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AFGHANISTAN ALTERNATIVE DEVELOPMENT OPTIONS ASSESSMENT

FINAL REPORT

MARCH 2016

March 21, 2016

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DISCLAIMER

The field assessment for this report was led by Paul Davis for Pragma Corporation under subcontract to Chemonics International Inc. for the USAID South RADP-S project. The report was authored by Paul Davis, Ken Swanberg, Tim Kock and Mahesh Rao with contributions from Luc Verelst. The authors' views expressed in this publication do not necessarily reflect the views of the United States Agency for International Development or the United States Government. All opinions and any errors/omissions are solely the responsibility of the authors.

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LIST OF ACRONYMS

AAEP	Afghanistan Agriculture Extension Project
ACE	Agricultural Credit Enhancement Program
AD	Alternative Development
ADF	USAID-supported Afghanistan Development Fund
AFSA	Afghanistan Farm Service Alliance
AGRED	Agricultural Research and Extension Development Program
AIB	Afghanistan International Bank
ALP	Alternative Livelihoods Project
AREU	Afghanistan Research and Evaluation Unit
ARIES	Rural Investment and Enterprise Strengthening program
ASAP	Accelerating Sustainable Agriculture Program
AVIPA	Afghanistan Vouchers for Increased Production in Agriculture
AVIRIS	Airborne Visible / Infrared Imaging Spectrometer
AWATT	Afghanistan Water, Agriculture and Technology Transfer Project
CADG	Central Asian Development Group
CHAMP	Commercial Horticulture and Agricultural Marketing Program
DDA	District Development Assemblies
DFID	Department for International Development, UK
FAIDA	Financial Access for Investing in the Development of Afghanistan
FME	Feature Manipulation Engine
FTE	full-time equivalent
GIRoA	Government of the Islamic Republic of Afghanistan
GPS	Global Positioning System
ICARDA	International Center for Agricultural Research in the Dry Areas
IDEA-NEW	Incentives Driving Economic Alternatives – North, East, West
INL	Bureau of International Narcotics and Law Enforcement Affairs
KFZ	Kandahar Food Zone Program
MAIL	Ministry of Agriculture Irrigation and Livestock
MCN	Ministry of Counter Narcotics
MFI	Micro-Finance Institution
MISFA	Microfinance Investment Support Facility for Afghanistan
MRRD	Ministry of Rural Rehabilitation and Development
PRRD	Provincial Office of Rural Rehabilitation and Development
RADP	Regional Agricultural Development Program
RAMP	Rebuilding Agricultural Markets Program
ROP	Roots of Peace
SRAD	Southern Regional Agricultural Development
UNFAO	United Nations Food and Agriculture Organization
UNODC	United Nations Office on Drugs and Crime
USAID	United States Agency for International Development
USDA	United States Department of Agriculture

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1. EXECUTIVE SUMMARY

Introduction: The purpose of the analysis undertaken is to provide options for future Alternative Development (AD) activities in Afghanistan. This analysis and the related recommendations were developed by a team of AD consulting experts with significant experience on agricultural development strategy/activities in Afghanistan, and extensive experience in the design and implementation of AD programs at the international level. The analysis combined a comprehensive review of past research on the history of AD strategy development and program implementation in Afghanistan, an assessment of the evolution of poppy production and prices in Afghanistan since 2002, and the interplay of production trends with AD and related anti-narcotics intervention programs; as well as a series of on-the-ground interviews with a range of public and private sector stakeholders. In addition a concise technical review was undertaken of the rigor and comprehensiveness of the Shamal crop measurement/monitoring related mapping system currently being implemented through USAID's Kandahar Food Zone (KFZ) Program in Kandahar. This comprehensive AD review/analysis exercise has culminated in a series of strategic recommendations for USAID's AD programming strategy/approach moving forward.

Past/Present Poppy Production Trends in Afghanistan: AD activities funded by USAID were initiated in 2002, and have received approximately $1.37 billion in AD funding over this time period. Activities have spread over the whole country, claiming over half of USAID's total funding, but have been predominantly focused on Kandahar and Helmand Provinces, which account for 60% to 75% of poppy production in the country, depending on pricing, climatological and security factors. The interplay between these factors has generated significant volatility in production figures: The country experienced a massive rise in production starting in 2002 following the collapse of the Taliban regime; a significant fall in production during the 2008-10 period (which coincided with the 'surge' and vigorous AD and related eradication efforts in key provincial locations); and a major subsequent surge in production during the 2011-14 period. The United Nations Office on Drugs and Crime (UNODC) is reporting a decline in production during the 2014-15 period.

Prior to the period of the U.S. intervention, poppy production ranged between 71,000 hectares (1994) to 82,000 hectares (2000). Then in 2001 the Taliban put a ban on poppy production and the acreage fell below 10,000 hectares. However, subsequent to 2002, poppy production jumped back to its former pre-ban level of 74,000 hectares, rising to a relatively high point of 193,000 hectares in 2007. Production fell back to 123,000 hectares in 2009-10. Since then there seems to have been a fairly steady rise in production, to a high of 224,000 hectares in 2014, but according to UNODC figures a 19% decline occurred in in 2015, dropping production to 183,000 hectares. However the UNODC reports may not be accurate for 2013-14, which may have resulted in an overstatement of the increase in production during 2013-14 and therefore some overstatement in the drop recorded during 2014-15.[1]

The accuracy of these numbers has been subject to considerable controversy, due to changing methodologies and uncertainties regarding the degree of rigor characterizing their application. Moreover, the degree of error in measurements is normally calculated to be plus or minus 20,000 hectares, a significant margin or degree of error. What does seem clear is that there has been a general secular rise in production since 2002; with annual ups and downs which have been impacted by a combination of short-run pricing variations, climate conditions and shifts in the security situation at the provincial level.

[1] UNODC appears to have changed its methodological approach for crop measurement over the past few years, including utilization of more detailed/refined visual imagery-based mapping information.

In general cultivation has been concentrated predominantly in two regions, 66% in the Southern Region, principally Kandahar and Helmand Provinces, and 24% in the Western Region. Seven percent has been from the Eastern Region, including Nangarhar, and only 3% from the remaining areas – Northern, North-Central and Central Regions. Yet even within these regions, there are certain provinces where poppy production is concentrated. Overall Helmand leads the way with approximately 47% of the country's total production, followed by Farah and Kandahar at 12% each, hence with 70% of production emanating from just these three provinces. When Badghis, Uruzgan, Nangarhar and Nimroz provinces are added, each of which averaged 6% of the country's total, the percent of poppy production country-wide accounted for from these Southern and Western provinces plus Nangarhar reaches almost 95%. Poppy cultivation in the other provinces has traditionally been minimal.

What is particularly striking, however, is that the three major producing regions reportedly experienced significant decreases in poppy production in 2015. And while the magnitude of the decrease in production may well have been exaggerated in the UNODC numbers, there appears to be general agreement among most informed parties that there has been a reasonably significant decline. The principal reason for the decrease in production appears to be a decrease in yields across-the-board, from an average of 28.7 kg/ha to 18.3 kg/ha. And this decrease from 2014 to 2015 followed after decreases to 29 kg/ha in 2014 from a high of 44 kg/ha in 2011, and an average of 36 kg/ha over the time period of 1999-2014. Assuming these figures are accurate, this would tend to indicate that the "pushing out" of production to hinterland regions has impacted poppy productivity significantly, consistent with recent research findings. However it will be important to continue to monitor trends over the 2016-17 period, prior to reaching any stronger conclusions in this area (particularly given the uncertainty regarding the accuracy of data estimates).

Shamal-Based Crop Measurement/Mapping System: With regard to the accuracy of crop measurement numbers, the consulting team discussed with KFZ and analyzed related documentation on the methodological approach ("Shamal") which that program has utilized to measure poppy production in Kandahar over the 2014-15 period. The results of that analysis are summarized below:

- The Shamal system extracts crop data from multisource imagery, using remote sensing and GIS techniques combined with data manipulation processes. Specifically, the KFZ document describes the semi-automated image classification method using different algorithms and databases along with field survey data.
- The image classification and information extracting procedures outlined by the KFZ – Crop Classification Methodology (KFZ-CCM) is broadly categorized into Phase 1, that utilizes ArcGIS mapping software to implement both supervised and unsupervised classification tools; and Phase 2, which implements information extraction procedures within Feature Manipulation Engine (FME) to transfer classified raster output information produced in Phase 1 to the land parcel vector data.
- Phase 1 image classification is implemented as a simple supervised classification procedure. It is based on the **Maximum Likelihood Classifier (MLC)** as the decision rule to classify and categorize image pixels to the different classes, based on reference data available through the KFZ Field Parcels boundary data with the Field Survey Data (April 2015).
- Phase 2 of the KFZ-CCM provides a description of the procedure to transfer the raster output information generated from Phase 1 to the vector data file i.e. the land parcel boundary layer. The procedure is implemented within FME to first convert the raster pixel information into points. These points are then aggregated and summarized based on a majority rule to determine the single crop cover type that can be transferred to the vector parcel polygon using a simple tabular join.
- The simplicity and robustness of MLC is well-documented in the literature pertaining to mapping science involving both agricultural and forested ecosystems. Additionally, the positive qualities of MLC

its wide usage is primarily in mapping broad and general land cover classes such as agricultural lands, fallow lands, forested areas, water bodies, urban environments, etc. For purposes of the KFZ project that maps only three crops, the MLC is implemented well to produce satisfactory results.

- The classification involved just three crop types – wheat, alfalfa, and poppy, the methodology implemented a visual assessment of the crop boundary using the 0.5 m WV2 imagery (RGB). Based on this visual analysis, about 830 polygons were randomly delineated and digitized.
- Based on the regional study undertaken, 830 polygons appear to be satisfactory. A trained analyst should be able to distinguish the field boundaries.
- The identity of these polygons were established using a global positioning system (GPS) field survey that resulted in a point reference data set. There were 293, 117, and 18 samples for wheat, poppy, and alfalfa. Using a field survey crew, the crop type identity and the GPS location coordinates were established to produce ground reference data, which is a valid protocol.
- About 30-50 points for each of the crop types were used to train the MLC for classification using the 10-m MS Imagery (WV2). This is a statistically valid sample to use in the analysis; although it should be noted that the usual norm is to set aside half the reference data for training of the MLC algorithm, and to use the rest for validation. This way you have an independent sample set of ground reference data to validate the classification procedure.
- The multispectral imagery was for the summer time (April 2015), and appears to be satisfactory and relevant (based on the quality assessment) to distinguishing just the three crops mapped.
- The classified output was further post-processed using the FME tool to summarize the different cover types within the parcel boundary. Classified output was visually verified using the all of the reference points collected.
- The existing approach can be enhanced by formally evaluating the classified output against a dataset that was not used during the training/classification process. This approach is considered a best practice. As a part of the formal approach, an accuracy assessment protocol should be implemented using a simple Error Matrix that cross-tabulates the samples used for evaluation to the corresponding crop types mapped at those locations. This would greatly enhance the statistical rigor of the training data collected and consequently the MLC classifier performance in mapping the crop types.

Overall the crop measurement approach adopted and conducted by KFZ appears to be technically sound. Although classification error rate cannot be specified exactly from a statistical perspective, it appears to be less than 4 % based on the information provided. In addition this has been supplemented by visual validation of 100% of the area covered by the program, through visual analysis of mapping data at the .5 meter resolution level. This yielded a correction rate of less than approximately 1%. Taken together, these empirical findings indicate that the color spectrum analysis-based crop measurement assessment process being carried out under KFZ yields sound and defensible results.

At the same time it should be noted that USAID continues to register concerns regarding the robustness and reliability of these results. As noted above, the failure to statistically validate the classified output against a dataset which was not used during the training/classification process meant that no error matrix could be calculated, which in turn limits the statistical precision of cross-tabulation results. In addition the degree to which the approach applied can accurately and precisely take into account/capture inter-cropping of parcels has been raised by USAID staff, most particularly within the context of pixel bleeding concerns related to colorized mapping imagery. Assuming that a determination is made to continue implementation of the Shamal system moving forward, it would be advisable to undertake an independent M&E assessment of the methodological approach being applied, in order to further clarify/address as needed any remaining concerns.

Core Features/Limitations of Past AD Programs: The analysis investigated the main features of past AD strategy/programs, as well as the major limitations on their capacity to impact on farmer decisions to avoid or transition away from participation in illicit activities. Most explicit anti-drug crop efforts have focused on the introduction of crops that compete directly with poppy production in terms of incomes generated and remunerative labor employed, commonly referred to as 'crop substitution'. This has been a hallmark of most AD programming implemented in Afghanistan. Typically this has focused on basic grain crops requiring limited on-farm investments in agricultural inputs and new cultivation practices. As programs have evolved support has shifted towards support for a mix of grain and higher value crops, with at times a concomitant focus on basic irrigation, technology and knowledge transfer and rudimentary linkages to market networks. Overall the core focus of 'AD-proper" programs has remained on promoting replacement of poppy with licit crops through predominantly farm level technology transfer and advisory support activities.

The results of the analysis conducted for this study indicate that the most critical constraint on sustainable impact for AD Programs has been their tendency to focus on short-term crop-substitution based approaches/objectives, with the individual farm plot or a group of land plots in a particular local area as the core unit of intervention. In general there has been inadequate focus on the village and sub-regional economy and polity as the unit of analysis and intervention, and limited efforts to develop an integrated intervention approach which could address the complex of economic, socio-institutional and state presence/security factors which combine to incentivize rural families to engage in illicit activities. The most critical factors limiting sustainable program impact are summarized below:

Lack of Long-Term Programmatic Focus: The AD programs implemented over the past dozen years have in general tendency to lack a consistent longer-term strategic focus. The programs have not been based on an integrated analysis of competitiveness constraints and opportunities and the pre-conditions for long-term sustainability of alternative livelihood options. Instead they have tended to focus on shorter-term crop substitution approaches, and related agricultural input supply provision and cultivation practice and storage training activities.

In addition programmatic support has often continued for 1-2 growing seasons and then been terminated, with limited market linkage development/sustainability impacts. This has also generated an unintentional and worrisome 'demonstration effect' impact on farm groups, which have come to question the staying power/commitment of donor and Government of the Islamic Republic of Afghanistan (GIRoA)-sponsored AD programs.[2] At times the project vehicles through which AD programs are implemented have had short 2-3 year life-spans – clearly inadequate to the task of fomenting sustainable stakeholder commitment to transitioning permanently away from engagement in illicit activities.

Likewise, the frequent priority focus on basic grains (wheat) as the major alternative to poppy reflects a focus on short-term crop substitution objectives. The strategy of focusing largely on substituting basic grains for illicit crops has failed at the international level on a consistent basis. As noted earlier crops such as wheat do not generate an income stream that is competitive with illicit production - unless grown on using the most modern systems which requires large acreages, mechanization, and input supplies beyond the capacity of smaller-scale farmers (and which is also less labor-intensive than poppy production). As a result it has proven difficult to permanently supplant poppy production with wheat, and there is significant anecdotal evidence indicating that many farmers who have participated in past AD

[2] This was commented on in both a number of individual interviews and during focus group discussions.

programs have continued to devote portions of their parcels to poppy production, even as they have participated in wheat production-focused AD initiatives.

Moreover as focus has shifted towards support for production of higher value annual crops, at times inadequate attention has been paid to the potential complementarity of these crops with poppy, and anecdotal information indicates that at times this has resulted in rotational cropping of poppy with annual crops supported under AD programs. In addition it appears that the provision of agricultural input supplies (e.g., seeds, fertilizer) to farmers under AD programs has sometimes been diverted into poppy production.[3] These types of outcomes underscore the lack of systemic planning which has at times characterized past programming activities. These have often been implemented with an (eminently understandable) sense of urgency to address an immediate need – to provide an immediate income generation and consumption stabilization alternative to poor farmers in geographical areas vulnerable to illicit production activities – but without taking adequately into account the market and institutional preconditions for sustainably incentivizing farmers/farm groups to turn away permanently from participation in illicit activities.

