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# Sustainable Agriculture in Aghali

## The Smart Village Concept in the Great Return to Karabakh

*Nazrin Baghirova*

> *"Look, life is returning here—to Zangilan, [to] other places, and [to] Shusha. You know very well that a lot is being done to develop this region. Everyone who travels along the road sees the railway, the highway, and a six- and four-lane highway. An airport is under construction in Zangilan, which will be commissioned this year. A large agro-park has already been built, and the first crop will be harvested this year."*
>
> *– Ilham Aliyev, remarks in Aghali, 27 May 2022*

On 31 December 2022, Azerbaijani president Ilham Aliyev delivered his annual televised address on the occasion of the Day of Solidarity of World Azerbaijanis and the New Year. One of his formulations serves as the political background to this essay: "the Great Return program is being successfully implemented. […] I am confident that hundreds of thousands of former displaced persons will return to their homeland in the nearest future."

The Great Return is a flagship state project to repopulate and rejuvenate the Karabakh and East Zangezur Economic Regions, which were liberated by Azerbaijan in 2020 thanks to its victory in the Second Karabakh War. This essay will examine how repatriated farmers can optimally utilize agricultural lands and water, gain access to equipment, fertilizers, and pesticides, and examine how they can gain access to agricultural retail markets thanks to technological innovation. The essay will focus on a pilot project being implemented in one part of Azerbaijan's liberated lands, namely the Zangilan district, which is one of the five districts that since the administrative reforms of July 2021 belongs the East Zangezur Economic Region.

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A milestone was achieved on 27 May 2022, when Aliyev participated in the official opening of a "smart village" project in the village of Aghali located in Zangilan (the quotation that serves as this essay's epigraph was pronounced by the president on that occasion). This ceremony marked the completion of the first stage of a green resettlement project that included 200 fully constructed residential buildings, the introduction of public services (ASAN services, banks, post office, hospital), a "smart" secondary school with a capacity for 360 pupils, a "smart" kindergarten for 60 children, modern infrastructure, a high-speed internet connection, and the Gilmed sewing factory. The state has also allotted agricultural fields to each household. (In the next phase of the project, the state plans to further expand the village and build 150 more homes, including two- and three-story apartment buildings.)

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This significant event marks the start of the "Great Return" of individuals and families that were ethnically cleansed by Armenian forces in the early 1990s, losing their properties, land, and friends and relatives as a result. According to the latest figures provided by the Zangilan authorities, about 66 families (326 residents, of which 169 are women, 157 are men, and 102 are children) have now come back home. To ensure adequate employment opportunities, the Azerbaijani government has taken a series of important steps—one being job creation and job training, including in the agricultural sector

(livestock, farm management, beekeeping, etc.), a grant of land ownership to each household, the provision of separate pastures for the development of animal husbandry, and the installation of pivot irrigation systems near the village.

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Due to the local landscape and the region's agricultural legacy, the Aghali smart village concept focuses on agriculture as one of the state's priorities to foster its sustainable development. Priorities in the domain of agriculture include animal husbandry, meat and milk production, and intensive horticulture (including apple orchards and vineyards).

The sowing season is right around the corner, and Aghali's repatriated villagers are ready to begin. There is no time to waste.

This essay will examine how to best optimize the public resources on offer to support farmers in Aghali—especially the younger generation (including women)—as they come together again as a community in their quest to achieve sustainable livelihoods. This examination will be conducted by dividing its contents into three sections: the first described the "smart village" as an agricultural concept in Azerbaijan, with reference to international best practices; the second explains the various needs of farmers during the agricultural production process; and the third examines production challenges like access to markets.

## The Concept

What is a smart village, and what purpose does it serve? A 2019 EU Commission document states that "smart villages are *communities in rural areas* that use innovative solutions to improve their resilience, building on local strengths and opportunities. They rely on a *participatory approach* to develop and implement their strategy to improve their economic, social, and/or environmental conditions, in particular by mobilizing solutions offered by *digital technologies*" (emphases in the original). Two years earlier, another EU Commission publication defined smart villages as "those (local communities) that use digital technologies and innovations in their daily life, thus improving its quality, improving the standard of public services, and ensuring better use of resources."





Such a conceptual definition can vary somewhat, depending on specific socio-economic circumstances. For example, in China smart villages are more focused on improving the quality of life of poor farmers, based on the specific economic circumstances of the various regions in this large country. Hence the emphasis in China on smart agricultural villages, smart public service villages, e-commerce villages, smart tourism villages, and "comprehensive development-type" smart villages. The idea is to promote and develop (to "smarten up") a village's objective comparative advantages.

