CIVIL-MILITARY FUSION CENTRE
AFGHANISTAN IN TRANSITION
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Comprehensive Information on Complex Crises

Executive Summary

Irrigation, Profits & Alternatives Crops

This paper addresses the role of irrigation water, market prices and profitability in Afghan farmers' crop selection, particularly in their decision to grow opium poppies as opposed to alternative crops such as cereals, fruits and vegetables. Research and experts cited in the report suggest that access to sufficient irrigation water is crucial in enabling farmers to take up alternative crops. Moreover, improvements in infrastructure, water management, farming practices and other areas are needed to ensure water is used efficiently so that it is available for licit crops. Irrigation is especially important in enabling the cultivation of high-value crops which may prove more profitable than opium poppies given that they require greater amounts of water.

Irrigation. According to a UN database, the total irrigated area in Afghanistan amounts to 3.2 million hectares (ha). The Afghanistan Research Evaluation Unit (AREU) states that the country has enough water to cover the current and future uses, but that transporting water from water-rich areas to water-scarce areas poses a challenge for infrastructure and institutions. Understanding Afghanistan's irrigation network, including the natural, technical and social elements, is key to assessing the prospects of alternative crops. Gaining such an awareness is particularly challenging given that almost 90% of irrigation in Afghanistan is done through more than 28,000 informal systems (e.g., *karez*, springs, wells and rivers). After describing Afghanistan's current irrigation infrastructure and management systems, the full report reviews experts' recommendations for maximising the efficiency of the country's multitude of irrigation networks. It shows that some increases in water availability may be attained by constructing or rehabilitating irrigation systems but that improving the efficiency and effectiveness of water use is particularly crucial. Most water loss is related to the low efficiency of the irrigation systems and the mismanagement of water distribution. The UK Department for International Development, for instance, found that efficiency of both formal and informal systems ranges from 20-40%.

Profitability. Contrary to the claim that poppy cultivation is more profitable than alternative livelihoods, this report cites research showing that there are alternatives which could yield higher returns than opium poppies. In order to make these alternatives feasible for implementation, farmers will have to have access to agricultural inputs as well as irrigation water. The water requirements for these alternative crops are much greater than for poppies, thus making it extremely important that water resources are used in the most effective and efficient manner. For instance, almonds need between 1,326 and 2,125 mm of water and could yield a profit of USD 16,068 per ha. Wheat needs less, between 338 and 1,013 mm, but yields only USD 320 per ha.

Beyond Water and Profits. Experts have found that, while Afghanistan suffers from patches of water scarcity, the country overall has sufficient irrigation water supplies to meet its needs. The challenge is to establish appropriate institutions and adequate physical infrastructure to distribute and manage that water in the most efficient way possible. In addition, AREU identified a combinations of additional factors which feed into farmers' decisions to grow opium poppies versus alternative crops, including the position of key elites vis-à-vis poppy cultivation, food security and social equality. The AREU study found that that "the absence of opium cultivation was more than a matter of water". Water availability generally is a necessary but insufficient condition to enable Afghan farmers switch to high-value alternative crops.

WANT TO READ MORE? The full report on "Irrigation, Profits & Alternative Crops" delves into further detail. To read this report and others from the CFC, visit our Homepage at: www.cimicweb.org/cmo/afg.

C I V I L - M I L I T A R Y F U S I O N C E N T R E

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The Decision to Plant Poppies: Irrigation, Profits & Alternatives Crops in Afghanistan

Part 5 of a 5-Part Series on Counter-Narcotics Issues in Afghanistan

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*This report comprises the fifth in a five-part series addressing opium production and counter-narcotics in Afghanistan. This piece addresses how factors such as irrigation water and profitability influence farmers' decision to cultivate licit "alternative crops" rather than opium poppies. Further information on these issues is available at www.cimicweb.org. **Hyperlinks to source material are highlighted in blue and underlined in the text.***

Afghanistan accounts for 63% of global opium poppy cultivation, according to the 2011 "World Drug Report". Stated differently, more than six out of every ten hectares (ha) of land planted with poppies anywhere in the world are in Afghanistan. Hence, those factors which lead farmers in Afghanistan to sow their land with poppies – as opposed to a licit alternative crop – are crucial. For instance, in a country where well-irrigated water is scarce, Afghan farmers' may choose to plant poppies given that poppies require limited quantities of water compared to licit crops. Confirming the importance of water, UNODC writes that the lack of irrigated land and irrigation infrastructure leads some Afghan farmers to cultivate opium instead of cereals, fruits or vegetables. Furthermore, a recent study on "Conflict-induced narcotics production in Afghanistan" found that the poor condition of irrigation infrastructure – and the lack of an institutional system for effectively managing irrigation water – are some of the main barriers to alternative crops. Yet others suggest that the high market value of opium may impel many Afghan farmers to choose poppies over licit alternatives – a claim which some experts (cited in the following pages) refute.