Similarly there has been inadequate consideration of 'second-round' effects of AD programming activities – most particularly the familiar 'balloon effect' impact of reduced poppy production within a particular intervention zone. As detailed in-depth by Mansfield[4] and other researchers, major poppy production zones such as Helmand and Nangarhar have witnessed major 'counter-surges' in poppy production in hinterland areas, following intensive and seemingly successful intervention efforts to transition from poppy to licit crops (mainly wheat) in the more fertile agronomic sub-regions of those provinces. These developments underscore the inherent limitations of an intervention schematic which is more or less exclusively focused on short-term crop or cash-flow substitution impacts in prime agronomic zones in a given region.

These approaches in turn do not adequately take into account the prospective impact that skewed land access patterns, and decreased demand for sharecropping labor, may have on incentives for farmers to engage in illicit activities in areas outside the immediate 'zone of influence' of AD programs. Nor do they incorporate into their program planning analysis intervention mechanisms which would be designed to 'intercept' or at least mitigate these pressures, for instance through examining prospects for enhancing licit farming opportunities in hinterland areas, and/or expanding off-farm employment options. This underscores the core constraint associated with narrowly focused short term crop substitution initiatives: By looking at the farm unit rather than the village or sub-regional economy and polity as the basic unit of intervention, they abstract away from the complex of socio-institutional and economic forces that must be analyzed and addressed in order to (1) avoid or at least minimize perverse secondary incentive effects from program interventions; (2) facilitate broad-based stakeholder buy-in/commitment; and (3) create a self-sustaining economic growth dynamic at the sub-regional level.

Lack of State Presence/Fragile Security Conditions: The absence of legitimate and trusted state institutional presence in the rural areas targeted for AD activities was identified as a crucial constraint by all stakeholder groups interviewed by the consulting team. Virtually all private sector stakeholders interviewed expressed a vehement lack of confidence in the readiness of local, district and national level state institutions to support AD objectives and transparently and competently provide complementary support services. It is worth emphasizing that there was as well a clear lack of trust exhibited in the readiness of state institutions and local police officials to transparently enforce prohibitions on illicit

[3] These phenomena have been widely referenced in research articles on alternative development experience in Afghanistan, and were specifically noted as well in a number of stakeholder interviews conducted by the Pragma Team.
[4] "From Bad They Made it Worse, The Concentration of Opium Poppy in Areas of Conflict in the Provinces of Helmand and Nangarhar," David Mansfield, Afghanistan Research and Evaluation Unit, May 2014.

production; and there emerged a 'real-politik' sense that significant public sector engagement in illicit production/distribution networks remains an open institutional sore. At the same time the team gained the sense from virtually all public and private stakeholders interviewed that rural producers are subject to strong pressures from extra-legal forces – both terrorist groups and criminal gang influences (including those with links to state institutions) – to become or remain engaged in illicit production activities.

Inadequate Focus on Value Chain Development/Off-Farm Employment Opportunities: The lack of an 'integrated' AD programming focus is also reflected in the failure to adequately and systematically incorporate value chain linkages and a related focus on off-farm employment opportunities as a critical element in AD intervention approaches. AD programs have in general focused to only a limited degree on development of quality management approaches/systems, cold chain linkages and related investments, agro-processing facilities, and related market development/access strategies and time-framed game-plans. While this type of intervention approach represents a very tall order within the current fragmented and uncertain institutional context found in Afghanistan, nonetheless the almost total absence of efforts to move in this direction is striking, in light of the importance of leveraging viable longer-term income and employment generation alternatives to illicit activities.

Lack of Focus on Financial Access/Investment Leveraging Support Efforts: AD Programming has yet to incorporate a systemic and sustainability-oriented focus on improving access to financial resources. This is a glaring deficiency which has crippled efforts to encourage greater risk-taking and shifting to higher value (particularly perennial) crops on the part of farmers/farm groups. Given the operating and (in some instances) capital financing requirements needed for purposes of permanently shifting out of illicit production and into licit, higher value cropping activities, it is fundamentally important that program vehicles be developed that work towards the establishment of effective and sustainable linkages between program beneficiaries and market-based financial service providers.[5]

It is also important to establish strategies for leveraging needed private investments into agricultural inputs, agro-processing and cold chain networks in a manner which will help promote the long-term viability of the shift towards higher value crops on which AD programming has become increasingly focused. There has been up until now very little focus on such initiatives under AD-relevant projects. No focused efforts seem underway at the moment to identify potential regional or diaspora sources of investment in the agribusiness sphere, and that could be tied to the planning/implementation of targeted AD initiatives.

Again the difficulty of financial access and direct investment leveraging under the fragile institutional circumstances which have long characterized Afghanistan is hard to overstate. At the same time it is virtually impossible to envisage successful sustainable achievement of AD transitioning objectives without the inclusion of agricultural producers within formal financial intermediation service networks; without the development of at least rudimentary value chain financing mechanisms; and in the absence of strategic investment leveraging efforts which can help ensure a strong demand-pull effect for producers transitioning into higher-end licit production activities.

Fragmentation of Programmatic Support Efforts: When reviewing the description of core constraints presented above, it is startling to observe that most of the areas referenced above include agricultural/agribusiness-relevant service provision areas in which USAID programs have to one degree or another been focused over the past decade, at times quite intensively. However what tends to stands out in this regard is that these programs have not been undertaken in a manner which has *effectively*

[5] Focus group participants put an extremely high emphasis on the absence of access to finance support as a source of frustration and a key constraint on readiness to participate in AD programs.

integrated them into the pursuit of AD objectives. As has been commented on not infrequently in the AD literature of Afghanistan, at times agricultural and rural development programs have been conceptualized and implemented in a manner which has run almost parallel to the pursuit of AD goals and objectives in the same geographical areas. Moreover core AD programming strategies and programs within the GIRoA have been developed in virtual isolation from broader agricultural and rural development strategies and programs; *including within the Ministry of Agriculture itself.* This puts AD strategy formulation and programming in an extremely challenging position in terms of gearing core service provision instrumentalities in a manner which can drive major and truly sustainable AD impacts at the local and sub-regional level.

Shaping a Strategic AD Strategy/Approach Moving Forward: The above analysis provides a sharp perspective on the critical programmatic elements which will need to be in place for accelerated and sustainable progress under a "next generation" of USAID-supported AD programming. These core elements are outlined below, along with their implications from an effective program design/coordination perspective.

Community-Level Social Contract Based Approach: This represents the fundamental institutional building block upon which a successful AD programming approach can be built. It entails development of a community-based consensus on what the key constraints are which need to be addressed in order to place farmers and other economic agents at the community level in the strongest position to turn away permanently from involvement in illicit activities. This needs in turn to be based on an ongoing dialogue with community representatives and groups regarding what those key constraints are, and a prioritized game-plan for working together to effectively address them.

Behind this type of approach is understanding that the fundamental unit of engagement and intervention is not the farm unit or a particular group of farm households, but the community level and sub-regional economy and polity. The analysis of 'drivers' must be carried out at this level, in order to facilitate effective understanding of the complex of short-term cash-flow, financial risk mitigation, security/state presence, socio-institutional 'muddling-through' pressures, and longer-range rural development constraints and opportunities which are all in play in determining vulnerability to ongoing engagement in poppy production and trading activities. In addition given the endemic uncertainty characterizing the bureaucratic competence and political legitimacy of national and regional level governance institutions, and the rampant mistrust which seems frequently to exist between inhabitants of rural communities and the state political apparatus, the development of an explicit type of 'social contract' between the community and the donor program in question regarding shared objectives and mutual obligations becomes critical in its importance. In other words, given the weaknesses of core governance institutions at higher levels of government, it is virtually inevitable that within the current Afghan institutional context, high impact engagement in AD planning can most effectively begin at the community level.[6]

Top-Down State Level Engagement: While it is extremely important that there from the beginning be an organic engagement of community level actors in the shaping and implementation of integrated AD programming efforts – both from an effective resource targeting as well as an institutional buy-in perspective – it is also important that there be an efficient top-down planning and management element built into AD programming as well. What does this effectively mean? First and foremost it means bringing to bear the institutional planning capacity and technical and financial resources of the state in supporting the key objectives of AD programming at the community/sub-regional level. This entails a combination of infrastructure investment, agricultural extension (an area which has been largely isolated from most core AD programs), investor outreach, and agricultural/trade policy reform activities geared

[6] This has been a critical element of the recent KFZ Program initiative, which drew virtually universal praise from all public and private sector stakeholders interviewed for this analysis.

towards promoting increased employment and income generation opportunities for rural economic agents in areas where significant AD programs are being planned/implemented.

It means effectively rewarding communities and local governments which move in the right direction with higher subvention levels to finance required investments. This will buttress the unified 'messaging' which the state will need to engage in on a consistent basis to show the rural citizenry that it has a transparent commitment to back up its rhetoric on combating poppy production. This will in turn will require effective "mainstreaming" of alternative development planning and implementation efforts into the overall strategy-setting, programmatic planning and budgetary allocation processes in key GIRoA sectorial institutions, in a manner which is clearly absent at present. It will at the same time on occasion require commitment of the state to take 'coercive' action in order to maximize the community's disincentive to engage in illicit activities (as well as to discourage other communities from 'gaming' state resource allocations in future). We are unaware of any past institutional contexts in which AD programming alone, with no negative counter-incentives, has succeeded in sustainably reducing illicit production. It would appear to strain credulity to assume that a strategy designed to foment sustainable reduction in illicit production can succeed without a combination of carrot and stick incentives.

Focus on Key Infrastructure Constraints: The development of an integrated AD approach will require a significantly intensified core focus on addressing the most critical infrastructure constraints at the local and sub-regional level which are restricting the capacity of farmers to access markets, secure competitive returns from licit production activities, and insulate themselves from excessive transitional risk when they shift from poppy to licit crop production. It appears that virtually all stakeholders were united in their identification of irrigation/water management services and related investments as the most critical infrastructure service provision area to be addressed under AD program initiatives. This has proven to be of critical importance under the recent KFZ program.

Value Chain Development/Off-Farm Employment Support Activities: Ultimately the sustainability of AD interventions at the farm level will be critically dependent on forging truly robust value chain linkages which can permanently 'ratchet-up' demand for higher-value added agricultural products; and which will indirectly help drive the investments in storage capacity, improved agricultural input networks, and enhanced on-farm quality management and cultivation practices which will be required to sustainably increase productivity, sales and incomes. This will also help drive increased off-farm employment opportunities, in a manner which further raises the opportunity cost for rural economic agents of engaging in illicit agricultural activities. Essentially this entails tying the rural communities targeted for AD engagement with sub-regional and regional peri-urban areas and major urban centers which can drive increased demand over time; and where possible leveraging access to export markets for annuals and perennials. This in turn will require sub-regional level competitiveness analysis and targeting of types of crops that have the potential to be linked into value chain networks, and a review of the key infrastructural, cold chain, market linkage/access, quality management, and financial constraints that are limiting their development.

Create Robust and Sustainable Financial Sector Access Platforms: The implementation of past AD programs has as noted earlier been undertaken in the virtual absence of a corollary systemic access to finance strategy and related support programs. This has in turn had a crippling impact of the viability and sustainability of these initiatives. In the absence of viable financing vehicles, for instance, a number of past programs have featured massive 'giveaways' of inputs that have complicated efforts to develop viable market-based agricultural input supply markets; and (according to anecdotal information, including a number of private and public stakeholders interviewed for this research initiative) at times redirected towards illicit production activities. In addition the absence of viable agricultural financing instruments has significantly complicated efforts to shift towards higher value added crops, and most particularly

perennials. These require lengthy gestation periods before income from their production can be realized, and therefore generate relatively high operating capital requirements for participating producers who have no access to sources of commercial finance.

In order to promote a viable AD strategy for the country, sustainable linkages have to be developed which, directly and/or indirectly, create the institutional capacity for provision of core financial services to the rural families who are the first tier beneficiaries of AD Programs. In assessing potential platforms for providing intermediation services to this manifestly under-served segment of the population, it is critically important to focus on practical market-oriented rural financial access approaches which could (1) take effective advantage of existing financial sector service delivery vehicles, while (2) encouraging a "demonstration effect" impact that would yield robust financial access benefits over time. The first element of a viable access strategy would be searching for a viable institutional partner potentially interest in expanding it rural lending activities. A strong potential partner might be found, for instance, in the Afghanistan International Bank (AIB), which is among the most progressive financial institutions in Afghanistan, and which directly indicated to the team during stakeholder discussions its potential interest in jumpstarting agriculture/agribusiness lending activities.

A second element in a strategic approach moving forward would be to foment development of 'second-tier' funding relationships between commercial banks and MFI's whose decentralized institutional presence and financial outreach skill sets place them in a stronger position to rapidly identify viable clients and provide efficient and cost-effective intermediation services to AD-relevant clientele. These institutions could thus serve as an effective 'indirect' service delivery vehicle to AD clients, and in the process tap-into the substantial under-utilized financial resources of selected commercial banking institutions. A third key element of a practical intervention approach could be to focus on remote or 'branchless' banking opportunities. This would entail an effort to work with one for more formal financial institutions to identify rural economic agents – for instance, pharmacies, retailers, barbershops, AgDepots – which would serve as representatives of the financial institution, and initiate client engagement. This could be combined with or supplemented by a mobile banking outreach approach.

Finally, the USAID-supported Afghanistan Development Fund (ADF) represents a distinct potential institutional target for AD-related financial outreach strategy and implementation efforts. As a direct USAID-supported financial outreach platform in the agricultural sector, this institution has developed a specialized skill set and organizational structure focused on efficient mid-to-larger end agriculture and agribusiness lending processes and products; including longer-term lending arrangements than those offered by most other commercial finance institutions. In addition, it now is under the direct governance oversight of the MAIL. As such, it provides a potentially unique vehicle for rapidly expanding financial service availability in a best practice consistent manner towards targeted AD beneficiary groups.

Long-Term and Effectively Sequenced Programmatic Focus:
The program strategies and intervention mechanisms which have been described should be designed in a manner which reflects a core understanding of the long-range rural development needs of the geographical area in which the programs are implemented. This would generally require programs with a relatively long implementation period. In a fundamental sense implementation of this type of approach would require an organizational framework for program planning/implementation which will help avoid the type of short term (1 to 5 years) resource planning and management stove-piping which has plagued implementation of AD programs up until now. On the GIRoA side, this would mean that the AD strategy-setting and program planning and budgeting process would entail proactive collaboration with and prioritization by all major functional areas within MAIL and MRRD – for instance including rural infrastructure, research/extension, financial sector access (MAIL has a predominant governance role to play in the operation of ADF), investor outreach, and agricultural policy reform activities. On the USAID

side, this would entail intensive efforts to examine/prioritize synergistic elements of, and effectively link up, a range of major agriculture/agribusiness and broader trade and fiscal reform support initiatives to its core AD programmatic initiatives.

Within USAID this could be achieved through the formation of a permanent AD working group which cuts across the Agriculture and Economic Growth Offices. This unit could develop cross-cutting activity management priorities and activity plans which are tied to annual and multi-year AD program goals and objectives. On the GIRoA side, this could be achieved through significantly further strengthening the organization of public sector planning and implementation processes and programs related to the NPP on reducing/replacing poppy production with licit income generation activities. In effect, this would require a type of "Plan Colombia" organizational framework which would allow the GIRoA to effectively prioritize AD programmatic objectives at an inter-ministerial level; and galvanize the strategic and budget planning processes and resources required to streamline decision-making processes and reduce stove-piping pressures.