*The driving reason for rebuilding Aghali as a smart village from start to finish is to ensure the sustainable livelihood of the former IDP population through the revitalization and agricultural development of the rural area.*

In the EU, on the other hand, "smartening up" is usually aimed at improving agricultural productivity as part of a broader campaign to ensure food security for the bloc, but also as a way to prevent the further mass exodus to urban areas through the improvement of public services offered at the local level. A 2017 EU Parliament appraisal report published by its Committee on Agriculture and Rural Development thus concluded that "success in rolling out the smart villages concept will depend on much greater investment in improving digital connectivity in rural areas," since the concept is itself "premised on access to high-speed internet in all rural territories." The same document also noted that the involvement of the local community is another prerequisite for launching the smart village concept.

In the context of Azerbaijan's liberated territories in general, and in the Aghali pilot project in particular, the driving reason for rebuilding the locality as a smart village from start to finish is to ensure the sustainable livelihood of the former IDP population through the revitalization and agricultural development of the rural area.

## Access to Land

An important pre-requisite to the achievement of higher labor productivity in the context of the goal of ensuring returnees' sustainable livelihood is access to

sufficiently-sized plots of land. Thus, the government has provided special pasture lands and granted ownership to each repatriate household in Aghali of a 0.12-hectare plot of agricultural land.

This is a critically important step, since the first factor for successful family agricultural endeavors in almost all cases is private property rights, specifically land ownership. As one of the world's foremost experts on global food needs, Gordon Conway, writes in *One Billion Hunger* (2012), "without such rights, there is little incentive for a farmer to invest in improving soil, water, and other sources." Indeed, ownership enables farmers to effectively assess the trade-offs between productivity, stability, and resilience, all of which helps to ensure the development of sustainable agriculture practices.

Understanding the specific economic roles of farms based on the size of land plots is also important. The EU's statistical agency Eurostat has categorized farms according to their physical (utilized agricultural area) and economic (standard output in monetary value of production) sizes. By this classification scheme, Aghali's farms are designated as "very small farms (i.e., they're each less than 2 hectares in size, with a projected output of below 8000 euros per year). In the EU context, more than 50 percent of what such farms produce is self-consumed. They are also typically characterized by a high share of family labor in farm work. To refer to a Eurostat publication's assessment: "while many [larger] farms with a high level of standard output occupied considerable areas of agricultural land, there are specific types of farming which may have considerable output in monetary terms from very small areas of agricultural land, for example, horticulture or poultry farming." (The Eurostat publication fails to take into account the role that animal husbandry can play in "very small farms," due to the manner in which this form of rural activity is typically structured in EU member states, particularly in the context of pasturelands.)

Thus, the disadvantages associated with "very small farms" can be overcome in various ways. For instance, in order to increase Aghali farmers' sustainable competitiveness, the Ministry of Agriculture could institute policies supportive of the organization of one or more farmers' cooperatives (which is not the same as the institution of the collective farm in the Soviet period). International best practices indicate that membership in a well-conceived farming cooperative enables participants to pool their resources and support one another in access to water, infrastructure, equipment, markets, and capital. On the other hand, if the owner of a very small farm wishes is to remain fully independent, then the Ministry ought to have programs in place to assist the owner to develop optimal production strategies for developing horticulture, poultry farming, and so on.





## Access to Water

Zangilan's geography is characteristically alpine, with sloped plains; its climate is thus a bit challenging for optimal agricultural production: summers are typically hot, dry, and clear whilst winters are very cold, snowy, and partly cloudy. Over the course of the year, the temperature typically varies from -5 °C to 31 °C. The hottest months are June, July, and August; the coldest are January and February. Annual precipitation is about 429 mm, with the wet period lasting from October to May (the wettest month is May, with 67 mm of rain; the driest months are June, July, and August, with an average precipitation of 15 mm per month).

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Again, the weather in Zangilan is not without its challenges. According to Professor Mirnaib Mirsalahov from Azerbaijan State Agricultural University,

> agricultural demands for water vary depending on the structure of the sown area, crop types, and irrigation method employed. We know that currently, Azerbaijan's irrigation practices in horticultural production require, on average, between 2,000 and 2,500 cubic meters of hectare per vegetation period—so four to five irrigation times throughout June to August—but 500 cubic meters per hectare per single irrigation.