This paper addresses these issues and debates, focusing upon factors such as the role of irrigation water, market prices and profitability in farmers' crop selection. The review of expert opinions and studies included within the

following pages ultimately suggests that while access to sufficient irrigation water is crucial, water supply, irrigation infrastructure, institutional capabilities, farmers' knowledge and practices and myriad other factors are also crucial in promoting efficient water utilisation. Similarly, while financial motives reportedly exist, research suggests that market prices alone often fail to account for numerous factors that determine what proportion of a crop's value does or does not accrue to the individual Afghan farmer.

Irrigation in Afghanistan

"Water Resource Management in Afghanistan" states that the primary barrier to Afghan agriculture is not the climate or geography but rather the lack of proper infrastructure to channel water for agricultural use. According to the Food and Agriculture Organization (FAO) of the United Nations, the total water storage capacity of Afghanistan's five river basins (Amu Darya River, Helmand River, Harirod-Murghab River, Kabul River and North River) and groundwater systems is 55 billion cubic meters (bcm) (*see Tables 1 & 2*). The Afghanistan Research and Evaluation Unit (AREU) estimates that this water supply is sufficient to irrigate approximately 7.7 million hectares (ha) of land, significantly more than the 3.2 million ha that are currently irrigated. However, as Table 2 demonstrates, the challenge is distribution of the water. For example, the Amu Darya Basin has nearly four times the water available than the Helmand River Basin despite having relatively comparable areas of land under cultivation.

Table 1. Afghanistan's Current Water Resources

Water Resources	Capacity (bcm)	Current Use (bcm)	Current Balance (bcm)
Surface Water	57	17	40
Ground Water	18	3	15
Total	**75**	**20**	**55**

Table 2. Water Storage Capacity and Land Use, by River Basin

River Basin (or Area)	Water Storage Capacity (bcm)	Area (ha) Intensively Cultivated[1]	Area (ha) Intermittently Cultivated	Total Area (ha) Cultivated
Amu Darya River Basin	24	354,000	48,100	402,100
Helmand River Basin	6.5	306,000	178,100	484,100
Harirod-Murghab River Basin	2.5	475,800	900,200	1,376,000
Kabul River Basin	22	172,500	128,400	300,900
Northern River Basin	No Data	237,800	387,000	624,800
Non-Drainage Areas	0	13,880	6,700	20,580
Total	**55**	**1,559,980**	**1,648,500**	**3,208,480**

Source: Watershed Atlas of Afghanistan (2004) and AQUASTAT (2010).

[1] With either one or two crops.

According to the FAO Information System on Water and Agriculture known as AQUASTAT[2], the total irrigated area in Afghanistan amounts to 3.2 million ha (*see Table 2)*. An additional 90,000 ha not listed in the table are used for private gardens, vineyards and fruit trees. In terms of physical infrastructure, Afghanistan is home to approximately 29,000 irrigation systems (*see Table 3*). Systems drawing surface water, such as from rivers and streams, accounted for 27% of the total. The remaining water is derived from sub-surface sources such as springs, *karez*[3] and wells. Although surface irrigation systems represent just a quarter of the total number of systems, they account for 86% of the total irrigated area. Hence, surface water may be understood as the most common source of irrigation in Afghanistan. For instance, the Helmand River, the Kabul River and the Northern River are responsible for irrigating more than the 75% of all irrigated land in Afghanistan.

Table 3. Irrigation Systems and Land Area Covered

Water Source	Systems (#)	Area (ha)
Rivers and Streams	7,822	2,348,000
Springs	5,558	187,000
Karez	6,741	168,000
Wells	8,595	12,000
Total	**28,716**	**2,715,000**

Source: Watershed Atlas of Afghanistan, as cited in AREU, "A Typology of Irrigation Systems in Afghanistan".

Irrigation systems in Afghanistan are differentiated by their types and by the social factors that regulate their use. The AREU has developed a classification that groups irrigation systems according to their physical and social characteristics. Annex A shows a modified version of the AREU's typology, which is first divided between formal and informal systems. Formal systems are defined as large irrigation schemes developed with central government assistance, financing, management and operation and maintenance (O&M) and with outside technical and financial support. These systems, originally developed in the late 1940s and the 1970s, were instituted to satisfy water needs and overcome distribution problems that informal systems could not address. Over the past 30 years, however, the quality of these systems has deteriorated due to a lack of funding and capacity. Since the majority of the formal systems are currently operating below capacity, the international community launched a series of initiatives to rehabilitate them over the course of the past decade, says AREU.[4] Although, the 10 formal systems are spread throughout the country (*see Annex B*), they benefit only 10% of irrigated land in Afghanistan, covering approximately 332,000 ha. The rest of Afghanistan's irrigated land draws upon informal systems.