This would seem to be the most viable organizational approach available at the moment to achieve the long-sought "mainstreaming" of AD programs into the overall agricultural and rural strategy-setting and budget planning processes. Although certainly no panacea, and subject to potential bureaucratic and political economy efforts to 'marginalize' or 'compartmentalize' a new or revised AD-specific organizational structure or working group, it would appear that such a structure would have a greater chance at building a planning & implementation system for AD programming which has some chance at sustainable success, particularly in relation to the status quo in agricultural/rural public policy formulation. This is particularly likely to be the case, in light of the fact that policy interest in the success of AD programming seems much stronger at the presidential level than it does among sector ministry leadership.

Within USAID, optimal implementation of this type of AD programming framework would imply the establishment of a multi-pronged rural institutional strengthening and capacity enhancement program geared both at improving opportunities for transition to high value licit crop production; and creation wherever possible of vibrant value chain linkages to regional and national markets – and, where possible over time, to export markets. These would be tied to efforts to improve extension service provision and targeted rural infrastructure development activities; and market-based provision of suitably-scaled financial access services. Efforts would also be made to target specific policy/regulatory reforms which might be required to reduce trade/transit costs and improve prospects for profitable trading activities. This would help further insulate low-income producers from the high levels of risk associated with shifting into licit production activities. For areas that have significant agronomic potential but are located somewhat farther from major urban centers, and which exhibit more fragile infrastructure and market access conditions, the programmatic focus would likely need to be more selective and sequential in nature, focusing more heavily initially on infrastructural and basic market linkage upgrading (e.g. storage facilities, basic input supply linkages). Subsequently greater focus could be placed on product quality improvements and agro-processing linkages. It would also need to focus on less perishable crops, such as nuts and dried fruit.

For more distant and vulnerable hinterland areas in core intervention zones, heavy emphasis would be placed on determining whether such areas provided viable opportunities for limited infrastructure investments, and for relatively simple technology transfer/enhanced cultivation practice support activities (most probably basic grain-focused). Strong emphasis would be placed on defining off-farm employment opportunities which could drain off labor supply from these areas as well (closely linked to the sub-regional value chain development aspects of the strategy). All of these strategic intervention efforts would be based upon a prior rapid diagnostic analysis of transition constraints and opportunities at the

local and sub-regional level. This aspect of the strategy will prove critical from the perspective of functioning to minimize "balloon effect" impacts at the regional level over the medium-term.

It would then be concretized through a community-level agreement on AD intervention strategy and programmatic efforts, and shared responsibilities between the program implementer, community participants, and relevant public sector interlocutors. This in turn would be tied to public sector agreement to focused allocation of cross-cutting resources in critical areas (e.g., research/extension, irrigation infrastructure, road construction/maintenance) that would both support effective program execution, and build social capital/shared expectational bonds at the community level. In addition it would be fundamentally important that state security presence be enhanced – particularly in the relevant hinterland areas – in order for program legitimacy to be reinforced and social capital bonds effectively developed.

AD Programming Options Assuming Major Budgetary/Political Will Constraints:
However it is quite possible that the GIRoA may, in the near term, prove incapable of mustering the institutional will/wherewithal, and the budgetary capacity, needed to successfully implement this type of resource and institutional leadership-intensive AD approach in key at-risk sub-regions. It may most particularly not have the budgetary and institutional resources required to ensure strong state security presence in such areas. If/when such conditions hold, it may prove more viable to initially implement a type of 'AD-Light' approach, which focuses on establishing a type of demonstration effect impact by implementing the above-described implementation strategy in areas that are touched by but not engulfed by illicit production activities.

Program implementation under such circumstances would also entail community level agreements and a multi-pronged resource leveraging and institutional engagement approach. However it would almost by definition not focus on significant short-term targets for net reduction in illicit production, and would serve more as a "testing ground" for AD initiatives. These could at a later stage be expanded out to more vulnerable regional areas, particularly as public sector resource delivery and security/state presence capacity expands. Both approaches could of course be applied on a targeted basis within distinct regional contexts; their application driven by donor and GIRoA resource envelopes and state presence conditions within a particular region/sub-region.

2. PAST POPPY PRODUCTION TRENDS

"Combating opium poppy cultivation is a major objective of USAID's agriculture program, along with promoting private sector-led economic growth and increasing food security. Within the USG's multi-agency effort to reduce opium production, USAID's role is to promote viable economic alternatives to poppy cultivation, otherwise known as Alternative Development (AD). The main purpose of AD programs are to compensate poppy producers, at least partially, for the income lost by foregoing poppy cultivation, and to change the risk/reward calculation of rural households in deciding whether to plant poppy or licit crops."[7]

Alternative Development activities funded by USAID were initiated in 2002, and have received $1.37 billion in AD funding over this time period. Activities have spread over the whole country, claiming over half of USAID's total funding but have been clearly focused on Kandahar and Helmand Provinces, which account for 60% to 75% of poppy production in the country, depending on various factors of prices, climate and security which cause production figures to be volatile and to rise and fall each year accordingly. Although the funding source is clearly noted as 'AD' funds the resulting activities are fairly similar in nature and characteristics to more general agriculture sector financing, which are also used for promoting "increased licit crop production through the introduction of improved technologies and practices, the rehabilitation of irrigation systems and other-related infrastructure, and though strengthening agribusiness and marketing channels."[8] However, the most explicit anti-drug crop efforts have been in the introduction of crops that compete directly with poppy production in terms of incomes generated and remunerative labor employed, commonly known as 'crop substitution'.

Given this scenario, this section will look at the trends in poppy production from 1999 to the present, present the underlying factors that influence farmers in their decisions to grow poppy versus other crops, and attempt to determine the factors that could be altered in order to reach sustainability in reducing poppy cultivation. Prior to the period of the U.S. intervention, poppy production ranged between 71,000 hectares (1994) to 82,000 hectares (2000). Then in 2001 the Taliban put a ban on poppy production and the acreage fell below 10,000 hectares. However, subsequent to 2002, poppy production jumped back to its former pre-ban level of 74,000 hectares, rising to a relatively high point of 193,000 hectares in 2007. Production fell back to 123,000 hectares in 2009-10. Since then there seems to have been a fairly steady rise in production, to a high of 224,000 hectares in 2014, but according to UNODC figures a 19% decline occurred in in 2015, dropping production to 183,000 hectares. However the UNODC reports may not be accurate for 2013-14, which may have resulted in an overstatement of the increase in production during 2013-14 and therefore some overstatement in the drop recorded during 2014-15. [9]

The accuracy of these numbers has been subject to considerable controversy, due to changing methodologies and uncertainties regarding the degree of rigor characterizing their application. Moreover, the degree of error in measurements is normally calculated to be plus or minus 20,000 hectares, a significant margin or degree of error. What does seem clear is that there has been a general rise in production since 2002; with annual ups and downs which have been impacted by a combination of short-run pricing variations, climate conditions and shifts in the security situation at the provincial level.

In general cultivation has been concentrated predominantly in two regions, 66% in the Southern Region, principally Kandahar and Helmand Provinces, and 24% in the Western Region. Seven percent has been

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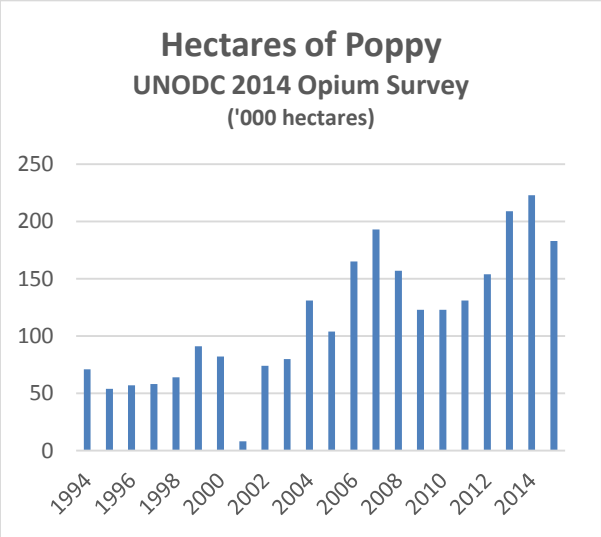
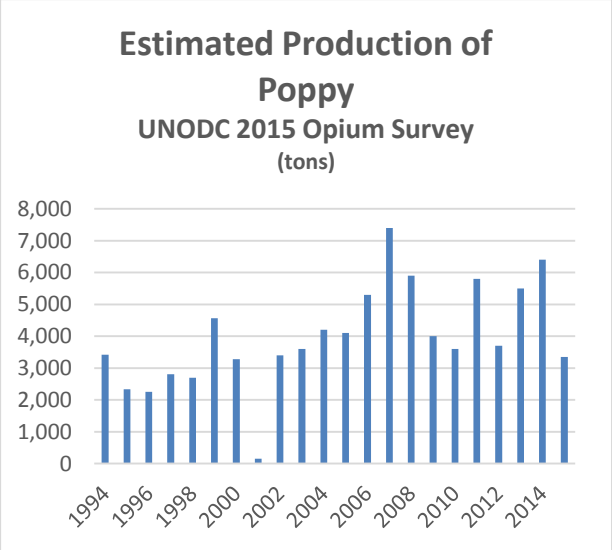
[7] "Poppy Cultivation and USAID Alternative Development Efforts in Afghanistan", pp 1, Executive Summary, USAID Afghanistan Agricultural Sector Assistance Strategy, Annex 5, Kabul, Afghanistan, August 15, 2015.
[8] *Ibid.*
[9] UNODC appears to have changed its methodological approach for crop measurement over the past few years, including utilization of more detailed/refined visual imagery-based mapping information.

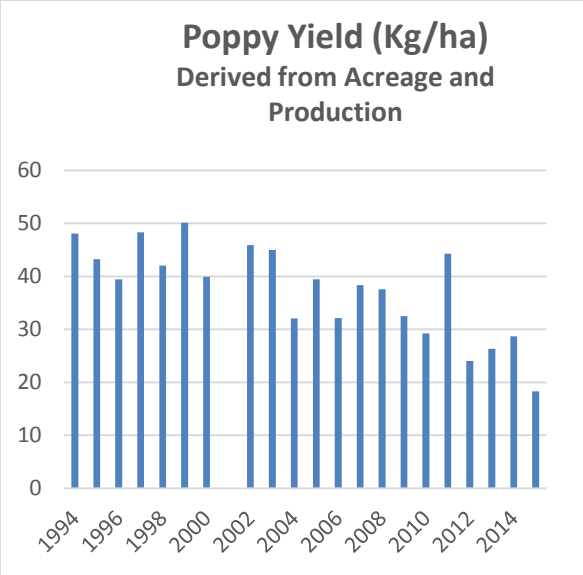
from the Eastern Region, including Nangarhar, and only 3% from the remaining areas – Northern, North-Central and Central Regions. Yet even within these regions, there are certain provinces where poppy production is concentrated. Overall Helmand leads the way with approximately 47% of the country's total production, followed by Farah and Kandahar at 12% each, hence with 70% of production emanating from just these three provinces. When Badghis, Uruzgan, Nangarhar and Nimroz provinces are added, each of which averaged 6% of the country's total, the percent of poppy production country-wide accounted for from these Southern and Western provinces plus Nangarhar reaches almost 95%. Poppy cultivation in the other provinces has traditionally been minimal.

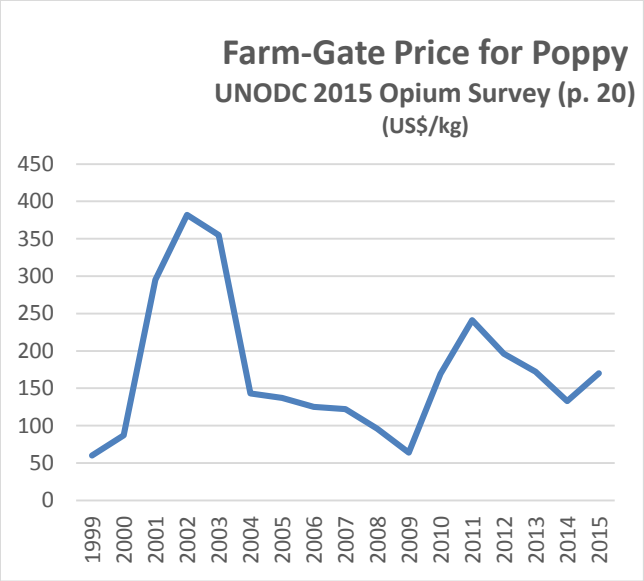
What is particularly striking, however, is that the three major producing regions reportedly experienced significant decreases in poppy production in 2015. And while the magnitude of the decrease in production may well have been exaggerated in the UNODC numbers, there appears to be general agreement among most informed parties that there has been a significant decline. The principal reason for the decrease in production appears to be a decrease in yields across-the-board, from an average of 28.7 kg/ha to 18.3 kg/ha. And this decrease from 2014 to 2015 followed after decreases to 29 kg/ha in 2014 from a high of 44 kg/ha in 2011, and an average of 36 kg/ha over the time period of 1999-2014. Assuming these figures are accurate, this would tend to indicate that the "pushing out" of production to hinterland regions has impacted poppy productivity significantly, consistent with recent research findings. However it will be important to continue to monitor trends over the 2016-17 period, prior to reaching any stronger conclusions in this area (particularly given the uncertainty regarding the accuracy of data estimates.

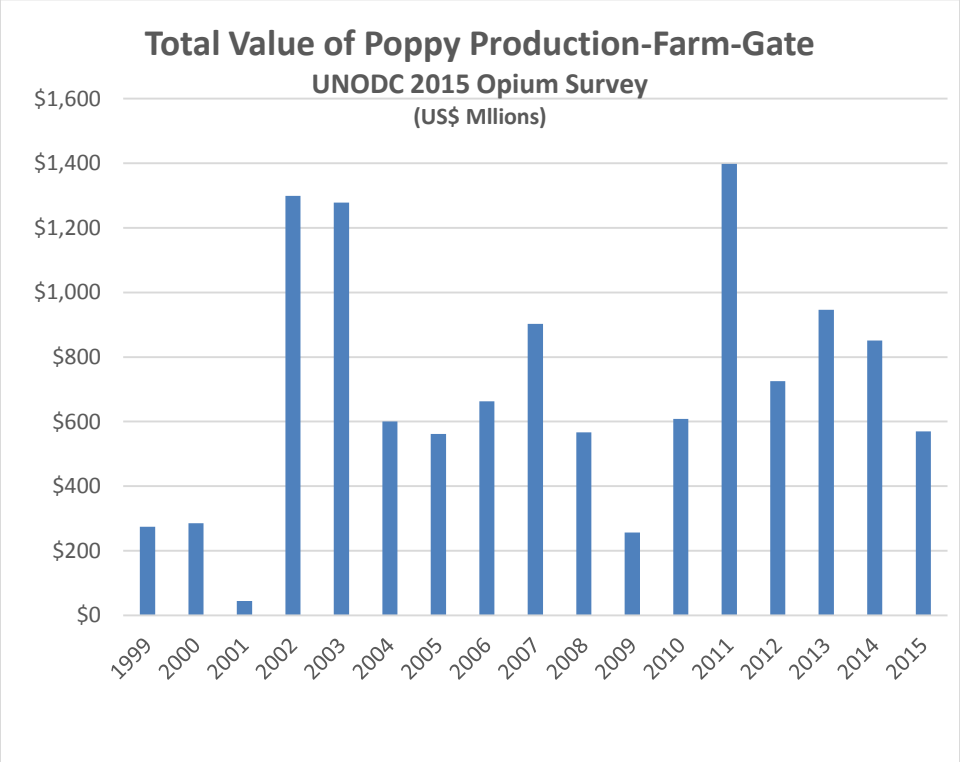
In analyzing the ups and downs in poppy production, one must look at the prices for opium, to see what correlations there are between acreage and price. When acreages decrease, prices normally increase, leading to a subsequent reaction in increased acreage during ensuing years. If yields decrease as well, the price response is even greater. To a certain extent this pattern fits quite well to the Afghanistan poppy data, but not completely. The following charts present the basic.

