has increased from 64 to 90 percent since the 1960s—with the amount of water per hectare dropping 50 percent—from 8,700 to 5,500 (cubic meters per year)—as yields continued to skyrocket.<sup>23</sup>

The technology was not without its problems, such as pipe clogging and breakage. Recently, a new generation of subsurface drip irrigation systems has emerged to address them, providing even higher levels of nutrients and water to plants while maintaining a dry soil surface. By burying the drippers seven to thirty centimeters below the surface, weeds were reduced, as were runoff and evaporation—eliminating almost completely human contact with poor quality effluents. Moreover, the longevity of the laterals and emitters in the system were greatly enhanced. Here was an environmental problem that truly had a technological fix that saved money and time.<sup>24</sup>

There are other, more vexing, aspects of Israeli high-input agriculture. Pesticide usage remains widespread and, when chemicals are replaced with clever biological substitutes developed in Israel, application often requires even greater sophistication and training. In arid regions, where the lands are sandy with low organic content, soils essentially serve as what Jared Diamond refers to as “flower pots,” with farmers providing the nutrients through costly organic and inorganic fertilizers.<sup>25</sup>

In short, Israeli agriculture has grown more technologically sophisticated. This has been key to the successive increase in yield, but it also meant that it has become more expensive to be a successful Israeli farmer. The upfront input costs money and the demands of human

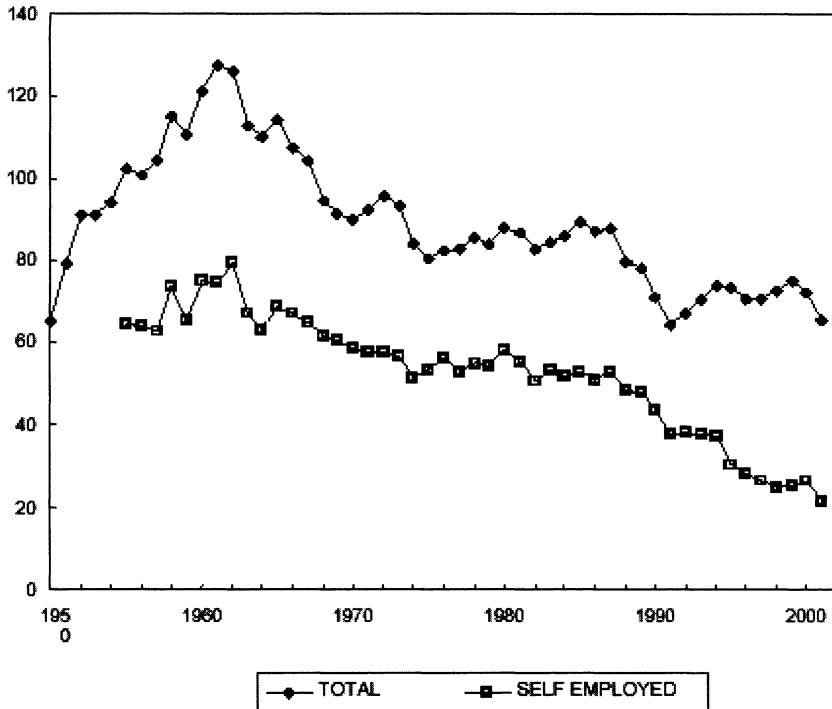


capital and associated expertise required to successfully compete has also increased. This serves to make the entire agricultural sector more vulnerable. The environmental balance sheet may be mixed, but on the whole, Israel's embrace of technological innovation has meant more efficient water and fertilizer utilization and, recently, a drop in pesticide consumption, but at an increasing financial cost.