According to AREU, informal irrigation systems are those which are traditionally developed and managed by communities with local resources and knowledge. Informal systems, some of which have existed for centuries, account for 90% of the irrigated area and are highly dependent on water availability. As shown in Annex A, informal irrigation systems consist primarily of surface water, including diversion structures, small dams and water harvesting, in addition to groundwater which is extracted via wells, springs and *karez*. Informal irrigation systems also serve as a source of water for livestock and domestic uses. In the paper entitled "Water Resource

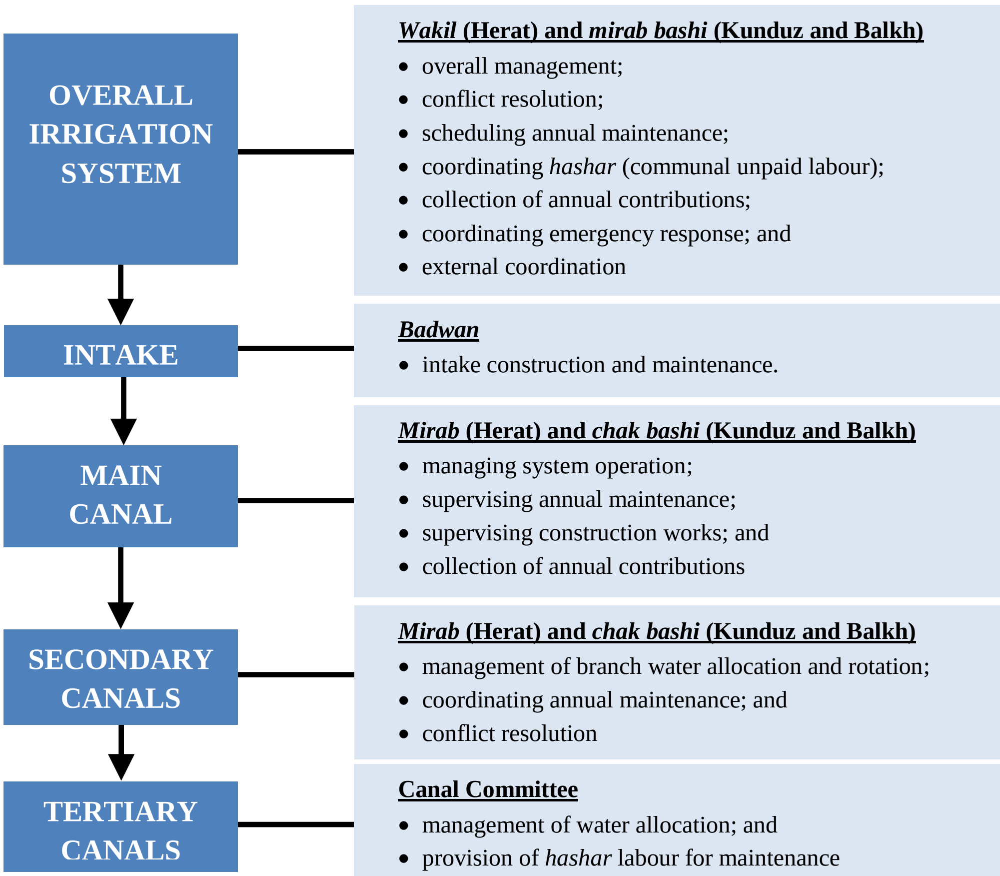
[2] Available information on Afghanistan's irrigation systems is rather outdated. The FAO carried out a satellite survey in the late 1990s to outline the irrigated land for each of the river basins. Similarly, the last survey to classify the different typologies of irrigation systems countrywide was undertaken in the late 1960s. Both are presented in the Watershed Atlas of Afghanistan. The following section describes the irrigation systems in Afghanistan using reports which primarily base their analysis on the data provided by these two surveys.

[3] *Karez* (or *Qanat* in Persian) are common irrigation systems in Afghanistan that have been used for centuries. The *karez* are made up of a horizontal series of vertical wells linked by sloped underground canals that take advantage of gravity to transport water from the water table. Most of the length is underground to reduce evaporation. The length of *karez* systems is between 5 and 15 km.

[4] Some of the larger and better-known programmes include the Emergency Irrigation and Rehabilitation Program, the Irrigation Restoration and Development Project, the Emergency Infrastructure and Rehabilitation and Reconstruction Project from the Asian Development Bank (ADB), the Balkh Basin Integrated Water Resource Management Project, the Kunduz River Basin Project, the Western Basins Project and the Amu Darya River Basin Management Programme.

Management in Afghanistan", the International Water Management Institute (IWMI) highlights that these multiple uses of water influence the operation, management and maintenance of informal systems. The organisational structure of informal systems is complex and often differs based on history and size of the system. Figure 1 depicts a standard organisational structure for a surface water system.

Figure 1. Roles in the Management of Informal Water Systems in Afghanistan[5]



Source: Modified from "How the Water Flows: A Typology of Irrigation Systems in Afghanistan", AREU.