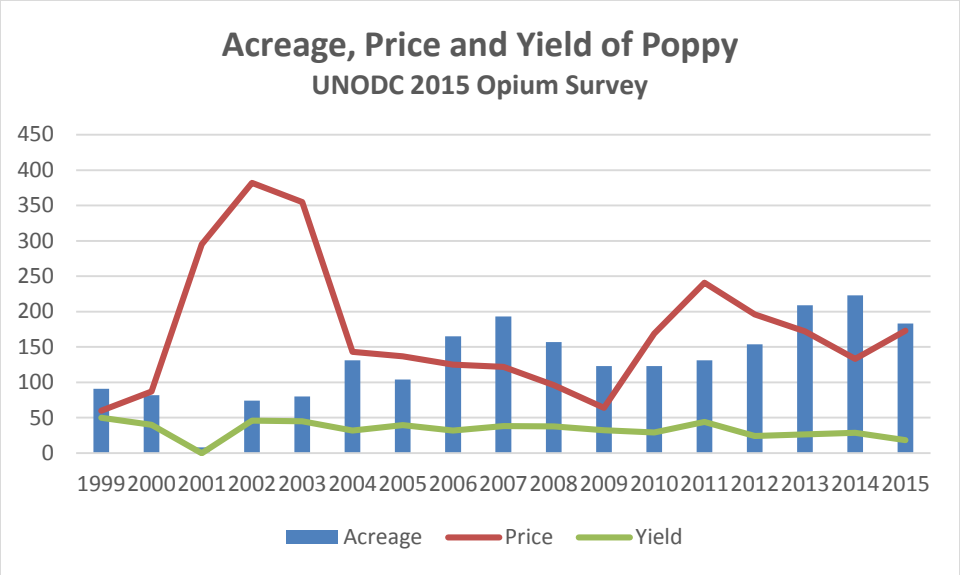





Poppy Yield (Kg/ha)
Derived from Acreage and Production
60
50
40
30
20
10
0
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014


Farm-Gate Price for Poppy
UNODC 2015 Opium Survey (p. 20)
(US$/kg)
450
400
350
300
250
200
150
100
50
0
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015


Total Value of Poppy Production-Farm-Gate
UNODC 2015 Opium Survey
(US$ Mllions)
$1,600
$1,400
$1,200
$1,000
$800
$600
$400
$200
$0
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015



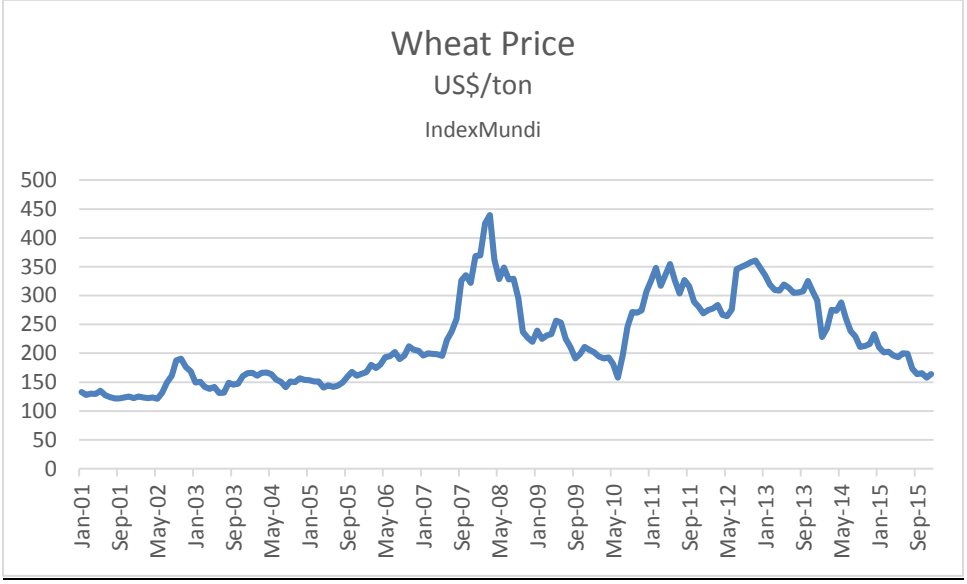
During 2001, the Taliban banned the production of poppy and the price surged to US$295/kg. When the Taliban ban on production was lifted in 2002, there was an immediate response to pre-ban levels in acreage, to 74,000 hectares, and the price continued to increase all the way to US$382/k. Production acreage rose to 80,000 hectares in 2003, with a price of US$355/kg. This surge in production finally led to over production in the spring of 2004, on 131,000 hectares, and the price fell to US$143/kg, what some farmers said barely paid for their harvesting labor. The following year acreage plummeted to 104,000 hectares and the price continued to fall to US$139/kg. However, the yield rebounded from 32kg/ha to 39kg/ha, so production remained relatively the same in 2005. But at this point, the economic dynamics cannot explain what goes on.

In the period of 2002 to 2003, incomes per hectare for poppy averaged $16,000. Then, in 2004, with almost double the production, per hectare incomes fell closer to the more normal level of $4,000/ha. For 2005, with a relatively high yield, per hectare incomes were $5,400. At this level of income, acreage jumped again to 165,000 hectares, presumably due to the high earnings per hectare rather than because of a high price. The price decreased somewhat the following year, leading to per hectare income of $4,000, but the acreage increased sharply again in 2007 to 193,000 hectares, with a relatively good price of US$122/kg and the yield increased, so incomes were $4,678/ha. At that point acreage fell to 157,000 hectares in 2008 and again to 123,000 hectares in 2009, and stayed the same for 2010. Yields were 38kg/ha for 2007 and 2008, and 33kg/ha for 2009. But at the same time, poppy prices fell to US$96/kg in 2008 to US$64/kg in 2009, an unexpected occurrence, leading to per hectare incomes for poppy of $3,600/ha and $2,000/ha respectively.

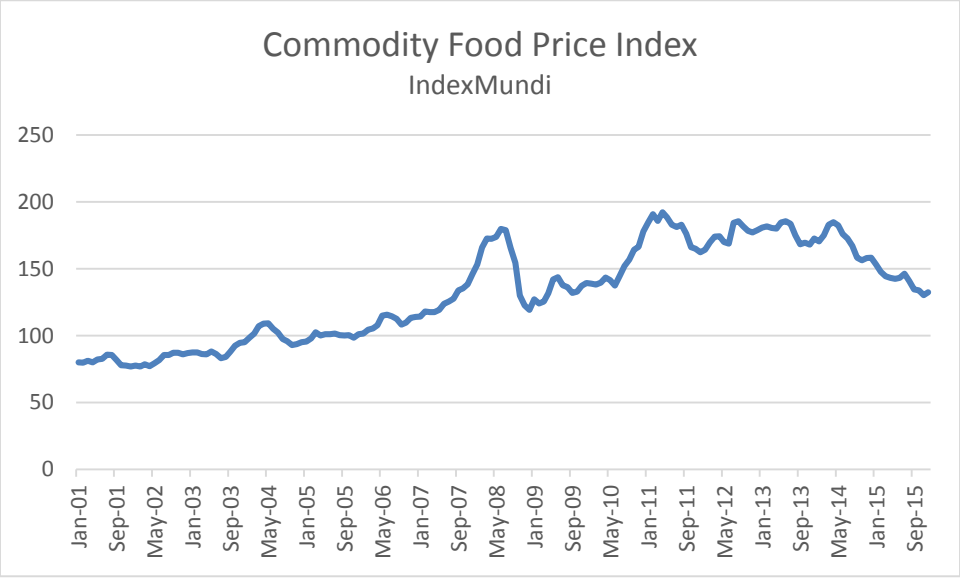
World Wide Price Volatility – 2007 to 2009 – All of this coincided with worldwide price volatility in several markets – wheat, oil and gold specifically, but also the Commodity Food Price Index displayed these kinds of movements. This was in turn likely impacted by speculative demand trends in international capital markets related to factors that are linked to the US sub-prime market implosion that led hedge-funds into pulling out of the mortgage markets en-masse and channeling massive speculative flows into futures. Within a year the prices for these commodities fell to their earlier levels.

This price volatility left the commodity and food markets around the world in a state of turmoil and uncertainty. This was definitely the case in Afghanistan, especially since poppy was basically an international commodity. The year 2010 saw the price of poppy rise from US$64/kg in 2009 to

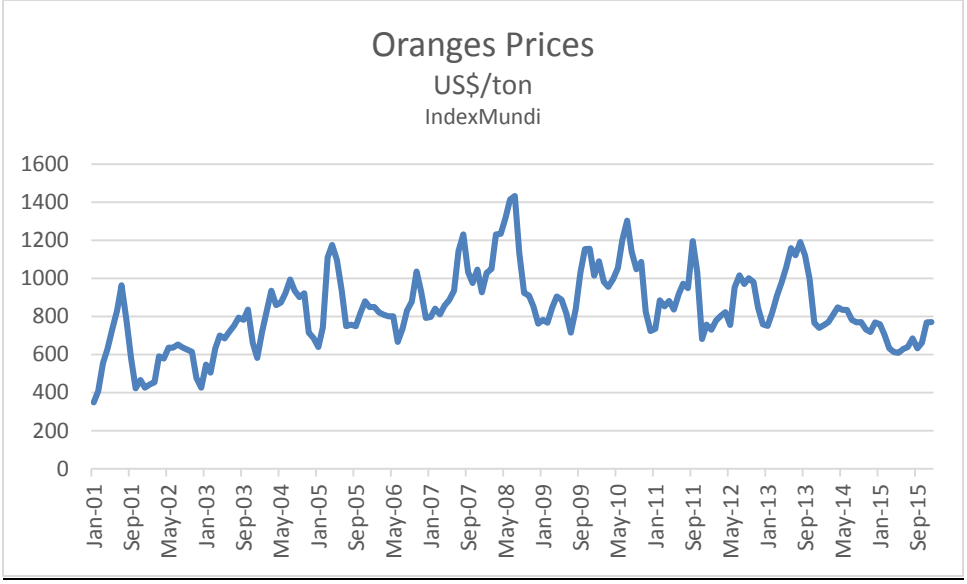
US$169/kg in 2010, and to US$241 in 2011. Internationally, this affected most commodities, and the only explanation that was feasible was the speculation in financial markets due to the "Arab Spring". Here is a look at the price volatility during these years.



From 2007 onwards, this was a period of food commodity price volatility, especially for wheat. From the fall of 2007 to the spring of 2008, wheat prices rose over 200%, an unprecedented event. Other commodity prices experienced the same situation (oil, gold) and most food prices followed suit.



Notice the same pattern, an abrupt increase in 2008-2009, falling back in late 2009 to 2011, and then an abrupt rise again in 2011 before tapering off in 2015. This is unusual and defies prediction or forecasting. In contrast, a perishable fruit has a much different price curve as shown below for oranges.



This shows the 'accordion' effect of rapid up and down prices, although close scrutiny can most likely determine some degree of seasonality, year to year but definitely not the pattern of the commodities. Nonetheless, with such marked price volatility, the normal dynamics of the economic market for poppy in Afghanistan were impacted by high levels of uncertainty regarding expected returns. In light of these factors, it is important to examine the impact which other key socio-economic variables appear to have had in driving acreage, production and pricing patterns. Suffice it to say, that acreage due to the high price in 2012 (US$196/kg) surged to 154,00 hectares, and the price stayed at US$196/kg, such that acreage in 2013 again rose to 209,000 hectares, with a slightly lower price of US$154/kg. 2014 saw the highest acreage at 224,000 hectares and a lower price at US$133/kg. Finally, in 2015, acreage fell 19% to 183,000 hectares and production fell 47% from 6,400 tons to 3,349 tons, a dramatic reduction. The reasons for the decline can be traced, in part, to a severe reduction in productivity (from 29kg/ha to 18kg/ha or less according to Mansfield) due to salinization, disease, and other climatic impacts and perhaps the price decrease of 2014, which then led to an increase in price to US$173/kg in 2014, which will more than likely lead to an increase in production for 2016.

To underscore, there are a number of financial and broader socio-institutional factors which influence farmer decisions to continue to grow poppy, or to desist from growing poppy. Since the lifting of the ban on poppy production by the Taliban in 2002, the Alternative Development programs of the US Government and other donor entities, including the efforts of the UNODC, the INL and Afghanistan's Ministry of Counter-Narcotics, initiated several activities designed to directly reduce poppy production, with varying levels of impact and ambiguous approaches for calculating attribution to these efforts.

The descriptive analysis provided above is quite revealing. On the one hand the charts reflect the fact that poppy, like any agricultural commodity, seems to follow the basic tenets of supply and demand: When production is banned, or productivity declines (disease, drought, hail, salinization, desertification), or input costs rise unexpectedly (pumps and diesel requirements), or eradication and interdiction intensifies, or there are public campaigns of discouragement, etc. – the price increases due to the constant high demand in export markets for its derivative, heroin. In essence lower production leads to an increase in price; higher production leads to a fall in price (reflecting Afghanistan's predominant supply position in the international heroin market). Moreover unlike fruits and vegetables, opium can be stored for some time, so perishability issues are not a detriment (and there may therefore be a degree

of downward stickiness expected in the supply response of producers to a perceived temporary decline in poppy prices).[10]

So at the time of the Taliban ban, the price was relatively low, as can be seen in the charts. But due to the lack of opium poppy in the market (and heroin and morphine) the price skyrocketed, to over $300/kg of opium. However, due to the constraints imposed on poppy production, the acreage response was slow to materialize, and it took several years to fully evolve. Then, when production rose in 2003, with a bumper harvest in April of 2004, the price came down precipitously, almost to the point where it did not cover the costs of harvesting. In 2003-2004 USAID's RAMP project was initiated, and this was followed shortly thereafter by the ALP (Alternative Livelihoods Project) initiatives. These programs, along with AVIPA and in combination with aggressive regional-level eradication efforts, experienced significant initial successes. They were however subsequently impacted by a severe response from criminal elements, who routinely assassinated government employees involved in these programs. (See their final reports and the UNODC 2015 report).