Over the half century of its existence, Israel's population has grown dramatically due to massive immigration and, to a lesser extent, a relatively high birthrate. When the dust settled after the War of Independence, the country had hardly a million citizens. Today there are seven million. This clearly created an employment challenge. During the 1950s agriculture provided jobs for hundreds of thousands of immigrants as well as indirect employment in related services. Agricultural jobs paid reasonably well and were part of the pioneering fervor that accompanied the creation of a Third Jewish Commonwealth. But their appeal began to decline by the late 1970s and 1980s.<sup>26</sup>

The lessening attractiveness of agricultural employment was due to a variety of reasons. Technology and mechanization supplanted many labor-intensive practices, which decreased the number of agricultural jobs available. As the society became more affluent, agricultural wages for laborers were relatively meager. At the same time, landowners themselves began to lose interest in agriculture. To keep up meant massive investment of income in the latest tractors and technologies. Agricultural operations, whose justification had initially been largely ideological or political, found that they could not make ends meet. The number of family farms dramatically decreased, with scores of small operations defaulting on loans that the triple-digit inflation of the 1980s inflated to extraordinary levels. Many farmers simply sought alternative employment. Agriculture, as a livelihood, was increasingly perceived as less prestigious and was empirically less lucrative than other professions. Government records show that between 1981 and 1995 the number of farms in Israel plummeted from 43,450 to 25,900.<sup>27</sup>

By 1999, after many farmers had relinquished their land, 70 percent of the eighty thousand people who worked in farming (3.3 percent of the labor force) were hired laborers. In many areas, foreign Thai farmworkers vastly outnumber the host landowners. These migrants joined Israel's workforce when their predecessors, Palestinian day laborers, were



**Figure 2.** Thousands of Workers in Agriculture; Self-Employed and Total. Source: Ayal Kimhi, "The Rise and Fall of Israeli Agriculture: Technology, Markets and Policy," paper presented at Sung Kyun Kwan University, 2004.

perceived as a security threat or simply grew unreliable due to mounting political tensions and violence. In short, by most estimates today, only some 20 percent of Israelis living in rural areas actually work as farmers. This employment profile did not help the troubling pathology of double-digit unemployment in Israel that resulted from the *intifadah* and associated political turbulence after 2000.<sup>28</sup>

Figure 2 shows the steady decline in the number of Israeli agricultural workers. The graph actually understates the phenomenon as it relates to the total *number* of workers. Inasmuch as Israel's population has increased six-fold over the past fifty-seven years, the drop in the *percentage* of the workforce engaged in agriculture is far more dramatic.

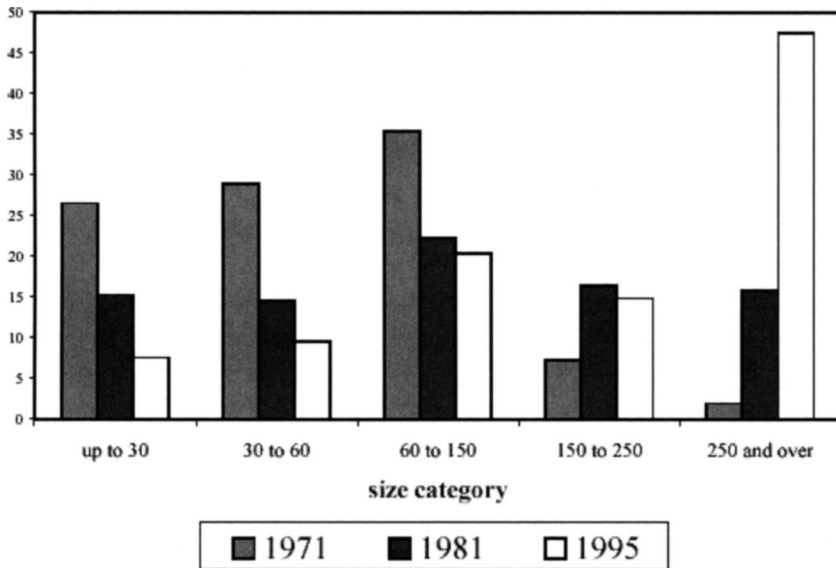
Along with fewer farmers in Israel, there has also been a loss of ideological unity in the agricultural collectives. Israel is the home to a variety of different ways of life in its rural sector, most notably kibbut-

zim—collective intentional communities—and Moshavim—rural villages with a modest cooperative base. From their inception, the members of these communities were highly motivated as “front-line soldiers” in many of Israel’s national challenges: immigrant absorption, creation of geopolitical facts on dangerous borders, and of course improving food security.<sup>29</sup>