Understanding Afghanistan's irrigation network, including the natural, technical and social elements, is key to understanding the prospects of alternative crops. Thus far, this report has primarily reviewed the availability and location of water in Afghanistan in addition to the institutional and socio-cultural structures that govern irrigation water management. In order to understand how the use of these resources could be maximised to make the switch from poppy cultivation to licit crops feasible, the following sections discuss the profitability and water requirements of alternative crops.

Alternative Crops: Are They Financially Competitive?

Much has been said about the inability of alternative crops to pay off better than poppies. In "Challenging the Rhetoric", David Mansfield, an expert with years of experience in counter-narcotics in Afghanistan, asserts that some development interventions emphasise the profitability of opium and the need to identify other high-value

[5] Names of relevant figures in the administration of informal systems vary from one region to another. Figure 1 reflects the terminology common in Herat, Kunduz and Balkh provinces, which AREU studied.

crops and improve market chains to establish a competitive substitute. He further notes that "the claim of the insurmountable profits to be earned from opium poppy is inaccurate" and often based on inappropriate comparisons between the gross returns on wheat and opium poppy. He argues that, partly due to the greater labour costs associated with poppy cultivation, there are a range of different crops that could provide far higher profits under appropriate market and security conditions.

A similar analysis is conducted by Gary Khun, executive director of Roots for Peace, in the paper "Comparative Net Income from Afghan Crops". He points out that "the power of the market has proven to be irresistible and unbeatable: if market conditions are right, someone will respond". However, Khun proposes using the same market forces that moved farmers from wheat to poppies to stimulate Afghan farmers to switch from poppies to alternative livelihoods. Khun says the climatic conditions in Afghanistan make high-value perennial crops such as grapes, pomegranates and almonds viable. He adds that, with the appropriate market connections, such crops would prove more profitable than opium poppies. He argues that individuals who claim poppies are the most profitable crop in Afghanistan factor gross income and do not consider the net profit accrued by most who grow them. Poppies reportedly require 10 times more labour than perennial crops, thus cutting into the high per-hectare value of the crop, particularly for farmers who are impelled to hire day labourers. Table 4 shows a comparative analysis of the net incomes of selected crops for one hectare of crops. The figures shown in Table 4 support the findings of a paper by Mansfield entitled "The Economic Superiority of Drug Production: Myth or Reality". That paper considered case studies from countries such as Thailand, Pakistan and Lebanon in which the substitution of poppies with flowers, onions or garlic significantly increased farmers' profits.

Research also shows that factors beyond profits are also a consideration. In order to switch away from a familiar crop, farmers will need to know how to cultivate an unfamiliar, alternative crop. The transition to alternative crops will highly depend on the availability of inputs such as seeds and fertilisers as well as farmers' access to credit, processing and marketing opportunities. In addition, the availability of water and its appropriate management will be a key factor in convincing farmers switching from poppy cultivation to licit crops in some areas in Afghanistan.

Table 4. Net Income for Selected Crops for 1 Ha of Crops, 2009

	Wheat	Opium at 2009 prices	Corn	Onion	Apricot	Sweet Oranges	Apple	Bush-grown Grapes	Opium at historic high	Pomegranate	Almond	Trellised Grapes
Production (kg/ha)	2,500	52	4,500	17,500	18,000	20,000	20,000	14,235	52	24,000	2,000	29,466
Price (USD/kg)	0.32	48	0.21	0.21	0.24	0.25	0.35	0.7	300	0.6	9	0.7
Other Income from by-products (USD)	--	--	125	--	125	63	125	--	--	125	125	--
Gross Income (USD)	**800**	**2,496**	**1,070**	**3,675**	**4,445**	**5,063**	**7,125**	**9,965**	**15,600**	**14,525**	**18,125**	**20,626**
Seeds (USD/ha)	24	10	26	480	--	--	--	-	10	--	--	-
Soil Amendments (USD/ha)	101	200	140	200	55	55	38	200	200	55	55	200
Mulch/Top Soil (USD/ha)	--	--	--	--	208	208	208	--	--	208	208	--
Integrated Pest Management (USD/ha)	--	--	--	--	15	15	15	20	--	15	15	20
Labour Costs (USD/ha)	172	1,500	250	375	190	190	190	200	1,500	190	190	170
Farm Services (USD/ha)	103	103	103	103	--	--	--	--	103	--	--	--
Taxes to Local Authorities	80	250	107	368	445	506	713	996	250	1,453	1,813	2,063
Total Costs (USD)	**480**	**2,063**	**617**	**1,526**	**690**	**751**	**941**	**1,396**	**3,373**	**1,698**	**2,058**	**2,433**
NET INCOME (USD)	**320**	**433**	**453**	**2,150**	**3,756**	**4,311**	**6,185**	**8,568**	**12,227**	**12,828**	**16,068**	**18,194**

Source: Modified from "Comparative Net Income from Afghan Crops", 2009.