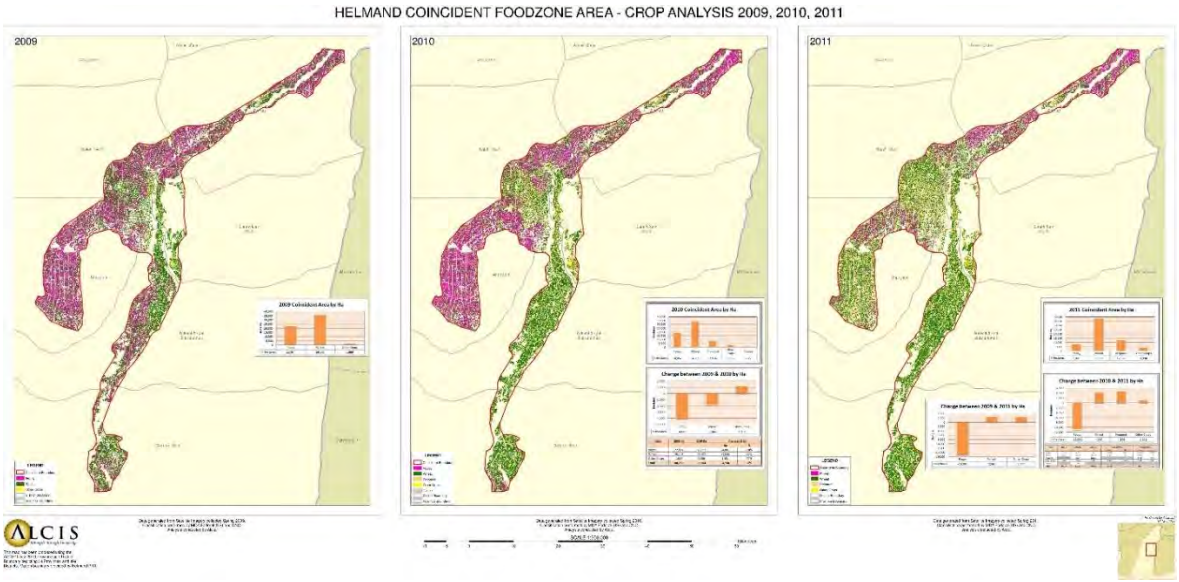
Then, in spite of the fact that RAMP and the Alternative Livelihoods Projects were initiated around the country, poppy production increased over 2006-7, before declining again in 2008. With the increase in production (7,400 tons), the price declined to US$96/kg, and fell to $64/kg for opium in 2009 (when production was 5,900 tons. It was claimed by some at the time that this was due to the fact that wheat prices increased significantly and acted as an effective 'competitor' crop. However, even with a price of 30 afs/kg (US$.54/kg) for wheat (it should be remembered that 2008 was the year that wheat prices spiked to around US$.45/kg internationally – see chart above), a hectare of wheat only earns roughly a net income of $1,000/ha compared to $3,600 for poppy (for 2008).[11]
At this point, as can be seen in the charts, acreage and production leveled off for a few years, until the price rebounded again, reaching a high point of $241/kg of opium in 2011, and this led to a resurgence of poppy production over the next couple of years. Presumably, as a result of the low acreage (123 thousand hectares), low income ($3,000/ha) and smaller harvest (4,000 tons), the price jumped to US$169/kg in 2010. Another noteworthy factor during this period is that the aforementioned AVIPA Program began in the fall of 2008, with a distribution of 113,000 hectares of wheat seed and fertilizer, ostensibly to counteract three years of drought in the North, East and West.

Subsequent evaluations indicated that adoption (plantings) was over 90%. Although wheat could not compete in terms of income earnings, virtually free distribution of seeds and fertilizers (only 20% co-pay) stimulated adoption, and the replanting of saved seeds was also practiced in subsequent years. This distribution continued for two more years at a rate of over 125,000 hectares per year, and seemed overall to have a constraining influence on poppy production for 2009-11. In the central irrigated areas of Helmand, the ALCIS aerial photography maps showed a significant decrease in poppy production over this period.

Moreover, beginning in 2009 AVIPA Plus was initiated in the South (Kandahar and Helmand), with a mandate to introduce the semi-free seeds and fertilizers of AVIPA into the South as a type of counter-insurgency tool. Since DFID was already distributing wheat seeds in these areas, AVIPA was tasked with introducing 'non-wheat' seeds, and ended up delivering 18 different seeds of melons (watermelon and

[10] However reliance on sharecropping will tend to heighten the contractionary supply response to a decline in poppy prices, since it limits the capacity of the land-holder to 'ride-out' price troughs through self-exploitation practices.
[11] Although the donor community in general treated wheat as a competitive crop vis-a-vis poppy during most of this period, it should be underscored that wheat never reaches anywhere near the income/hectare that poppy can earn. It hence is not likely to serve as an effective substitute crop under most circumstances, even though it is traditionally the only crop grown at the same time as poppy and on the same land. In many instances it is the cash flow requirements (low for wheat, higher for poppy) that can result in a farmer selecting wheat even though he knows the profit potential is much higher for poppy. This can be particularly true when critical costs such as seed and fertilizer are given to the farmer free, or nearly free.

musk melon), vegetables (tomato, eggplant, cucumber, spinach, radish, spring onion, carrots and bell pepper), okra and legumes (mung bean, black eyed peas), corn (2 jeribs), and barley and forage crops (alfalfa and clover). Adoption was 85% with plantings of over 40,000 hectares. The labor generated by this program in Helmand alone was 20,000 FTE (full time equivalents,) and at least another 50,000 FTE in terms of its estimated multiplier effect. The vegetable crops earned over $3,000/ha per season and some of them were planted twice in the year. When the gross earning of vegetable crops are in the same range as poppy and the cost of inputs is heavily subsidized by donor programs, farmer's decisions to plant vegetable crops over poppy is highly rational as the net profit will be higher for the vegetable crop. Although this program appears to have had a significant role in the reduction of poppy acreage in the Helmand Food Zone from 2009 to 2011, it is extremely difficult to assign attribution in such cases.[12]



Unfortunately, this reduction in poppy in the highest producing province in the country was counteracted by what is generally known as the 'balloon effect'. Several authors report that poppy production simply migrated to isolated and remote areas, where there was more limited state presence and less influence of programs designed to suppress poppy production; as well as less favorable agronomic conditions (i.e. desert-like areas). As David Mansfield has pointed out, two of these areas received thousands of migrants, used poppy proceeds to improve the land and purchase equipment for irrigation, and proceeded to settle areas that were originally uninhabitable and unproductive. These two areas were the north of the Boghra Canal in Helmand and the Bakwa area of Farah, on the Farah/Nimroz border. This trend may in part have been reinforced by the misallocation of agricultural inputs provided under the afore-mentioned donor programs.

Balloon Effect – Two articles by David Mansfield address this phenomenon. The first was "Ready to Burst? Examining the Role of the 'Balloon Effect' in the Expansion of Opium Poppy into the Desert Frontiers of Afghanistan"[13] and the second was "Where Have All the Flowers Gone?"[14] These articles

[12] Afghanistan Vouchers for Increased Production in Agriculture-Plus (AVIPA Plus): Commodity Value Chain Analyses and Program Benefit-Cost Analysis, September 2008 – November 2011, International Relief and Development, SRAD Project, 2012, USAID, Kandahar, Afghanistan.
[13] "Ready to Burst? Examining the Role of the 'Balloon Effect' in the Expansion of Opium Poppy into the Desert Frontiers of Afghanistan", David Mansfield, March 23, 2015, Kabul, Afghanistan.
[14] "Where Have All the Flowers Gone? The Real Reasons for the Drop in the Poppy Crop in Afghanistan in 2015", David Mansfield, October, 2015, Kabul, Afghanistan.

by Mansfield refer to what is known as the 'balloon effect', where patches of poppy production will spring up in remote, isolated areas because farmers, usually landless, have been edged out of the former poppy producing areas due to licit crop production, pushing out the poppy because of the introduction of crops that are more remunerative than the poppy. Mansfield cites two areas as the most prominent locations for this effect, namely the north of the Boghra canal in Helmand and the Bakwa are of Farah.

At the same time, Mansfield's in-depth analysis demonstrates that migration by the landless, sharecroppers and day-laborers to these areas actually started before the 2009-2011 period referred to as edging the landless out of the irrigated central areas. In a sense these areas were 'primed' for expanding production of poppy when the central Helmand and central Farah areas began shifting to wheat and other crops, hence they retained the label of 'balloon effect' areas. But with the decline in national acreage and production on 2015, these areas have been cited as having experience a significant decrease in productivity due to disease, increased cost of production due to the need for sinking deep wells, and increased salinization. Productivity decreased to 16 kg/hectare in the Boghra Canal area, although the Bakwa area reportedly has not experienced as precipitous a decline.

The core rationale for producing poppy in these areas is that the new technologies for pumping from deep wells that came from Pakistan, and the cheap pumps and other machinery from China, allowed for such production to be profitable, at least initially. And these areas were unhindered by Government sponsored counter-narcotics efforts, and were in fact propelled by 'extra-legal' political influences in terms of payments and bribes. It should be underscored in this regard that addressing "balloon effect" vulnerability in hinterland areas is and will in future be critically dependent on enhanced state presence and commitment to both enhance physical and social infrastructure services, as well as security service provision, in these isolated areas – a point we will return to subsequently.

Our brief analysis of poppy production trends indicates that, in general, production seems to follow supply-demand dynamics in a reasonably clear manner, but that adjoining socio-institutional factors (e.g. state presence, regional commitment to enhanced security conditions) have impacted on production trends as well. Moreover, Alternative Development efforts seem to have had some temporal impact in inducing a transition to licit production in certain areas, and forcing the drug-crop production into more remote and isolated geo-spatial areas. Nonetheless, the intervention programs that have been applied do not seem to have been successful in triggering a sustainable transition to licit crops, although clearly the transition process has been impacted severely by constraining exogenous institutional factors.

Within this overall context, it may be worth examining explicitly the key factors or variables other than price which seem to strongly influence farmer decisions to grow poppy:

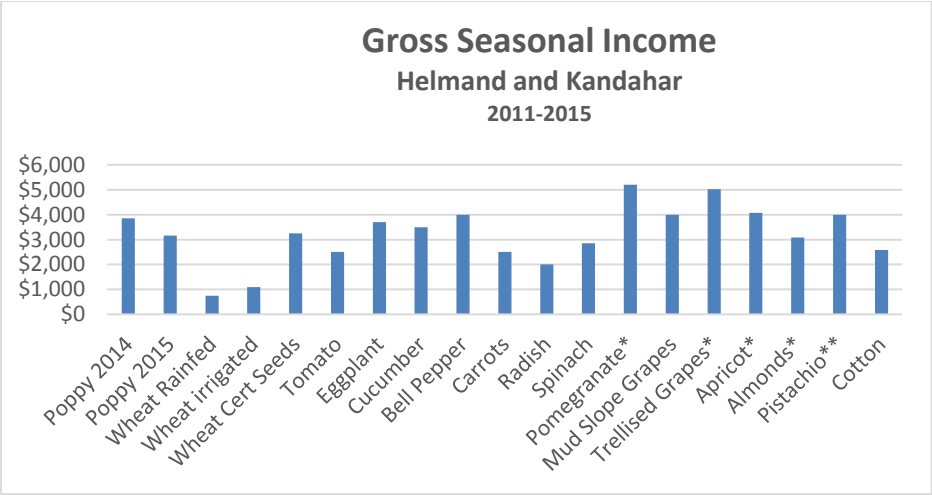
Net Income and Labor Income – Poppy versus Wheat and other Crops - It has often been emphasized that poppy production is by far the most lucrative cash crop available to low income farmers, and because of this, farmers have a propensity to grow poppy above all else. Even though evidence has been presented in Central Helmand showing the robust substitution of wheat and other non-wheat crops (perennials and annuals) during the dramatic decline in poppy from 2008 to 2011, the 'income' factor still remains a predominant influence driving poppy production decisions. However, the following information helps qualify such observations. Poppy production fell from its traditional level of 35kg/ha (15 year average, nationwide) to a national average of 18.3 kg/ha in 2015. At this level of production, and given the variable production costs per hectare of $1,174 for labor and $249 for fertilizer and other inputs, net income to poppy production was **$1,468** - not a particularly high comparative income level. If the year 2014 poppy season is considered for comparison, then yield is 29 kg/ha, the price is $133/kg of opium, labor costs are $968, and net revenue is **$2,159.** This is significantly higher than 2015, but not as high as a 15-year adjusted average of $4,178. Adding back in

harvest-related labor costs (assuming they are 'family labor'), then returns to the farmer would be $2, 642 for 2015 and $3,334 for 2014.

On the other hand, wheat is considered to be a poor competitor with poppy. Once again using data from the UNODC 2015 report and additional cost data from the AVIPA report in 2012, wheat production income under *rain-fed* conditions is $741 with a price of $.39/kg (1,900 kg/ha), and production costs are $360 (of which $216 (40 days) are labor costs). Net income to *rain-fed* production is $581. However, since poppy is irrigated, presumably the wheat that would substitute for the poppy would also be irrigated, and in such a case, the gross income would be $1,092 (at the same price of $.39/kg and yield of 2,800 kg/ha); with input costs of $504 of which $308 are labor costs (55 workdays). Net revenue would be $788/ha, not sufficient to substitute for poppy, even when adding back in the family labor costs of $308. If the farmers receive foundation or first generation certified seed, productivity would increase towards five tons/hectare, giving rise to gross income of $3,250/ha (certified seed price of $.65/kg) with costs of $725 (of which $459 would be labor – 82 days). Net revenue would be $2,910 and net income plus labor income would be $3,369. However presumably only a small portion of the farmers would be able to obtain and plant the new seeds that are emerging, and landing a contract with a Seed Company to be a 'seed multiplier'.

Although wheat struggles to act as competition for poppy, there are several other crops and cropping systems that it appears could serve quite well in that regard. Most analysts point towards the rich tradition of perennial fruits and nuts. Unfortunately, in order to make a transition from poppy to perennials, new saplings would have to be planted, and these new saplings would take several years to mature. In some cases, poppy can be grown underneath the trees while they are maturing, though this is not likely to generate high yields. Most farmers grow alfalfa or clover under and amongst the saplings in the early years, but these forage crops do not earn high incomes, although they are useful for feeding to livestock. It is not common to grow vegetables among the trees in the early years although it might be feasible.

Regarding the vegetables, a comparison of their productivity indicates a high degree of competitiveness vis-à-vis poppy. The principal vegetables, with their respective productivity rates, are displayed in the table below, and compared to both poppy and wheat. Note that all of these vegetables can be grown two to three times from February to November, and with low and high tunnels, a fourth time through the winter. This increases their income several-fold because prices in those off-seasons are more than doubled.



This chart shows that the perennials earn slightly more than the poppy, though there are some caveats. It takes at least four years for the 2-year-old saplings to reach full maturity in production. Most farmers cannot wait this long, and will look to grow poppy or other crops during this period. Secondly, the fruit and nut trees are harvested during specific time periods in the summer and fall. Very little maintenance labor is required during the growing period, and no other income is generated accordingly. However, the vegetables can be grown in three to four different time periods. The data presented is for the summer period – June to September. But if a seedling is produced in February for transplanting in March, a crop can be harvested in May. In May the prices are 3-5 time higher than in the summer - 50afs/kg compared to 10afs/kg. The same is true for the fall, planting a seedling first of September.

In this case, the vegetables would earn up to five times the numbers presented above. And then if a high or low tunnel is provided, another rise in expected income would be generated. Hence, the open-field vegetables would represent the best option for producing competitive crops for poppy, even though they are produced, for the most part, during the spring, summer and fall, which is the off-season to poppy. The additional income this system could generate - assuming that it would be sustainable - would presumably put farmers in a strong position to willingly desist from growing poppy, due to the significantly higher incomes from vegetables and the frequency of timing for receiving income (when selling the vegetables three or four times a year). This represents commercial high-value agriculture for small holders, and has been initiated in Afghanistan under a number of past donor projects over the years, including most recently with the RADP programs.

In addition to the economics of alternative crops, there are a number of additional reasons cited for growing poppy, or refraining from engagement in poppy production. Key factors are listed below, which reflect both our desk review and interview results.[15]

<u>Key Advantages:</u>

- Poppy acts as an insurance policy, it can be virtually grown anywhere, is not perishable and hence can be kept for some time without deteriorating, and cover household expenses when all other sources of income disappear - because the market is always there.
- Poppy is labor intensive and generates employment income in an economy persistently characterized by extremely high rates of unemployment. Labor can be employed in poppy for harvesting and not interfere with labor for other agricultural pursuits if properly programmed (end of April).
- Poppy distributors provide ample access to credit – credit is offered for poppy production in October or just before the harvest, and it can be used for production inputs and other household uses. Also, investing in crops and fertilizers in one season can have an impact on the next and so forth, two, three seasons down the road.
- Poppy gives access to land for landless and land-poor households, by allowing them to sharecrop with landowners, or to rent-lease land from landowners.
- Poppy can grow where many other crops cannot grow – i.e. drought resistant and hardy.
- The high value of poppy allows farmers to purchase high-cost irrigation to become profitable.
- The wealthy are more able to grow poppy than the poor – due to larger land holdings, livestock holdings, and the number of males available to work in the fields – this makes them better able to withstand bans on poppy production by switching to other crops until the ban is lifted, or to cover losses if their crop is interdicted or destroyed (eradicated).