But today, Israel’s rural sociology is a very different mosaic. Many kibbutzim have parted ways with the Marxist utopian aspirations of their founders. Members receive differentiated salaries, and the level of shared commitment has given way to a preference for privacy and the profit motive. They have become quaint, but capitalist, rural villages. Many moshavim have turned into little suburbs, with fields covered in condos, and members preferring to join the general labor force. Even the many kibbutzim who have chosen to retain their collectivist ethos do not automatically embrace national challenges with the alacrity that they once did. The less than charitable market conditions and the material aspirations of their members make them more circumspect.<sup>30</sup>

Additional economic forces are at work, changing Israeli agriculture. There is no denying that the general agronomic trend is in the direction of economies of scale. To be competitive, farms have had to grow bigger. A major initiative by the Ministry of Agriculture during the 1990s both upgraded the environmental regulations for dairies and encouraged mergers to improve efficiency. The government provided grants worth over a billion dollars to ease the transition, but the modernized results essentially squeezed out dozens of small-scale family milking operations. Once a 1.2 hectare greenhouse was considered enormous, and now 4 hectares is the standard.<sup>31</sup>

In this sense, Israel is not disconnected from the world dynamics of agriculture, which in most countries appear to be more conducive to larger than smaller operations. One could argue that there is a greater justification to subsidize small producers, as they often get more yields on the average with less waste and are often perceived as having the potential to produce less environmental disruption than bigger operations. Yet not just capital investment, but regulatory red tape and price supports often favor the agribusiness man over the family farmer. Figure 3 confirms the magnitude of this transition in Israel with small family farms in the moshav villages giving way to larger agribusinesses.<sup>32</sup>



**Figure 3.** Size Distribution (in dunams) of Active Farms among Israeli Moshavim. Source: Ayal Kimhi, "The Rise and Fall of Israeli Agriculture: Technology, Markets and Policy," paper presented at Sung Kyun Kwan University, 2004.

Profits, rather than ideology and lifestyle, are at the heart of agribusiness decisions. It is likely that the increased economies of scale will be good for the food and fiber industry. The increase in the size of Israeli farms probably bodes well for the environment as well; as empirical studies have demonstrated large farms have been shown to have greater resources and ability to adopt environmentally friendly practices. Whether this trend is healthy for the social fabric of rural Israeli society, is another matter entirely.<sup>33</sup>

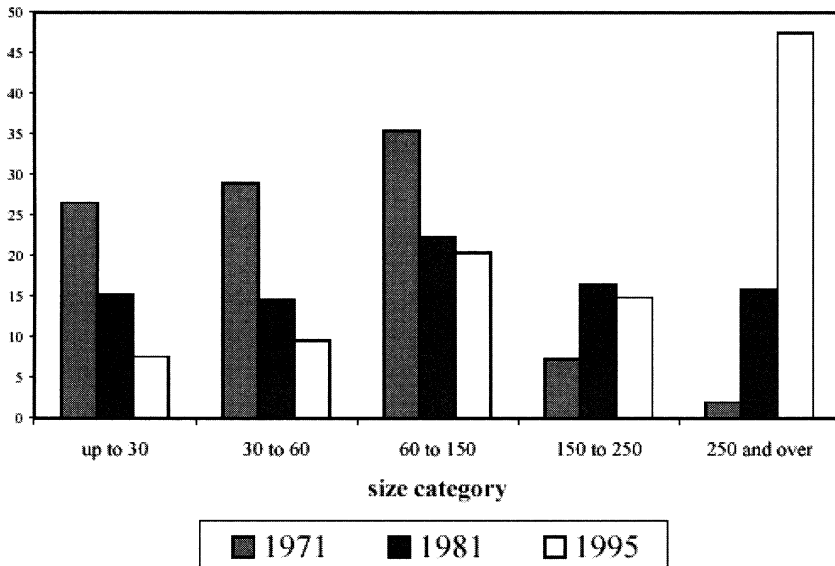
Political change has further hampered Israeli agriculture. There has always been an agricultural lobby in Israel whose influence was far greater than its actual numbers of the population. Its strength has never rested on its diminishing electoral power, but rather on the deeply embedded pro-rural impulse that resides in decision-makers regardless of their political affiliation. Israelis identify with the verdant landscape of the countryside and see something wholesome in its preservation. Moreover, in a nation still under attack by some Arab nations who have successfully initiated boycotts against Israel in the past, food security is not just a slogan but a real concern.<sup>34</sup>