Alternative Crops: How Much Water Do They Require?

A paper entitled "Water Requirements of Different Crops" by the Integrated Sustainable Energy and Ecological Development Association (ISEEDA) says that the success of crops grown in a particular region depend on three basic resources: climate, soil and water. Therefore, under a given set of environmental conditions, crop production may be particularly limited by the availability of water (as well as nutrients, which are commonly supplied through fertilisers). Given the limited access to water resources in Afghanistan, it is important that these resources are used in the most effective manner. One of the key measures to understand the water needs is the Crop Water Requirements (*see Box 1 for related key terms).*

Box 1. Key Terms

The following is a compilation of basic definitions collected from the FAO, ISEEDA and other organisations.

Evapotranspiration (ETo): This is a combination of evaporation and transpiration. Given that these two processes occur simultaneously, there is no easy way of distinguishing between them. Evaporation is the process whereby liquid water is converted to water vapour (vapourisation) and removed from a surface. Transpiration is the vapourisation of liquid water contained inside of plant tissues, often through small openings on the plant leaf. When a crop is small, water is predominately lost by soil evaporation. Once a crop is well developed and completely covers the soil, transpiration becomes the main source of plant water loss.

Crop Water Requirements (CWR): This is the quantity of water, exclusive of effective growing season precipitation, winter precipitation stored in the root zone or upward water movement from a shallow water table, which is required (e.g., via irrigation) to meet the evapotranspiration needs of a crop. It also may include water requirements for germination, frost protection, prevention of wind erosion, leaching of salts and plant cooling.

The International Union for the Conservation of Nature (IUCN) highlights the importance of knowing the CWR for a particular crop in a particular agro-climatic context. While there does not seem to be any open-source document which highlights the various CWRs of different crops in different parts of Afghanistan, IUCN data from Pakistani Baluchistan (*see Table 5*) is illustrative.[6] The climate in Baluchistan is arid, similar to Kandahar, Helmand and Nimroz. However, even this part of Pakistan was found to have six agro-climate zones (thus demonstrating the high degree of variation within particular areas and the need for fine-tuned analysis of CWR).

Comparing Table 4 and Table 5, it appears that crops yielding greater profits tend to require greater amounts

Table 5. Water Loss and Crop Water Requirements

Crops	Evapotranspiration (water loss), in mm	Crop Water Requirements, in mm
Wheat	338 – 1,013	255 – 777
Cotton	984 – 1,341	757 – 1,025
Potato	784 – 1,270	505 – 825
Onion	770 – 1,852	434 – 1,037
Sunflower	651 – 964	560 – 842
Grapes	1,258 – 2,636	566 – 1,209
Dates	2,001 – 3,392	920 – 1,809
Apple/Cherries	1,326 – 2,125	719 – 1,204
Apricot/Almonds	1,326 – 2,125	708 – 1,075
Pomegranates	1,326 – 2,617	740 – 1,353
Pulses	270 – 405	203 – 321
Alfalfa	742 – 2,031	601 – 1,675
Maize	756 – 1,080	657 – 925

Source: "Water requirements of major crops for different agro-climatic zones of Balochistan", IUCN, 2006

[6] Comparative figures for opium poppies were not provided and could not be identified from open sources.

of water. For instance, almonds need between 1,326 and 2,125 mm of water but could yield a profit of USD 16,068 per ha. Wheat needs between 338 and 1,013 mm of water and yields USD 320 per ha. Therefore, switching to alternative crops will depend on greater water availability and more effective and efficient water use.

Some increases in water availability may be attained by constructing or rehabilitating irrigation systems. However, an AREU study notes that improving the efficiency and effectiveness of irrigation water use is particularly crucial. Most water loss is related to the low efficiency of the irrigation systems – that is, the proportion of water from a source (e.g., a river or well) which ultimately reaches the root zone of crops – and the mismanagement of water distribution. The aforementioned AREU report says that there is a dearth of information regarding the efficiency of irrigation systems in Afghanistan except for the fact that both distribution efficiency and production per area are very low. One estimate comes from the UK Department for International Development (DFID), which found that efficiency of both formal and informal systems ranges from 20-40%.

Increasing the efficiency of water usage is critical given that higher-value crops, which may be a viable alternative to opium poppies, tend to require greater amounts of water. To achieve this goal, the International Water Management Institute (IWMI) recommends a micro-watershed management approach in which community-based and diversified water-harvesting initiatives are implemented instead of large-scale schemes. According to IWMI, community-based water-harvesting can provide the right amount of water for irrigation and domestic use in Afghanistan. IWMI says that "during drought years with less than 50 mm of rainfall watersheds larger than 50 ha will not produce any appreciable water yield while small natural watersheds will [continue to] yield between 20 and 40 cubic meters per ha".