[15] These socio-economic constraints will be discussed more fully in Section V.

- Poppy incomes allow for bunding of the fields, which can seldom be afforded with other crops.
- Poppy allows for the most efficient user of water – and provides the highest returns per unit of water.
- Wealthy landowners can arrange more favorable sharecropping agreements.
- Programs linking alternative development support to bans on poppy have been undermined by lack of community trust that the public sector can/will deliver services which it has promised.

Disadvantages:

- Mono-cropping poppy over time degenerates the soil, reducing yields, increasing disease contributing to rapid salinization, and therefore driving down the water table; all of which leads to lower yields.
- Concentrated poppy areas drive up land costs, higher rents and lower sharecropping arrangements. The high cost of production with deep wells and other agronomic constraints, lessens competitiveness internationally.
- Poppy production is associated with lawlessness and dysfunctional social behavior; and therefore tends to be associated, ceteris paribus, with a certain level of social opprobrium at the community level.

3. CURRENT STATUS OF PRODUCTION NATIONALLY AND REGIONALLY

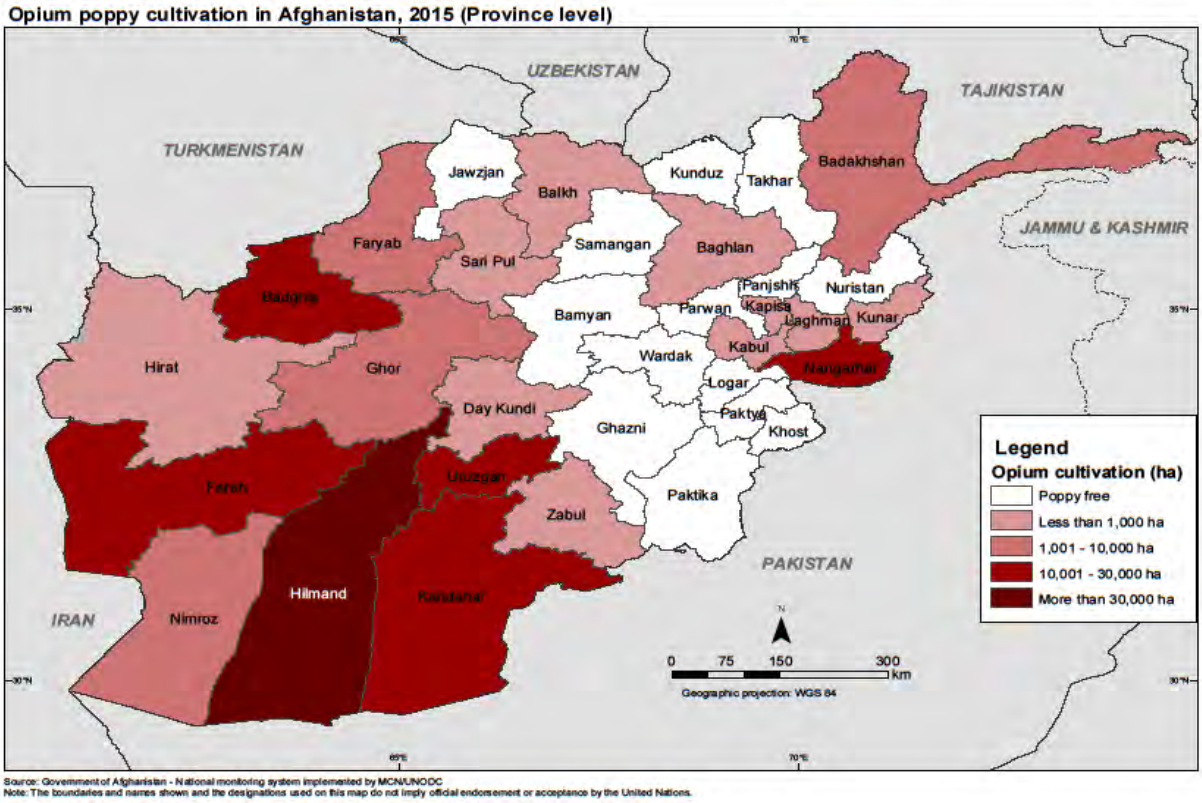
Section II has shown the statistics on the production of poppy on a national scale, and has demonstrated that three regions account for over 90% of total production. This section will break down these figures by province and present maps showing the areas of principal concern with respect to poppy production. To demonstrate the geographic location of poppy production, the UNODC has broken the country down into six regions – Southern, Western, Eastern, North-eastern, Northern and Central, in order of importance and poppy acreage for 2015. The table below presents their poppy acreage.

Regional Poppy Production

Region	2014 (has)	2015 (has)	2015 (% of total)
Southern	149,711	119,765	66%
Western	49,049	44,308	24%
Eastern	20,353	12,242	7%
North-eastern	4,253	4,056	2%
Northern	738	1,875	1%
Central	233	321	.2%
Rounded Total	**224,000**	**183,000**	**100%**

Within these regions there are certain provinces that are more concentrated poppy producing provinces than others. Eight provinces account for about 96% of the poppy production. In the Southern Region, Helmand is the most prolific with 86 thousand hectares, followed by Kandahar with 21 thousand hectares. Uruzgan, also in the Southern Region, allocated 11 thousand hectares to poppy in 2015. In the Western Region, Farah had 21 thousand hectares of poppy, and Badghis had 12.4 thousand hectares of poppy; while Nimroz had 8.8 thousand hectares of poppy. In the Eastern Region, Nangarhar saw 10 thousand hectares devoted to poppy production, and in the North-eastern Region, Badakhshan had 4 thousand hectares of poppy.

Given this distribution of poppy production, a focused program aimed at the Southern and Western regions could easily cover over 85% of the area currently dedicated to poppy. The map below shows this concentration and how contiguous the southern provinces are located in relation to each other.



This map clearly indicates that the major areas which would need to be addressed by future Alternative Development programs are those areas in dark red – namely Helmand, Kandahar, Farah and Uruzgan, and two isolated provinces of Badghis and Nangarhar. The rest of the areas appear to exhibit minimal poppy production, although any number of them could be receptive to the 'balloon effect' at a particular time. It should be noted here, that Badghis is part of the Western Region, and hence ostensibly covered by the RADP-W program of USAID, but has seen its security deteriorate in recent months, such that Government access is limited. On the other hand, Nangarhar is the other dark red province, and its situation is marked by a complex political power struggle as depicted in the recent article by David Mansfield, "From Bad They Made It Worse"[16].

In spite of this rather concentrated area where poppy seems to flourish best, there seems to be enough inconsistencies in the explanations and analyses to suggest that a focused and geographically targeted approach is required for each area identified above – Southern, Western and Eastern, and other pockets that might pop up such as Badakhshan.

[16] "From Bad They Made It Worse", David Mansfield, AREU, 2014, Kabul, Afghanistan.

4. ANALYSIS OF KFZ MAPPING SYSTEM

The analysis included in this chapter provides a summary assessment of the Shamal-Based Crop Measurement/Mapping System being utilized under the USAID-supported KFZ Program. In this regard the consulting team was asked to assess the prospective accuracy/validity of the methodological approach utilized by the Shamal System to measure crop production changes over time. With regard to the accuracy of crop measurement numbers, the consulting team discussed with KFZ and analyzed related documentation on the methodological approach which that program has utilized to measure poppy production in Kandahar over the 2014-15 period. The results of that analysis are summarized below:

KFZ-Crop Classification Methodology

The report KFZ – Crop Classification Methodology (KFZ-CCM) outlines the methodology designed and developed by KFZ program to extract crop data from multisource imagery, using remote sensing and GIS techniques combined with data manipulation processes. Specifically, the KFZ document describes the semi-automated image classification method using different algorithms and databases along with field survey data.

The image classification and information extracting procedures outlined by KFZ-CCM is broadly categorized into Phase 1, that utilizes ArcGIS mapping software to implement both supervised and unsupervised classification tools; and Phase 2, which implements information extraction procedures within FME to transfer classified raster output information produced in Phase 1 to the land parcel vector data.

Phase 1 image classification is implemented as a simple supervised classification procedure. It is based on the **Maximum Likelihood Classifier (MLC)** as the decision rule to classify and categorize image pixels to the different classes, based on reference data available through the KFZ Field Parcels boundary data with the Field Survey Data (April 2015).

Phase 2 of the KFZ-CCM provides a description of the procedure to transfer the raster output information generated from Phase 1 to the vector data file i.e. the land parcel boundary layer. The procedure is implemented within FME to first convert the raster pixel information into points. These points are then aggregated and summarized based on a majority rule to determine the single crop cover type that can be transferred to the vector parcel polygon using a simple tabular join.

Review of the KFZ Methodology

The KFZ-CCM outlines the implementation of the MLC as the decision rule to classify the image data into crop types. MLC is a robust and comprehensive image classifier that is widely used in diverse land cover mapping projects, producing reliable estimates of the spatial extents of the different land cover classes. Traditional mapping protocols over the past several decades have relied on the MLC to provide general estimates of broad land cover classes.

The simplicity and robustness of MLC is well-documented in the literature pertaining to mapping science involving both agricultural and forested ecosystems. Additionally, the positive qualities of MLC and its wide usage is primarily related to its utility for mapping broad and general land cover classes such as agricultural lands, fallow lands, forested areas, water bodies, urban environments, etc. For purposes of the KFZ project the mapping process utilized covers only three crops.

Evaluation of Supervised Classification Methods (Phase 1)
Overall, the supervised classification technique (MLC) implemented as proposed in KFZ-CCM is in general outlined well. However the original cited documentation which the consulting team reviewed lacked in providing specific details that are standard in any land cover mapping project involving remote sensing data. The key to successful implementation of the MLC algorithm is largely dependent on the training data and related procedures that ensure adequate analytical and statistical rigor in the reported results.

However, further documentation was subsequently provided in *Explanation of Crop Classification Methodology, Crop Classification Quality Assessment.* This, along with a follow-up teleconference discussion (2/22/2016) between the consulting team and the lead KFZ specialists implementing the Shamal tool, provided further important clarification of the methods utilized and the analysis conducted. As a result, the team has determined that the approach adopted and conducted appears in principal to be technically sound.

The specific details that needed clarification included:

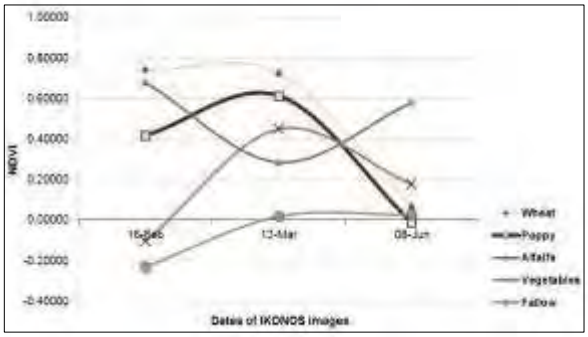
- Implementation of unsupervised and supervised classification
- Data resolution used. Approach to implement the visual analysis and the image classification using the high spatial resolution and high spectral resolution data
- Sampling protocol and the reference data collection and development for crop signature file
- Implementation of an accuracy assessment protocol – Error Matrix.

Based on the discussions and the additional information provided, the following conclusions were reached:

- The classification involved just three crop types – wheat, alfalfa, and poppy. The methodology implemented a visual assessment of the crop boundary using the 0.5 m WV2 imagery (RGB). Based on this visual analysis, about 830 polygons were randomly delineated and digitized.
    - Based on the regional study undertaken, 830 polygons appear to be satisfactory. A trained analyst should be able to distinguish the field boundaries.
- The identity of these polygons were established using a GPS field survey that resulted in a point reference data set. There were 293, 117, and 18 samples for wheat, poppy, and alfalfa respectively.
    - Using a field survey crew, the crop type identity and the GPS location coordinates were established to produce ground reference data, which is a valid protocol.
- About 30-50 points for each of the crop types were used to train the MLC for classification using the 10-m MS Imagery (WV2).
    - This is a statistically valid sample to use in the analysis; although it should be noted that the usual norm is to set aside half the reference data for training of the MLC algorithm, and to use the rest for validation. This way you have an independent sample set of ground reference data to validate the classification procedure.
    - The multispectral imagery was for the summer time (April 2015), and appears to be satisfactory and relevant (based on the quality assessment) to distinguishing just the three crops mapped.

- The classified output was further post-processed using the FME tool to summarize the different cover types within the parcel boundary. Classified output was visually verified using the all of the reference points collected.
    - It is a good protocol to evaluate the classified output against a dataset that was not used during the training/classification process. At the same time, it is worth noting that an accuracy assessment protocol should have been implemented using a simple Error Matrix that cross-tabulates the remaining 438 samples to the corresponding crop types mapped at those locations. This would greatly enhance the statistical rigor of the training data collected and consequently the MLC classifier performance in mapping the crop types.

Recommendations for Further Improving Crop Classification Methodology



As noted above the KFZ-CCM approach represents a valid and analytically rigorous crop measurement approach. At the same time there are further improvements to the system which could further enhance its accuracy at the margin, assuming time/resource availability. These are elaborated below:

Phase 1

The KFZ-CCM describes and implements a single-date image data for crop classification. **A spatio-temporal analysis** would be an alternate approach to map different crop types including poppy. The spatial extents of the different cover types could be mapped using remote sensing data collected from **at least two different time periods** that coincide with peak vegetative growth and maturity for major crops including poppy, within a year or season. This is something recommended by the UNODC-MCN satellite-based analysis of opium-growing areas in Afghanistan. The graphic illustrates the distinguishability of the opium crop from other crops in the region, and indicates a two date image acquisition and analysis, where February provides the maximum separation between wheat and poppy that seem to have similar cropping and phenological characteristics, based on the NDVI spectral response shown in the graphic.

- **A tiered approach** to image classification. This refers to a broad-level analysis to discriminate vegetated crop land cover from non-vegetated cover could be first implemented. In the next tier analysis, the non-vegetated pixels are "masked" out to focus only on the cropland pixels. This will greatly aid in the better training of the supervised classification algorithm and related signature file generation for the different cover types.
    - A simple vegetation index such as the Normalized Difference Vegetation Index (NDVI) could be used for the non-cropland vs cropland mapping separation. Based on the additional documents provided, it appears Landsat data was used for a preliminary analysis, but it is hard to interpret if croplands vs. non-croplands were distinguished, since details are not provided.
- **A hybrid approach** involving unsupervised and supervised classification would greatly help improve the mapping results by addressing the landscape vegetation heterogeneity. While this study has mapped only three crops using a visual approach, an unsupervised approach would have easily captured the heterogeneity for a more stratified sampling of the polygons in an automated manner. While the KFZ-CCM references using both the unsupervised and supervised techniques, it is not clear whether a combined analysis was effectively and comprehensively implemented.

The methods describe only supervised classification (pg. 11-13). Basically, a hybrid approach first implements an unsupervised classification to automatically generate a specific user-defined number of land cover classes (actually called "clusters"), which form the basis for the training and supervised classification procedure. The benefit of this analysis is derived from accounting for the heterogeneity in

the cover types, by using unsupervised classification, which groups pixels based on spectral similarity/dissimilarity.