This leads Mirsalahov to provide the following estimates, based on the accepted logic that 1 mm of precipitation translates into 10 cubic meters of liquid equivalent: since Zangilan receives 670 cubic meters of rain in May and an additional 740 cubic meters in total from June to August (the sum is thus 1,410 cubic meters from May to August), the vegetation period will require the additional provision of approximately

1,660 cubic meters of irrigated water per hectare. However, as Mirsalahov himself allows, it is possible that the foregoing amounts of required water are an underestimate: the driest summer months will probably need even more irrigation in comparison to the indicated requirements for May, which will also need additional irrigation water, but less than in the summer period.

Aside from the supply of water that is provided by a connection to Azerbaijan's national network, the availability of other sources for the irrigation of Aghali's agricultural plots are dependent on local hydrogeological conditions—i.e., tapping into rivers, springs, and underground waters. This is not without its challenges. Zangilan's rivers include transboundary one like the Okhchuchay, the Basitchay, and the Hakari. All originate in Armenia and flows through Azerbaijani liberated territory into the Araz river, which in that part of the country delineates the border with Iran.

The Okhchuchay, in particular, is heavily polluted: its source is located in the Armenian district of Gafan, near a copper-molybdenum plant and an iron ore processing factory. Their production processes, which involve the discharge of untreated industrial wastewater, have greatly contaminated this river with heavy metals, causing an ecological disaster along the river's basin in Azerbaijan, as documented by the country's Ministry of Ecology and Natural Resources. This makes the water from the Okhchuchay effectually unusable.

Another challenge is that only the Hakari-Basitchay fluvial system runs near Aghali. Only those farmers whose plots of farmland are closest to the river could access its water, but only after having constructed special pumps. Thus, not all the smart village's farmers would have equal and cost-effective access to the river through recourse to this method.

The third option is gaining access to groundwater. This, too, is challenging, since not all sources of underground water are close to the farms—and they are not equally dispersed among the allotted plots of farmland. The Azerbaijan Amelioration and Water Economy Open Joint Stock Company (OJSC) is in possession of precise maps and can guide villagers through the process of identifying and constructing water wells.

Insufficient precipitation, pollution, and unequal access to fluvial and underground sources of usable water indicate that the optimal solution for Aghali's farmers is the establishment of an artificial irrigation system. This has already been done: a pivot irrigation system has been constructed for use by farmers.

The irrigation system established near the Aghali village is a hydraulic pivot irrigation set designed to irrigate 100 hectares per machine. The advantage of the pivot irrigation system is that it allows for the watering of crops in a targeted way. Water is delivered to plants on a regular basis, and the individual farming homestead determines how much and how often plants are irrigated. The pivot irrigation method is also a low-pressure application. As a result, less water is wasted compared to other methods of irrigation—if used correctly.

However, this system is designed to irrigate more or less flat valleys and plains. This does not correspond to Aghali's geographical conditions. Hence the imperative to apply another innovative irrigation method. The relatively inexpensive technique that relies on a system of IoT-based sensors for precision agriculture is a promising way forward. Rafiq Verdiyev, the Deputy Head of Azerbaijan's National Hydrometeorological Service, has pointed to research indicating that such a system could precisely monitor soil water levels and schedule sprinkling times in well-calculated amounts.

Other localized irrigation techniques—these apply water directly to where the plant is growing and thus minimize water loss through evaporation from the soil—include the use of porous clay pots, porous pipes, and perforated plastic sleeves, as noted by Mirsalahov. All in all, drip irrigation can dramatically reduce water use, with some studies showing a 70 percent savings rate.

There are other methods and systems—none of which are exclusionary—that could be implemented in the context of Aghali and, if successful, subsequently be applied elsewhere. For instance, the establishment of a piped water supply system from nearby surface water sources, which would minimize water loss and increase water usage efficiency. The rain harvesting method (RWH)—i.e., collecting rainwater during periods of heavy rain and storing it for later usage—could also be utilized, supplemented by groundwater resources, as needed.

Whatever the specific solution or set of solutions are chosen, all should operate in a holistic and coordinated manner. This will require

the establishment of a benevolent regulatory environment, which would help ensure farmers have equal access to, and share of, the water supply. This might include the establishment of a water-user association at the local level, whose centerpiece would be an online platform accessible to all farmers. Surely, the instauration of a cooperative would facilitate such an endeavor.