The International Centre for Agriculture Research in the Dry Areas (ICARDA) further concluded that increasing efficiency – and providing a greater volume of water for alternative crops – is dependent on farmers' knowledge regarding watering techniques and land levelling. Afghan farmers reportedly tend to irrigate based on past experience and visible signs of dryness, thus resulting in over-watering or inappropriately-timed irrigation (with respect to the crop's stage of development). Validating this point, Afghanistan's Ministry of Agriculture, Irrigation and Livestock (MAIL) says that on-farm water management problems are both of a technical and organisation nature. On the technical side, the MAIL points at the absence of farm-level irrigation systems, water losses due to seepage (in earthen canals) and the lack of proper water distribution systems and water storage capacity. On the institutional side, MAIL points to insufficient institutional structures to oversee water distribution and maintain irrigation infrastructure; the Ministry also notes that farmers lack knowledge regarding crops' water requirements and new technologies. For instance, farmers may not level their land, thus leading them to flood their land in order to ensure that irrigation water covers the highest point. Failing to level land leads to an uneven distribution of water, since low-lying areas will be over-watered while higher patches of land will receive insufficient water, according to a report on "Sustainable Agricultural Production: Providing an Alternative to Opium in Afghanistan". Over-irrigation is not only linked to an overuse of water resources but also to a severe reduction of crops yields (i.e., the amount produced per hectare). ICARDA claims that proper levelling of fields could reduce the use of water between 33% and 50% and significantly increase crop yields, including for high-value alternative crops.

Alternative Crops: Is It All about Water and Profitability?

Experts have found that, while Afghanistan suffers from patches of water scarcity, the country overall has sufficient irrigation water supplies to meet its needs. The challenge, instead, is to establish appropriate institutions and adequate physical infrastructure to distribute and manage that water in the most efficient way possible. However, other factors beyond irrigation water and profits may also be at play. For instance, AREU examined two provinces in a report entitled "Opium Poppy Cultivation in Kunduz and Balkh". Both Kunduz and Balkh

provinces lie on Afghanistan's northern plain bordering Uzbekistan and Tajikistan, respectively, and both are fed by the Hindu Kush's snowmelt through major irrigation systems. Using UNODC data on opium production by district from 1994 to 2005, AREU found an inconsistent relationship between irrigation and poppy cultivation. Despite strong irrigation infrastructure in both provinces, Kunduz has little poppy cultivation whereas Balkh has a history of growing the crop. In Balkh, the districts growing the most poppies are those which are best irrigated. Rather than facilitating alternative livelihoods and crops, the irrigation in Balkh appears to have fed into poppy cultivation. However, despite having access to irrigation and a ready supply of labourers, few poppies were grown in Kunduz. The AREU report thus points to a combinations of factors beyond infrastructure which feed into farmers' decisions to grow opium poppies versus alternative crops, including the following: (i) the position of key elites vis-à-vis poppy cultivation, (ii) food security and (iii) social equality. That is, if key government officials or power-holders opposed poppy cultivation, their opposition could prevent farmers from planning the crop even where conditions otherwise seemed ripe. In addition, AREU found that greater food security and social equality lead to reduced poppy cultivation. Ultimately, the study found that that "the absence of opium cultivation was more than a matter of water". Therefore, the report suggests that water availability is a necessary but insufficient condition to enable a switch to alternative crops and that, under certain conditions, strong irrigation systems may in fact incentivise poppy cultivation.