Assuming improved image datasets at higher spatial and spectral resolution become available at regular intervals, such as Sentinel-2, WV2, then **advanced image classification techniques** should be implemented. Innovative and improved image classification techniques such as Support Vector Machines (SVM), Random Forest, and other decision tree classifiers are yielding higher levels of accuracy in mapping crop types. These machine learning algorithms are particularly useful when processing high resolution data sets. More so, these techniques are being implemented on operational scales by USDA, USGS and other agencies (Cropland Data Layer, croplands.org, etc.). Similarly, object-oriented classification techniques that combine spatial metrics such as shape, size and related ratios metrics with spectral metrics can provide more accurate measure for detailed crop types mapping based on image segmentation and classification techniques. While the steeper learning curve might be a negative point, these newer and advanced techniques are becoming popular in the open source software primarily for their capabilities to handle big data at higher levels of classification accuracies. Furthermore, SVM and other supervised techniques are available within ArcMap as well.

Phase 2

The FME method described and implemented in KFZ-CCM to transfer classification crop type information to the land parcel appears to be overly complicated. A GIS operation such as Zonal Statistics could be implemented to transfer crop type information, particularly the class value from the classified raster output to a vector.

- The zonal statistics function summarizes pixel data from a raster data layer based on zones identified in a vector layer. The summary includes statistics about the min, max, mean, minority, majority, range, sum, etc. for the group of pixels within each zone. Basically, the function calculates these statistics based on the cell values in the value layer (classified crop classification output, in this case) within each of the zones existing in the zonal layer (parcel boundary vector layer, in this case). The majority statistic provides the cell value of the most frequently occurring cover type within the vector zone (parcel polygon), while the count provides a number of cells, and the variety indicates the number of classes within each zone.
    - The output of the zonal operation is an attribute table that could be easily joined back to the attribute table of the vector parcel data file using the polygon ID as the primary key.
    - The issue of partial pixels intersected by the boundary file is to a certain degree accounted by some pixels getting included or excluded and can be assumed to balance off. Additionally, a resampling operation could be implemented when raster data are at coarser resolution (for example, 30-m Landsat data). But at the image resolution (0.5 m) at which the KFZ crop classification was implemented, the zonal statistics operation should provide good results.
    - Note: A Region Group tool should be run prior to running the Zonal Stats function. This grouping tool creates contiguous groups of cells with similar cell values.

Summary and Conclusions

The KFZ-Crop Classification Methodology document outlines the procedures to extract crop data including poppy from multisource imagery, using remote sensing and GIS techniques in combination with data manipulation processes. Phase 1 utilizes ArcGIS mapping software to implement supervised classification, while Phase 2 implements information extraction procedures within FME to transfer classified raster output information in Phase 1 to the land parcel vector data. In general the consulting team concluded that the approach adopted and conducted appears to be technically sound and to yield valid statistical results. In addition, the analysis has provided some additional guidance on further data

measurement and analysis refinements which could be adopted in future to further strengthen the crop measurement system.

Maximum Likelihood Classifier (MLC) is a robust and comprehensive algorithm implemented as a supervised image classification technique. Based on additional documents provided and a follow-up discussion, it appears the image analysis was conducted in a scientifically sound manner. Based on the random sampling sites to collect ground reference data, the training data is statistically adequate to implement the supervised classification procedure to map the three crop types.

However, to improve the MLC implementation, some of the recommendations for future land cover mapping include:

1. Implement an unsupervised classification prior to the supervised classification to establish landscape heterogeneity and guide the polygon selection and ground sampling based on a stratified approach, rather than a random approach.
2. A multi-temporal image data set to capture crop phenological differences would provide an ideal basis to distinguish poppy from other crops, particularly wheat, when compared to a single-date analysis.
3. Although an accuracy assessment of the crop classification was not required, it is a good and recommended practice to assess the rigor of the training process resulting in the classified output.
4. Furthermore, with the advent of image data at higher spatial, spectral, radiometric, and temporal resolution, more advanced and innovative machine learning algorithms such as SVM and Decision Tree Classifiers should be explored and implemented.
5. Phase 2 analysis could be better implemented within the ArcGIS environment using zonal statistics operations.
6. The existing approach can be enhanced by formally evaluating the classified output against a dataset that was not used during the training/classification process. This approach is considered a best practice. As a part of the formal approach, an accuracy assessment protocol should be implemented using a simple Error Matrix that cross-tabulates the samples used for evaluation to the corresponding crop types mapped at those locations. This would greatly enhance the statistical rigor of the training data collected and consequently the MLC classifier performance in mapping the crop types.

Overall the crop measurement approach adopted and conducted by KFZ appears to be technically sound. Although the classification error rate cannot be specified exactly from a statistical perspective, it appears to be less than 4% based on the information provided. In addition this has been supplemented by visual validation of 100% of the area covered by the program, through visual analysis of mapping data at the .5 meter resolution level. This yielded a correction rate of less than approximately 1%. Taken together, these empirical findings indicate that the color spectrum analysis-based crop measurement assessment process being carried out under KFZ yields sound and defensible results.

At the same time it should be noted that USAID continues to register concerns regarding the robustness and reliability of these results. As noted above, the failure to statistically validate the classified output against a dataset which was not used during the training/classification process meant that no error matrix could be calculated, which in turn limits the statistical precision of cross-tabulation results. In addition the degree to which the approach applied can accurately and precisely take into account/capture inter-cropping of parcels has been raised by USAID staff, most particularly within the context of pixel bleeding concerns related to colorized mapping imagery. Assuming that a determination is made to continue implementation of the Shamal system moving forward, it would be

advisable to undertake an independent M&E assessment of the methodological approach being applied, in order to further clarify/address as needed any remaining concerns.

5. TYPOLOGY OF PAST AD PROGRAMS

<table>
<tr><th>2002</th><th>2003</th><th>2004</th><th>2005</th><th>2006</th><th>2007</th><th>2008</th><th>2009</th><th>2010</th><th>2011</th><th>2012</th><th>2013</th><th>2014</th><th>2015</th><th>2016</th></tr>
<tr><td></td><td colspan="6">RAMP</td><td colspan="4">ASAP</td><td></td><td colspan="4">RADP-S</td></tr>
<tr><td></td><td></td><td colspan="5">ADP-N</td><td colspan="4">IDEA-NEW</td><td colspan="4">RADP-N</td></tr>
<tr><td></td><td></td><td></td><td colspan="4">ADP-E</td><td colspan="3">AVIPA</td><td colspan="2">SRAD</td><td colspan="4">RADP-W</td></tr>
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<tr><td></td><td colspan="7">MISFA - Micro-finance Coordinator</td><td colspan="7">FAIDA</td></tr>
</table>

The chart above lists USAID's portfolio of agricultural projects since 2002 in Afghanistan. Though not exhaustive, it includes priority/major projects with some AD focus over that period. Of those shown, over $2.2 billion has been spent on these projects, of which over $800 million came from Alternative Development funding.[17]

The first post-conflict USAID-supported effort of note was implemented by the Central Asian Development Group (CADG), and was responsible for importing Acala cottons from Arizona, which helped improve the quality of Afghan cotton. The first major project, however, was the Rebuilding Agricultural Markets Program (RAMP-2003-2006). The most important thrust of the project was on basic grain productivity enhancement and production expansion, as it focused first and foremost addressed the issue of 'food security'. Wheat was seen as the most important agricultural commodity, with the ability to both meet household consumption needs and drive expanded sales/income, all within the context of relatively limited technology/transfer cultivation practice enhancements. In addition the program incorporated several sub-contractors to carry out 'task orders' for implementing infrastructure rehabilitation (roads, reservoirs, irrigation canals, dams and bridges), as well as the United Nationas Food and Agriculture Organization (UNFAO) Village Based Seed Enterprises program (which established 30 or more seed companies to produce high-yielding, certified wheat seed from ICARDA foundation varieties).

At the same time, RAMP maintained a secondary focus on grape production (Roots of Peace), including marketing fresh grapes to India and processed grapes into raisins (CADG in Kandahar plus an American-Afghan from Colorado in Charikor, and several others around the country, especially in Kabul). Development Works Canada established a dried vegetables factory, also near Charikor, to dry vegetables for the European 'Cup of Soup' industry, with monthly container-sized exports. Protected agriculture with high and low plastic tunnels was introduced by ICARDA in Helmand and Nangarhar for vegetable production, and cold rooms for packing centers were imported from Argentina and distributed around the country.

[17] Data for some of these projects, such as MISFA, AWATT (which is Watershed Development and not AD), ARIES, AAEP I,II (originally USDA, then USAID, for agriculture research and extension), SIKA-West, East, South and North – governance projects) and AFSA (Farm Stores of CNFA), was not available at the time of this report.

The Dutch Committee for Afghanistan (DCA) started the well-known Veterinary Field Units, with paravets to diagnose and treat animals, with medicines available in the field. RAMP financed several micro-finance activities through the Microfinance Investment Support Facility for Afghanistan (MISFA), the World Bank umbrella and coordinating facility. Other financing activities included grants for agribusinesses and leasing to the AIB and AFC, respectively, of $2.5 million each. Several other high-valued crops were promoted during the project, and the staff of RAMP were then disbursed throughout all of the ADPs, ALPs, RoP and ASAP, as they continued to promote wheat and to some degree high value crops. Their work is evident in the value chain studies and crop production profiles prepared for those projects, many of which are still referenced today by RoP.

The ADPs and ALPs started during the period of RAMP, and were located in the South (Helmand), East (Nangarhar), Northeast (Badakhshan), and Southwest (Farah). These were specifically planned as AD Projects that were subsequently re-defined as Alternative Livelihoods Projects. For this reason, they were located in the heart of poppy provinces. Their objectives were to induce crop substitution. As mentioned above, at that time, most development experts believed that wheat was the major competitor for poppy since it was grown at the same time, October-November to April-May. However, in addition to wheat, the ADPs/ALPs focused to some degree on [18]high value crops as well - fruits, nuts and vegetables. Significant reports of vegetable and fruit/nut tree production can be found in their final reports.

Roots of Peace (RoP), the implementer of the current CHAMP project, received a large grant from RAMP to initiate their patented work in grape production, based on their work in Eastern Europe where farmers whose fields had been demined, requested assistance in production. In collaboration with UC Davis, they introduced T-trellising for grapes throughout the country. Although turning a bush vine or mud slope field into trellising can dampen productivity for one year, and with the costs of the concrete T-trellising being upwards of $5,000 per hectare, they persevered and have been quite effective in transforming the vineyard system of Afghanistan which is traditionally mud slopes, into several hectares of trellises. Roots of Peace have been working continuously in Afghanistan since their days with RAMP, managing the successful CHAMP project, which not only promotes grapes and other fruits but also vegetable production and (more recently) export-focused value chain linkage activities.

In parallel to the agriculture-focused projects, there were a series of finance-oriented projects. MISFA began in 2004, and RAMP contributed several million dollars in financial support through 9 to 12 micro-finance entities. ARIES followed (Agriculture, Rural Investment and Enterprise Strengthening program implemented by AED) with support provided through several micro-finance subcontractors, and eventually ACE (Agricultural Credit Enhancement project managed by DAI) established and implemented the Agricultural Development Fund ADF) of MAIL, which continues today. One of the key lending activities of ADF is its window for Islamic Funding, approved under Sharia Law. Four instruments are available, and almost 50% of the ADF portfolio falls into these categories.

- Restricted wakala - typically applied to production
- Murabaha - used for raw materials, tools, and machinery
- Ijara - equipment lease
- Salam - advances in the context of contract farming

However this instrumentality, as with those referenced above, has not thus far focused in any significant manner on lending activities to farmers engaged in alternative development related activities. The

[18] A notable finding in the AD literature on Afghanistan, also reported elsewhere, is that work of these projects may well have contributed to forcing landless laborers and sharecroppers out of the principal producing areas of the Herat and Farah provinces and into area north of the Boghra Canal in Helmand, and the Bakwa area of Farah. Nangarhar was poppy free in 2011, and then restarted poppy production, within the context of a badly deteriorating political and security environment.

Financial Access for Investment in the Development of Afghanistan (FAIDA) program is an umbrella facilitation and promotion project, implemented by Chemonics, and has focused on defining and working to address critical policy/institutional constraints limiting sustainable access to finance, and developing related financial access outreach strategies with progressive partner institutions (e.g., AIB). All of these projects, to one degree or another, have supported provision of financing for farm production, input supply, marketing and (to some degree) agribusiness processing.

Overall agriculture and agribusiness financing remains woefully underdeveloped in Afghanistan, and most commercial banking institutions essentially eschew agricultural lending and client outreach activities. For the most part the programs which have been implemented thus far have not been geared towards and have not succeeded in shifting the market focus and the risk perceptions and management strategy of existing commercial finance institutions – or succeeded in developing new market-focused institutions - in a manner which could promote a major increase in competitive access to finance for farmers and other rural families in traditionally under-served/un-served areas. Moreover these programs have had little interrelationship with the on-going Alternative Development or Agriculture Programs of USAID's portfolio, except for the RAMP project, which provided financial resource transfers through subcontractors embedded within the RAMP project (which served a short-term purpose, but of course predictably generated its own sustainability and replicability issues).

The ASAP Program was in some sense a follow-on or extension of RAMP. ASAP place a more pronounced focus on value chain activities and marketing, but also promoted production with their Badam Bagh (MAIL Research Farm in Kabul) and related focus on fruit trees, low tunnels and high tunnels. However in 2007-8, after the country experienced a severe three year drought - which decimated the livestock herd and left the majority of farmers with little or no wheat seed to plant for the ensuing year – the focus shifted more intensively back towards basic grain production. This situation was further complicated by the fact that the international price of wheat skyrocketed during this period, causing the local price for wheat seed to jump over US$.60/kg. Within this context the AVIPA Program was initiated in the fall of 2008, and provided one acre of wheat seeds and three bags of fertilizers to 297,000 farmers, covering 71,280 hectares, spread across the North, East and West of Afghanistan, all for a minimal co-pay of 15%. Planting adoption was initially over 90% according to project records, and follow-on replanting of the saved open-pollinated seeds was reportedly 60% and 30% in succeeding years.

The initial AVIPA was financed by Disaster Relief funds of roughly $60 million, but before the project was terminated, an additional $300 million was added for an AVIPA Plus 'voucher' program in the south (Kandahar and Helmand), as a component of broader 'counter-insurgency' programs. With DFID the primary institution charged with wheat seed distribution, the AVIPA Plus Program implemented a 'non-wheat' seed distribution and application support initiative.[19] Elsewhere the AVIPA Plus North continued wheat seed distribution activities in the entire country with 366,000 farmers, covering 109,711 hectares. When AVIPA Plus was further extended, wheat seeds were distributed through the NSD (National Seed

Distribution program) of MAIL for 254,000 farmers covering 93,082 hectares. AVIPA Plus South covered 74,000 farmers in Helmand and 184,000 farmers in Kandahar with these non-wheat voucher packages, covering 47,000 hectares and 106,000 hectares respectively. The follow-on project, SRAD - $79 million, implemented in Kandahar and Helmand only - planted 48,000 hectares of 'non-wheat' seeds. AVIPA Plus and SRAD were 70% financed by AD funds, but the initial thrust was 'disaster relief' in the north, east and west, focused again on wheat. AVIPA Plus South and SRAD were focused on non-wheat

[19] Melons (musk melon and watermelon), corn (2 acres), okra, mung beans and black-eyed peas, barley, alfalfa and clover, and spring vegetables (tomato, cucumber, eggplant, spinach, radish, spring onions, carrots and bell pepper), and fall vegetables (spinach, radish, cauliflower, carrots, turnip and red onion).

crops. In Helmand, low tunnels were added to the vegetable voucher package. This innovation was extremely well-received, and low tunnels can be seen all over central Helmand. Fruit and nut tree saplings and vine cuttings were originally to be distributed as vouchers, but ended up being a distribution by the cash-for-work program as a direct benefit to farmers. The U.S. military in Kandahar asked the AVIPA Plus South project to assist in pruning the pomegranate trees, especially in Arghandab District.