From the first day of independence, this political support was translated into money. The government subsidized water. It offered price supports for many basic crops and for soil conservation activities and provided disaster relief. It made available a highly professional army of extension agents and it generously funded research. For example, on average, the Ministry of Agriculture in Israel currently invests some seventy million dollars a year in agricultural research; by way of comparison, the Ministry of Environment's annual research budget averages less than two million dollars.<sup>35</sup>

The past few decades, however, have seen a softening of this support. Water prices for farmers have gradually increased and, if present trends continue, there will soon be no difference between the domestic and agricultural water cost. The status of the once-vaulted kibbutzim has suffered from many decades of rule by right-wing parties who harbor few nostalgic sentiments towards the epicenter of their political nemesis. Indeed, since the Likud Party was elected into power in 1977, the sector has been denied the preferential economic treatment it enjoyed during the country's first thirty years. Additionally, it has had to deal with a disinformation campaign, frequently supported by politicians who were happy to caricature the entire farm sector as freeloading parasites. The Jewish Agency, a Zionist development agency funded by Jewish donors from around the world, bankrolled hundreds of settlements for almost a century, only to phase out its institutional support for agriculture and new agricultural settlements during the 1990s.<sup>36</sup>

Where previous policies made it practically impossible to sell agricultural lands, new flexible policies have allowed many farmers to change the zoning of their lands—or simply illegally rent them to sundry commercial ventures—producing powerful incentives to cease farming. As a result, Israel's agriculturists are sometimes branded as land speculators, with enough examples of abuse to provide justification for Supreme Court intervention to stymie the dynamic. In short, Israel's agricultural community finds itself on its own as never before.<sup>37</sup>

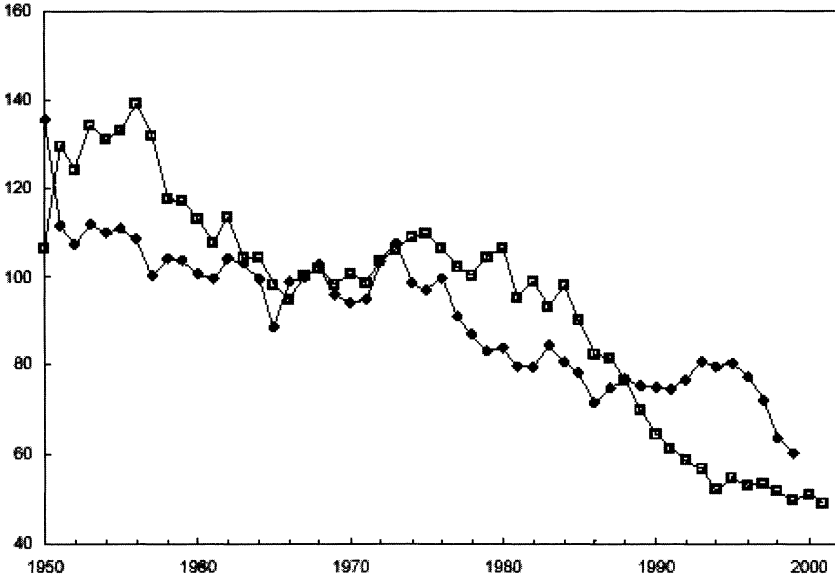
Israel's export of agricultural products has also declined in recent years, further endangering the agrarian community. By 1960, although its population had doubled twice in twelve years of statehood, Israel was already self-sufficient in food production. And the yields continued to grow. Export markets provided a continuously steep demand curve,



**Figure 3.** Size Distribution (in dunams) of Active Farms among Israeli Moshavim. Source: Ayal Kimhi, "The Rise and Fall of Israeli Agriculture: Technology, Markets and Policy," paper presented at Sung Kyun Kwan University, 2004.

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**Figure 4.** Price Index of Agricultural Products—Israel and the World. Source: Ayal Kimhi, "The Rise and Fall of Israeli Agriculture: Technology, Markets and Policy," paper presented at Sung Kyun Kwan University, 2004.

nomic and environmental demands. Historical developments and progression appear to point clearly to a future direction for Israeli agriculture.