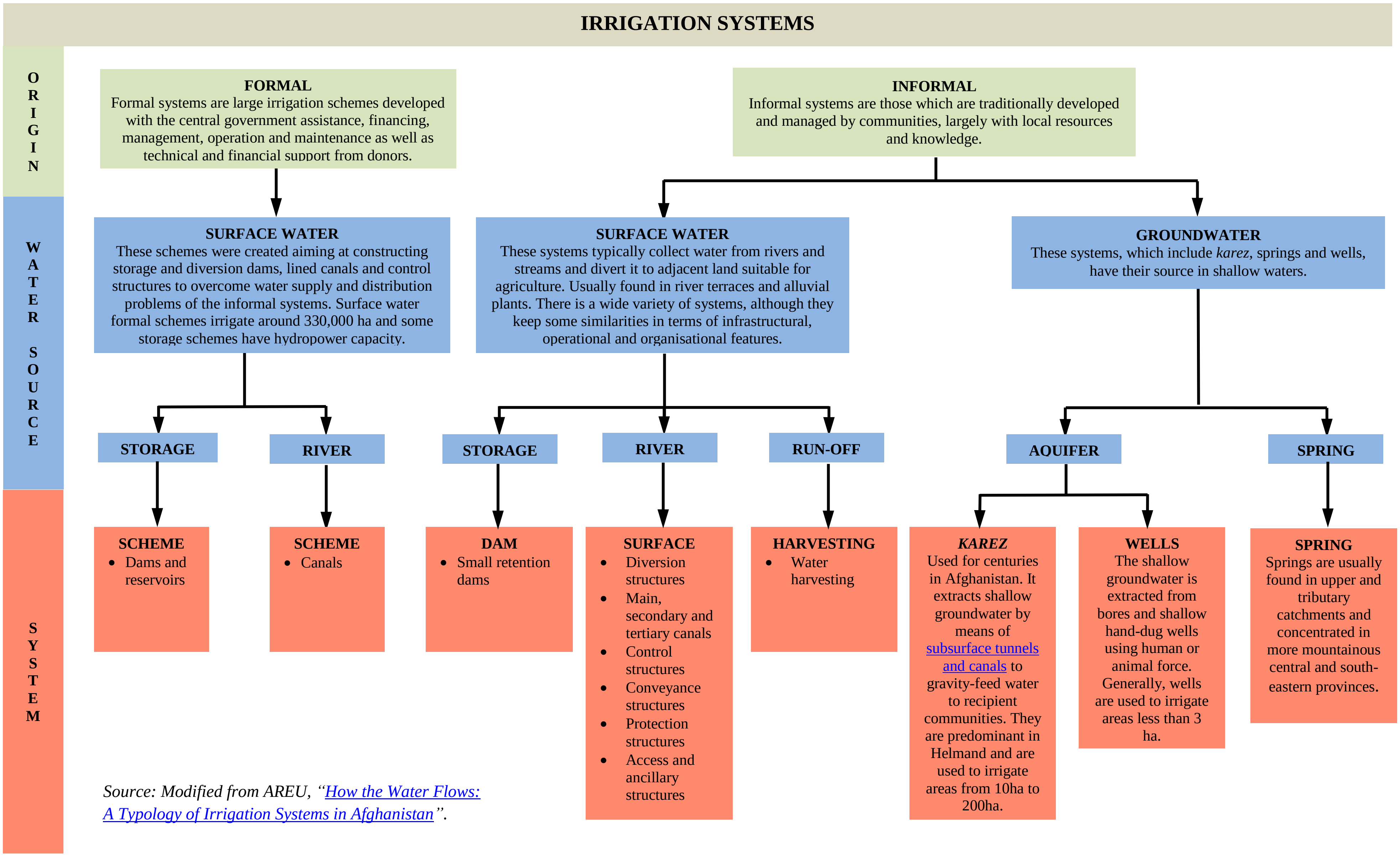
Further supporting the notion that other factors beyond irrigation and income affect poppy cultivation, Mansfield writes that a singular focus on the profitability of different crops does not capture the complex socio-economic and political – as well as security – factors at play. He argues that profits present a simplistic economic model that fails to explain complex decision-making dynamics surrounding poppies in Afghanistan, particularly in more insecure areas where insurgent influences and the threat of violence add an additional consideration. Mansfield further differentiates between the farmers located adjacent to provincial or urban centres and the ones who live in remote rural areas. Farmers closer to urban areas, where they have greater, easier and cheaper access to markets, reportedly find it less daunting to shift to crops other than poppies. In addition, because alternative crops are less labour intensive than opium, households near urban areas can more readily combine agricultural activities with other sources of non-farm income (which is more bountiful in densely-populated areas). Conversely, in remote rural areas, the shift to alternative crops can be inhibited more by high transportation costs and constrained commodity and labour markets than by concerns regarding net profits or irrigation water.

Conclusion

Contrary to the claim that poppy cultivation is more profitable than alternative crops, this report has cited research showing that there are other alternatives such as grapes, pomegranates or almonds which could yield higher returns than opium poppies. In order to make these alternatives feasible for implementation, farmers will have to have access to agricultural inputs as well as irrigation water. The water requirements for these alternative crops are much greater than for poppies, thus making it extremely important that water resources are used in the most effective and efficient manner. The documents cited within this report provide a number of more specific strategies for doing so than are addressed within this paper.

Yet, while increased water availability may be an essential precondition for alternative crops, other economic, social and cultural factors must be further studied and considered. Experience has shown that the decision to switch from opium to licit crops widely depends on factors such as good governance, access to agricultural commodities and labour markets as well as transportation and transaction costs.

Annex A. Classification of Irrigation Systems in Afghanistan



Source: Modified from AREU, "How the Water Flows: A Typology of Irrigation Systems in Afghanistan".