## *Access to Equipment*

Both a lack of training in the operation of farm machinery and equipment (and spare parts), as well as their actual unavailability, could be a bottleneck during production periods. This could result in the inability of a farmer to harvest in time, thus affect the yield. Depending on the types and brands of agricultural machinery, including smart machinery, that is or will become available to farmers in Zangilan, proper capacity-building training programs must be delivered, and licenses should be received. In addition, the equal and equitable availability of machinery to all farmers necessary for production should be delivered on time—otherwise, the yield can be lost.

What, then, could be the reasons for the unavailability of the farm machinery on time?

Generally, Azerbaijani farmers have identified three main reasons: *one*, the high cost of farm equipment; *two*, delayed delivery of leased machinery; and *three*, the absence of spare parts and unavailability of mechanics and qualified service personnel when they are mostly needed (i.e., during peak periods of production).

The Azerbaijani authorities have addressed the high-cost issue by providing certain forms of subsidies. According to Firdovsy Fikratzade, the head of the country's Agricultural Research Center, the government has instituted new regulations whereby public funds cover 40 percent of the purchased cost of equipment and machinery, which is procured directly from local or international dealers.

The second method for obtaining farming machinery is by renting it. The going daily rate, apparently, is 50 AZN per hectare. In many cases, this produces bottlenecks, since the owners of the machinery (assuming they use these themselves, which is typical) cannot always ensure prompt delivery—even assuming there is no rental waiting list, which there typically tends to be.

The final challenge is the absence of spare parts and necessary machinery service when it is most needed, i.e., during the peak production season. Professor Vagif Mirzaliyev of Azerbaijan State Agricultural University makes this point succinctly:

> There are more than 1,000 different types of farm machinery brands available on the local market in Azerbaijan in the context of horticultural production alone. Each of them enters the market with a package of equipment and spare parts services. However, one of the main concerns of farmers is that none of the providers conduct information sessions and training programs on how farmers can fix at least minor problems to the machinery that is sold, or how to obtain replacement spare parts without going through a cumbersome process with the providers. Since farmers do not receive necessary information and training on fixing spare parts and cannot access spare parts on time, they tend to be unable to complete their production in a timely manner if equipment breaks down. And this results in both a loss on investment and additional high costs.

The equipment challenge, which is hardly unique to Aghali, suggests strongly that the solution is the instauration of farmers' cooperatives. This would, inter alia, increase farmers' equipment and machinery purchasing power.

Several concrete recommendations derive from such a policy proposal. For instance, developing an online demand-responsive platform for sharing equipment and providing mechanical services. Training programs on farm machinery could be more easily organized and focus on the types of machinery and equipment available to Aghali farmers and used by all members of the cooperative. The power of collective bargaining could be harnessed to ensure service contracts include robust provisions for the timely supply of spare parts, maintenance services, and information and training sessions. This could include penalties for non-compliance. Surely there are others, but only implementing these could lead to vast improvements.

## *Access to Fertilizers and Pesticides*

Despite drawbacks in some cases, fertilizers unquestionably ensure higher crop yields and agricultural production: they are food for plants and replace the nutrients that crops uptake from the soil. Fertilizer consumption measures the quantity of plant nutrients used per unit of arable land. It is crucial that farmers are able to balance the nutrients while using

chemical fertilizers in the way that the plants fully absorb them in the appropriate quantities.

That being said, excessive use of certain types of fertilizers diminishes crop yields, which varies with crop and soil type, levels of humidity and other climatic factors, and nutrient types. It is also harmful to consumers. According to Professor Hasanali Aslanov of Azerbaijan State Agricultural University, "the excess of nitrates in crops is poisonous to human beings and can be fatal to human health."

Moreover, an excessive release of nutrients (especially nitrogen and phosphorus) in the environment—stemming from the excessive use of certain fertilizers and the fact that not all nutrients used in agriculture are effectively absorbed by plants—is another major source of air, soil, and water pollution. All this has an adverse impact on the climate and also harms biodiversity in rivers, lakes, wetlands, and seas. Increasing greenhouse gas flux and the emission of nitrous oxide are additional consequences to excessive fertilizer use on croplands.

One way forward is to develop what the EU calls an "integrated nutrient management action plan." This would both address nutrient pollution and increase the sustainability of the livestock sector. Precise fertilization techniques are critical to fostering sustainable agricultural practices consistent with the smart village concept. These should include programs to recycle organic waste into renewable fertilizers whenever possible. In this regard, Aslanov and his colleague at Azerbaijan State Agricultural University, Vigar Bashirov, emphasize the importance of identifying nutrient load reductions and applying balanced fertilization techniques.