For many years Israel's environmental movement considered farmers and agricultural policy as constituting "ecological enemies." Farmers' profligate use of water and the Israel Water Commissioners pro-agriculture allocation priorities left many nature reserves high and dry. Pesticides left drinking water and a range of fresh produce unhealthy. Fertilizers spawned eutrophication in surface waters, and the resulting nitrate concentrations led to the closing of dozens of drinking water wells. Streams stunk with the excrement of discharged livestock wastes. The plastics associated with high-input winter cultivation created a solid-waste disaster. When they were mixed into the bonfires that frequently disposed of crop residues, it created a serious air pollution hazard. Most of these environmental complaints were well founded.<sup>40</sup>

Yet, as Israel's environmentalists started to prioritize their environmental challenges, the country's dwindling open spaces topped every-

one's list. The irreversible nature of sprawl, the retreat in the astonishingly rich local biodiversity, and the loss of a landscape that had for so long inspired pilgrims and prophets—all these led to a sense of crisis. Objective analysis led to the conclusion that past successful government protection of Israel's landscape had been founded in agrarian policy. But, as the protection of farmland weakened, so environmental degradation and decimation of open spaces followed. Suddenly, farmers did not look so bad after all. Even from an aesthetic point of view, there was a new sense of appreciation. To be sure, nature reserves have an enormous power and appeal. Yet, some 25 percent of Israel's land is already set aside for biodiversity preservation and hiking. It was the farmlands that were threatened with extinction. Israelis realized how much they had come to appreciate this verdant heart of their local landscape.<sup>42</sup>

When Hebrew University economists Aliza Fleischer and Yaakov Tsur took a look at how the agricultural landscape affected the travel decisions of Israeli tourists, they found that there was an enormous "willingness to pay" for travel to and through a cultivated countryside. The results of their research suggest that the economic return (crop sales) on agricultural land is only 16 percent of its actual value, given the Israeli penchant for rural vistas. The rose-colored tinted vision of bucolic Israeli landscapes largely ignores ethnic divisions. Both Arab and Jewish agricultural lands are viewed with the same sentimental and perhaps wistful fondness.<sup>43</sup>

What we have here in short is an "externality." Externalities typically connote a negative result from an economic activity that is thrust on an unsuspecting and unenthusiastic public. But externalities can also be positive. In this case, Israel's beleaguered farming community is producing a landscape, valued at millions of dollars, for public enjoyment. Yet it receives no return on the product, because it is essentially a byproduct of agriculture that just happens to benefit the public. In this context, subsidies make sense economically. Moreover, as many European nations have stressed, agricultural lands serve as real estate reserves, preserving options for future generations.

In conjunction with a growing national appreciation of the agrarian landscape, Israel's agricultural community had taken a greener path. Spurred to a large extent by European pesticide residue standards, chemical usage began to drop during the 1990s. The Ministry of Agri-



culture actively promoted Integrated Pest Management, using a variety of pheromones, natural predators, and biological materials to control unwanted bugs and weeds. The waste treatment systems installed in many Israeli feedlots and dairies more than equaled the sewage plants installed to treat human residuals. Some kibbutzim even managed to recycle their plastics and make mulch out of their organic loadings.<sup>44</sup>

Despite this, Israeli agriculture still has its ecological critics. In a paper published by the local chapter of World Watch Israel, Ami Ettinger subjects Israeli agriculture to a strict ecological critique. As the introduction summarizes:

In Ettinger's eyes, Israeli agriculture, similar to that of the world's, is not sustainable, and contributes significantly to the growing environmental crisis on our planet. Ettinger's point of departure is the urgent and unavoidable need to change direction in order to stop the deterioration in ecological systems on which humans are dependent for existence. Ettinger strongly criticizes modern agriculture as ignoring this dependency on natural systems and thus damaging them. In so doing it damages itself. In his view, the origin of the problem is in the modern uni-directional agricultural perspective instead of a cyclical one. Rather than using a cycle of plantings, modern agriculture is based on monocultures. Rather than conserving the fertility of the soil from year to year, there is a perpetual need to fertilize. Rather than using eco-agricultural systems, that encourage solving pest problems through natural enemies, modern agriculture uses chemicals excessively until they wipe out entire ecological systems along with the natural enemies of the pests.<sup>45</sup>