Annex B. Location and Description of Formal Irrigation Systems

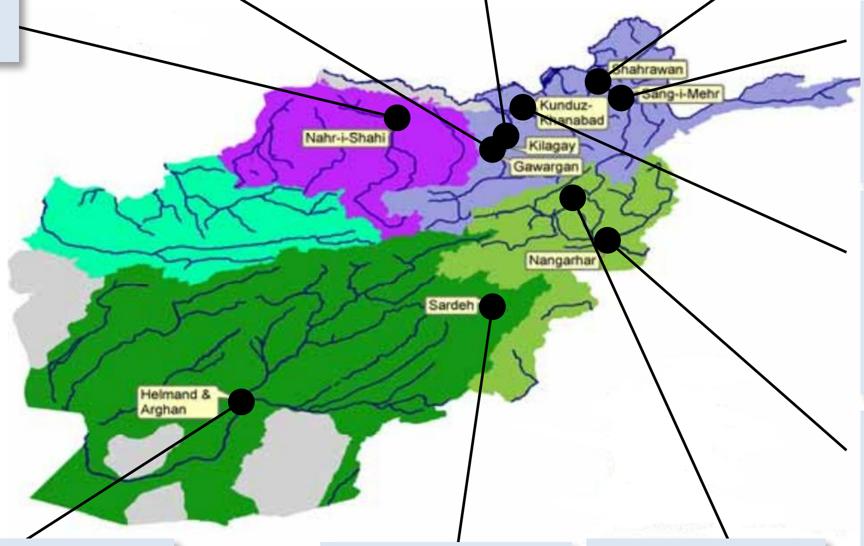
Nahr-e Shahi
Irrigated Area: 50,000ha
Structures: diversion weir, main canal and division structures.

Gawargan
Irrigated Area: 8,000ha
Structures: intake and main canals.

Kelagay
Irrigated Area: 20,000ha
Structures: intake and main canals.

Shahrawan
Irrigated Area: 40,000ha
Structures: intake and main canals.

Sang-e Mehr
Irrigated Area: 3,000ha
Structures: intake and main canal.



Kunduz-Khanabad
Irrigated Area: 30,000ha
Structures: diversion weir, main and secondary canals.

Nangarhar
Irrigated Area: 39,000ha
Structures: Darunta dam, power station, main canal, pumping station and state farms.

Helmand-Arghandab
Irrigated Area: 103,000ha
Structures: Kajaki and Dhala Dams as well as diversion of Boghra. Main canals of Boghra, Shahrawan, Shamalan, Darweshan and Baba Walee.

Sardeh
Irrigated Area: 15,000ha
Structures: Reservoir with 164 million of cubic metres as well as diversion canals.

Parwan
Irrigated Area: 24,800ha
Structures: diversion weir, main and secondary canals, pumping station and power house.

Source: Adapted from the Watershed Atlas of Afghanistan.

Annex C. Current Status and Advantages of Informal Irrigation Systems

	Informal Surface Water Schemes	Karezes	Springs
Performance	▪ Estimated efficiency between 25% and 40%.	▪ Open canal losses may be approximately 20% and subsurface canals between 20% and 30%.	▪ *Data not available*.
Advantages	▪ simplicity of structures; ▪ use of material labour; ▪ organisational independence, local representation and community participation; and ▪ adaptability of system operation to variable supply levels using proportional allocation of water to maximise water distribution.	▪ gravity-fed system; ▪ sustained perennial flow; ▪ good quality water sustainable for multiple uses; and ▪ community-based system.	
Constraints	▪ limited durability of structures; ▪ lack of control of peak flows; ▪ limitations of organisation, financing, technical support and inadequate transparency in election processes; ▪ high maintenance requirements for intake and de-silting of canals; and ▪ high canal losses and low efficiency at time of low flows.	▪ vulnerability to subsurface slumping and collapse as well as potential instability of tunnels and access wells; ▪ water losses in subsurface canals; ▪ flood damage to surface structures; and ▪ vulnerability to depletion.	▪ difficulties in construction and maintenance of canals; ▪ limited flow rates; ▪ lack of water storage to improve distribution and application of efficiencies; and ▪ a small command population to support system maintenance.
Room for Improvements	▪ controls such as regulation of intakes for protection and optimisation of distribution; ▪ building better structures and flood protection; ▪ reducing maintenance costs; ▪ canal design to enhance efficiency in distribution and reduce sedimentation; ▪ organisation skills to improve financial sustainability; and ▪ water allocation dynamics.	▪ lining subsurface canals to reduce water losses, improve water supply and reduce labour for maintenance; ▪ rehabilitation of access wells to improve access and water supply; ▪ rehabilitation subsurface canals; ▪ improving structures to protect canal structures and irrigated land from flooding; ▪ construction and rehabilitation of storage structures to improve efficiency, distribution and application; and ▪ improving water allocation management based on irrigation demands.	▪ reconstruction of the canal to reduce seepage losses and maintenance costs; ▪ rehabilitation of conveyance structures to improve supply reliability and distribution efficiency; ▪ spring development to improve water supply, including rate and sustainability of flow; ▪ construction of diversion structures for supplementary surface water supplies from washes; ▪ construction and rehabilitation of flood protection structures; and ▪ uses of storage to improve distribution and application of efficiencies.

Source: Modified from AREU, "How the Water Flows: A Typology of Irrigation Systems in Afghanistan".