Other recommendations include adopting a participatory approach to improving the efficiency of fertilizer usage by farmers. Working together, experts and farmers should identify the nutrient balance of the soil and type of crops to be planted whilst taking into account local climate conditions before the sowing period starts. Lastly, farmers or at least their agronomists should pass a certified capacity-building training program to ensure they know how to properly use the fertilizers on offer.

Related to fertilizer use is pesticide use—also an indispensable part of agricultural production that significantly helps to increase fruit, vegetable, and cereal yields. Pests detrimental to agriculture can be broken down into four main categories: vertebrates (rodents, birds, reptiles, and other mammals); invertebrates (insets, spiders, ticks, slugs); weeds (any plant growing out of place); and diseases (fungi, bacteria, viruses, and other microorganisms). Various methods are used to bring these four categories under control. All in one way or another relate to pesticide use.





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The excessive use of chemical and other hazardous pesticides in agriculture, however, contributes to soil, water, and air pollution and biodiversity loss. It can also harm non-target plants, insects, birds, mammals, and amphibians.

Various mitigation techniques ought to be applied in Aghali, in accordance with the smart village concept. Making less toxic chemical pesticides available is one avenue. Moreover, environmentally friendly pest control techniques should be adopted. These could include integrated pest management (IPM), whereby farmers are trained to focus on pest prevention and alternative pest control methods (with chemical pesticides only being used as a last resort).

The integrated use of specialized drones is also possible, as a way to ensure a more precise and efficient application of not only pesticides, but also fertilizers, and as a way to minimize exposure to harmful pesticides. Finally, making use of nano structured biosensors in the detection of soil nutrients and fertilizers should also be considered as part of a broader set of integrated, smart technology-based measures.

## Access to Markets

Smallholder farming is a fragile business, with success depending on a variety of factors, some of which have been discussed in previous sections of the essay. In the present section, we will analyze the ways in which smallholder farmers, like those inhabiting the Aghali smart village, can gain proper access to the marketplace. This is, evidently, a key component of the returnees' quest to achieve sustainable livelihoods.

In general, there are three types of consumer outreach channels available to farmers, depending on

the types of agricultural product they produce: direct to consumers, selling to retailers, and selling their products to producers of processed or secondary agricultural merchandise. In the case of Aghali's farming community, all three of the foregoing outreach channels are available.

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Officials from the country's Ministry of Agriculture are planning to organize the sale of what is produced in Aghali—both in the Azerbaijani market and abroad. However, the full-on development of efficient supply chains will take time, given the state of the market: public-private partnerships will need to be established, and this will involve bringing policymakers, farmers, cooperatives, and state authorities together, thereby ensuring decreased production costs throughout the supply chain. There is thus an argument to be made that, at least in the short-term, Aghali's farmers should focus on producing and distributing their output in the local and nearby rural areas.

However, Aghali's farmers could use an online platform—the lead time to design such a platform is relatively short—as an additional way to promote their products directly. Having recourse to relevant information and communication technologies (ICT), they could reach more consumers and, in turn, increase their sales. ICTs properly used can help Aghali's farmers overcome most of the impediments to rapidly and optimally gaining direct access to outside markets with as few middlemen as possible.

According to a Chinese study conducted among the rural population of its Guangdong province, where a smart village strategy had been previously launched by the state, 82 percent of respondents indicated that the "internet has played an important role in bringing together the power of internet users to help poor farmers." ICTs fostered the rapid development of rural e-commerce, which in turn helped increase agricultural product sales and made it easier for farmers to obtain information about market demands.

In other words, the full embrace of ICT is an integral part of the smart village concept, which is, after all, predicated on the idea that technology is holistically adopted to hasten the growth of sustainable development. A statistical analysis indicates that revenues from e-commerce in Azerbaijan are expected to double by the end of 2023 against a baseline of 2020—the year marked by the onset of the COVID-19 pandemic and the Second Karabakh War. The number of e-commerce users in Azerbaijan is also projected to grow along similar lines.

This clearly creates an opportunity for Aghali's farmers, but the initial learning curve may be steep. Improving their financial and digital (ICT) literary through targeted training programs, as well as enabling access to financial instruments and other resources, would be imperative—as would the development of a new e-commerce platform for the envisioned farmers' cooperative, as part of a holistic business model that would need to be instituted.

With sufficient coordination, benevolent state actions, and enough local open-mindedness, the Aghali smart village can become a successful, sustainable community and come to serve as an example amongst many others of just what the Great Return can accomplish "in the nearest future." BD

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