These high ecological standards should be set in the context of an increasingly tough world market. Israel has been experimenting with organic agriculture since 1943 and since 1982 is home to a moderately active Union of Organic Growers. But organic produce has not caught on. Despite several efforts to be competitive, Israeli organic products are still considerably more expensive or, alternatively, less productive. For example, the highly successful date orchard at Kibbutz Samar converted to become organic during the 1990s and finds its yields to be roughly two-thirds of its neighboring settlements, which actually use extremely modest chemicals.<sup>46</sup>

Israel's population has grown, and it is unlikely that the country will ever return to full food self-sufficiency. The organic ideal has an important place in any agricultural community and should be a constant presence as a source of inspiration and an object of aspiration. With current practices consistently moving in an ecologically sensitive direction, it seems unfair, however, to brand conventional agriculture as downright unsustainable. Enforcing existing pesticide residue standards and the Israel Water Law's prohibition on causing any form of pollution could provide sufficient incentive to continue the trend of reduced reliance on chemicals. And more effective public education about the health benefits of chemical-free produce might boost consumer demand sufficiently to make organic alternatives competitive.

Along with the problem of pollution remains the issue of water. Some water experts argue that the way to solve the region's water scarcity problem is by phasing out agriculture. They favor "virtual water"—the importing of water-intensive crops over continued cultivation. Yet, even proponents of virtual water agree that Israel will always need to produce its own eggs and milk. The present 85 percent local food production is an impressive achievement, especially when considering the enormous quantities produced for export. This accomplishment has even greater meaning given the land and climatic conditions in which much food production takes place. While Israel should seek to avoid the export of water-intensive crops, it makes perfect sense to continue production of locally consumed products that can still successfully compete with the subsidized international produce.<sup>47</sup>

Water limitations are also the focus of Israeli innovations in developing salt- and drought-resistant strains of fruits and vegetables. Creative and patient combinations of germplasm have produced new crops with the potential to eliminate famine in drylands. Here Israeli agriculture is making a commendable contribution internationally. Perhaps, in an ideal world, the greater land reserves available in neighboring Arab countries could provide much of the food and fiber consumed locally. But, at present, this appears even more of a dream than a prosperous organic agricultural sector.<sup>48</sup>

With the very future of the agricultural sector wavering in the balance, it is time that Israeli society makes an active agrarian choice once again. It needs to reaffirm its historic obligation and try to meet the

biblical standard of turning the land into one of “Milk and Honey,” by make an enduring commitment to its rural sector. Present subsidies of Israeli water are trivial compared to the past and far below those of other western nations. However, for a variety of produce and flowers, water, perhaps, will no longer constitute a constraining factor, as government-funded research uncovers new ways of producing usable water. New breakthroughs in membrane technologies have reduced the price at Israel’s new generation of desalination plants to fifty-five cents per cubic meter. Many crops are economically viable at this rate—and desalination prices are likely to drop even further over time. A recent government decision, upgrading wastewater treatment standards is another critical step. While it will cost the country over two hundred million dollars over the next ten years, it also means that farmers will be able to use municipal effluents without compromising the fertility of the soil or the integrity of the underlying groundwater in the future.<sup>49</sup>

All the same, public policy needs to be rational and strategic. Scarce resources should not be subsidized, creating incentives for wastefulness, when alternative targets for support exist for which there is a clear surplus. In the present context, surely water, a scarce resource, should not be subsidized when the same support could be funneled through other, more abundant, factors of production—such as unemployed workers. There is a compelling national interest to ensure that agriculture continues to provide landscape and ideological returns to local citizens. The risk of abandoning agriculture includes spawning desertification in the southern semi-arid regions. It is important for national self-esteem for Israelis to know that, to a large extent, they do feed themselves. It also sends a significant message to many developing countries, who for some fifty years have looked at Israel to confirm the prospects of a highly productive agricultural economy in conditions of intense water scarcity.

Because a globalized economy will continue to put pressure on Israeli farmers, they will have to continue to be as clever as ever in developing crops and cultivation methods that can make their drylands bloom with as little waste of natural resources, residuals, and cash outlays as possible. If the past hundred years is any indication, the core of agricultural communities and individual farmers who have survived the vicissitudes of Israel’s checkered agricultural history are up to the task.

## NOTES

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