Approximately 72,000 jeribs were pruned with a 10 to 20 kg/tree impact. The farmers then asked for saplings for their old trees to rehabilitate their orchards. Over 700,000 saplings were distributed the first year of AVIPA Plus South in Kandahar and another 500,000 during the one-year extension. Under the follow-on project, SRAD, another 1 million saplings were planted between Helmand and Kandahar. Overall, the adoption rate for the non-wheat seeds was over 80%. When the farmers in the focus group who reported they had received some of these trees were asked about survival rate, they reported mortality of perhaps 20%. In August of 2014, Rozuddin Ayazi reported that there was a pomegranate boom in Kandahar as a result of this program, and that farmers were earning sufficient money from pomegranate sales that they were able to steer clear of engagement in poppy production.[20]

As noted earlier, the AVIPA Plus South and SRAD projects appear to have contributed to the abrupt decline in poppy recorded for 2009-11 (presumably along with the major increase in wheat prices, and the influence of the surge and related state presence factors. Over this same period IDEA-NEW, a $150 million dollar project, supported increased production and improved storage/marketing for wheat, grapes, orchard crops, vegetables, poultry, silk, honey and karakul skins.

The more recent Helmand Food Zone and Kandahar Food Zone (HFZ & KFZ) projects have received significant attention, and the combination of and illicit crop technology transfer/cultivation practice and irrigation infrastructure support activities appear to have been successful in developing substitute crops and reducing poppy production in the central areas of Helmand, as well as in Kandahar (principally in Zahri and Panjwayi districts). However in Helmand this has contributed as well to propelling landless farmers out to the north of the Boghra Canal area, where poppy production dramatically accelerated subsequently. The HFZ Program was implemented within the context of a ban on poppy by the Governor, which added to the impact of poppy reduction. These two projects were funded with AD resources.

The Regional Agricultural Development Projects (RADPs – North, South, and West) have a significant degree of funding from the AD account. However, the major objectives outlined for the projects do not address anti-poppy activities directly. Nonetheless, it is intended that by having a strong impact on the core licit cropping activities covered under these programs, they will have a significant indirect impact on reducing poppy production, by providing an alternative set of crops, along with selected value chain activities to help get the products to market. However the strongest emphasis appears to be on wheat, with over 70% of the funding of each RADP. Since as noted earlier it has been amply demonstrated that wheat does not compete directly with or effectively against poppy, the prospective effectiveness of such an approach is clearly open to question.

The second core focus is on horticulture, which reportedly receives around 20% of the funding. This is broken down into perennial crops and annuals. The third area of focus is livestock, and most of the RADPs have chosen to concentrate here on small ruminants, although potential opportunities may exist as well for milk and other by-products to be addressed, such as cashmere, wool and leather. RADP-S and RADP-W have placed a priority emphasis as well on demonstration farms (78 demonstration farms in all four provinces of RADP-S, and both women's and men's demonstrations for vegetables in RAD-

[20] Ayazi, Rozuddin, "Pomegranate Boom in Kandahar", Institute for War and Peace (IWPR), August 2014.

W); including for high-valued vegetables – using seedbeds and seedlings, staking and trellising, raised beds and furrow irrigation, over-winter open-field production of garlic, onions and other leafy vegetables, and also low and high tunnels for full-term vegetable production over winter. Growing vegetables in high sequence, up to four or more times/year depending on their growth cycles (some are every 30 days - radish, spinach, cress, coriander, and 45 days for tomato, bell pepper, cucumber, green beans and eggplant on stakes from seedlings), can lead to incomes/year of over $20,000/ha, which would be extremely competitive with annual poppy returns. Inter-cropping of vegetables with perennials during their maturation stage could also be extremely profitable.

RADP-S and RADP-N have been in operation 2 years, while RADP-W has been in place for 11/2 years. it is worth noting that these programs appear to have shifted back towards a relatively heavy focus on wheat, which as we have underscored is not likely to be a strong competitor with poppy under most circumstances (this may have to some degree been impacted by MAIL's post-drought focus on moving towards "self-sufficiency" in basic grain production). The demonstration farm and related storage/distribution support activities of these programs could potentially have a significant impact on dis-incentivating engagement in illicit activities, if these were to be more intensively targeted towards major poppy production areas. In this regard the scope of these projects could be adjusted somewhat to have a more direct impact on alternative development objectives, as will be discussed in greater detail in the section on Pilot Recommendations below

6. CORE LIMITATIONS OF PAST AD PROGRAMS

The Pragma Team undertook a thorough review of past descriptive literature on AD programming in Afghanistan, including by noted regional experts such as David Mansfield, Richard Brittan, Paul Fishstein, and William Byrd. Team members also conducted detailed interviews with leading researchers, key past and current AD practitioners, and with a range of major private and public stakeholders involved in AD programming decisions and/or implementation activities. Major GIRoA interlocutors included a number of MAIL officials involved in AD strategy formulation and activity management, and past and present officials in the MCR.

In addition team members conducted three major focus group discussions in Kandahar with a group of farmers from Helmond province, a group of farmers from Kandahar, and a group of agricultural value chain agents and market intermediaries from Kandahar and Helmond. From all of these discussions, as well as from our team's related analysis of analytical review documents, we have developed a focused analysis of major strategic and operational limitations of past AD Programming approaches, which would need to be addressed within the context of developing and implementing initiatives with more scale-able and sustainable impacts. These are summarized below:

Lack of State Presence/Fragile Security Conditions: The absence of legitimate and trusted state institutional presence in the rural areas targeted for AD activities was identified as a crucial constraint by all stakeholder groups interviewed by the Pragma Team. Virtually all private sector stakeholders interviewed expressed a vehement lack of confidence in the readiness of local, district and national level state institutions to support AD objectives and transparently and competently provide complementary support services. It is worth emphasizing that there was as well a clear lack of trust exhibited in the readiness of state institutions and local police officials to transparently enforce prohibitions on illicit production; and there emerged a 'real-politick' sense that significant public sector engagement in illicit production/distribution networks remains an open institutional sore. At the same time the team gained the sense from virtually all public and private stakeholders interviewed that rural producers are subject to strong pressures from extra-legal forces – both terrorist groups and criminal gang influences (including those with links to state institutions) – to become or remain engaged in illicit production activities.

This institutional maelstrom creates an exceptionally challenging institutional environment within which to try to convince agricultural producers operating at the margin of socio-economic survival to incur the risk associating with transition away from illicit activities. It became very clear in this regard, particularly in our focus group interviews with farmers from Helmond and Kandahar that a major credibility gap exists in this area which will need to be addressed if future AD programs are to succeed on a sustainable basis. This was actually recognized as well by public sector stakeholders, further underscoring the criticality of building into future AD initiatives a tangible focus on efficient and accountable state engagement as a core partner in AD programming – again both from an ancillary service provision and from a transparent enforcement perspective.

Lack of Long-Term Programmatic Focus: The AD programs implemented over the past dozen years have in general tended to lack a consistent longer-term strategic focus. The programs have not been based of an integrated analysis of competitiveness constraints and opportunities and the pre-conditions for long-term sustainability of alternative livelihood options. Instead they have tended to focus on shorter-term approaches largely focused on crop substitution, and related agricultural input supply provision and cultivation practice and storage training activities.

In addition programmatic support has often continued for one or two growing seasons and then been terminated, with limited market linkage development and sustainability impacts. This has also generated an unintentional and worrisome 'demonstration effect' impact on farm groups, which have come to question the staying power and commitment of donor and GIRoA-sponsored AD programming activities.[21] Frequently the project vehicles through which AD Programs are implemented have had short 2-3 year life-spans – clearly inadequate to the task of fomenting sustainable stakeholder commitment to transitioning permanently away from engagement in illicit activities.

Likewise, the heavy focus on basic grains (wheat) as the major alternative to poppy reflects a focus on short-term crop substitution with poor competitiveness vis-à-vis poppy. The strategy of focusing primarily on substituting basic grains for illicit crops has failed at the international level on a consistent basis. As noted earlier crops such as wheat do not generate an income stream that is competitive with illicit production - unless grown on large farms with mechanization and first-world inputs and practices which are beyond the capacity of smaller-scale farmers (and which is also less labor-intensive than poppy production).

As a result it has proven difficult to permanently supplant poppy production with wheat, and there is significant anecdotal evidence indicating that many farmers who have participated in past AD programs have continued to devote portions of their parcels to poppy production, even as they have participated in wheat production-focused AD initiatives. As focus has progressively shifted towards support for production of higher value annuals, at times inadequate attention has been paid to the potential complementarity of these crops with poppy, and anecdotal information indicates that at times this has resulted in rotational cropping of poppy with annual crops supported under AD programs. In addition it appears that the provision of agricultural input supplies (e.g., seeds, fertilizer) to farmers under AD programs has not infrequently been diverted into poppy production.[22] These types of outcomes underscore the lack of systemic planning which has at times characterized past programming activities. These have often been implemented with an (eminently understandable) sense of urgency to address an immediate need – to provide an immediate income generation and consumption stabilization alternative to poor farmers in geographical areas vulnerable to illicit production activities – but without taking adequately into account the market and institutional preconditions for sustainably incentivizing farmers/farm groups to turn away permanently from participation in illicit activities.

Similarly there has been inadequate consideration of 'second-round' effects of AD programming activities – most particularly the familiar and previously referred to 'balloon effect' impact of reduced poppy production within a particular intervention zone. As detailed in-depth by Mansfield[23] and other researchers, major poppy production zones such as Helmand and Nangarhar have witnessed major 'counter-surges' in poppy production in hinterland areas, following intensive and seemingly successful intervention efforts to transition from poppy to licit crops in the more fertile agronomic sub-regions of those provinces. These developments underscore the inherent limitations of an intervention schematic which is more or less exclusively focused on short-term crop or cash-flow substitution impacts in prime agronomic zones in a given region.

These approaches in turn do not take adequately into account the prospective impact that skewed land access patterns, and decreased demand for sharecropping labor, may have on incentives for farmers to engage in illicit activities in areas outside the immediate 'zone of influence' of AD programs. Nor do they

[21] This was commented on in both a number of individual interviews and during focus group discussions.
[22] These phenomena have been widely referenced in research articles on alternative development experience in Afghanistan, and were specifically noted as well in a number of stakeholder interviews conducted by the Pragma Team.
[23] "From Bad They Made it Worse, The Concentration of Opium Poppy in Areas of Conflict in the Provinces of Helmand and Nangarhar," David Mansfield, Afghanistan Research and Evaluation Unit, May 2014.

incorporate into their program planning analysis intervention mechanisms which would be designed to 'intercept' or at least mitigate these pressures, for instance through examining prospects for enhancing licit farming opportunities in hinterland areas, and/or expanding off-farm employment options. This underscores the core constraint associated with narrowly focused short term crop substitution initiatives: By looking at the farm unit rather than the village or sub-regional economy and polity as the basic unit of intervention, they abstract away from the complex of socio-institutional and economic forces that must be analyzed and addressed in order to (1) avoid or at least minimize perverse secondary incentive effects from program interventions; (2) facilitate broad-based stakeholder buy-in/commitment; and (3) create a self-sustaining economic growth dynamic at the sub-regional level.

Inadequate Focus on Core Infrastructure Needs: Many prior AD programs have not focused in a sufficiently intensive manner on integrating infrastructure service provision needs into their menu of core services (major exceptions including RAMP and the current KFZ Program). This issue was singled out by virtually all private and public sector stakeholders as a critical AD programming need, which when absent significantly inhibits the impact and sustainability of these efforts. Most particularly, the absence of targeted support for improved irrigation facilities and related water management/harvesting techniques and practices has at times hampered capacity to promote sustainable transition to higher value crops. The incorporation of this program element in the KFZ program was consistently highlighted by stakeholders as critically important from both a productivity enhancement and a stakeholder buy-in perspective.

Other critical infrastructure service provision areas, including secondary road construction/ maintenance, electricity/alternative energy facilities (e.g., solar panel interventions), cold chain capacity, and low-tech storage facilities, were also cited by a range of stakeholders as critically important under-emphasized elements in many AD programs. While it is clear that USAID agricultural development programs have at times placed emphasis on interventions of this nature, it does not appear that these have been coordinated in a manner which has specifically targeted their application towards intended AD beneficiaries. This in turn has both reinforced the tendency to focus predominantly on low-tech basic grain oriented alternative cropping strategies, and simultaneously limited the income generation and overall economic integration impact of AD initiatives.

Inadequate Focus on Value Chain Development/Off-Farm Employment Opportunities: The lack of an 'integrated' AD programming focus is also reflected in the failure to sufficiently incorporate robust value chain linkages, and to build a related focus on off-farm employment opportunities, as a critical element in most AD intervention approaches. AD programs have typically focused intensively on development of quality management approaches/systems, cold chain linkages and related investments, agro-processing facilities, and related market development/access strategies and time-framed game-plans. While this type of intervention approach represents a very tall order within the current fragmented and uncertain institutional context found in Afghanistan, nonetheless the fragmented nature of efforts to move in this direction is somewhat striking, in light of the importance of leveraging viable longer-term income and employment generation alternatives to illicit activities.

This has in fact been commented on by virtually all groups of stakeholders consulted by the Pragma Team. The recent increase in emphasis on annual and perennial crops in fact will in all likelihood prove very difficult to sustain and further accelerate in the absence of more intensive and focused efforts to define and address key policy, institutional strengthening and informational constraints to value chain development in these sub-sectors. Leveraging additional investment and effectively promoting enhanced market linkages which drive demand-pull effects at the farm and village level will prove critical to the

longer-term viability of AD efforts, and to avoiding the 'market-glut' phenomenon which appear at times to have short-circuited efforts to transition towards high value crop production in Afghanistan.[24]

More broadly, the absence of a more intensive focus on off-farm employment opportunities has significantly hampered the efficient design and sustainable execution of AD initiatives. As noted earlier past AD programs have in general failed to examine the competitiveness constraints/potential at the village and sub-regional level. As a result they have not looked proactively at opportunities for creating sources of labor market-pull demand which would drain-off agricultural sharecropping labor which may otherwise be vulnerable for engagement in illicit activities (other than occasional one-off cash for work programs, which are unsustainable). This type of approach is effectively intertwined with value chain development strategy formulation and institutional linkage activities, and its absence has significantly weakened the longer-term viability of past AD efforts.

Urgent Need for Expanded Research/Extension Services which tie in to AD Crop Production, Marketing and Processing Capacity: AD programs have traditionally lacked an integrated focus on development of permanent informational provision networks between AD program beneficiaries and sources of expertise. This includes critical areas such as agricultural input supply management, cultivation practices/techniques, low-tech storage and practical cold chain technologies/applications, and market information systems. In this regard little progress appears to have been made towards improving basic plant health knowledge, developing certified seed and root stock testing facilities and dissemination networks, and improving foraging technology application and management systems. It appears that more progress has been made in developing/introducing green-housing technologies/systems on a limited basis. However these technical/training support activities have not necessarily been established as core elements of AD intervention strategy.

Perhaps most importantly, despite past support efforts insufficient progress has been made towards establishing a viable network of MAIL agricultural extension offices regionally, and the strategy for operationalizing these and targeting the related provision of outreach services has not been tied in any meaningful/specific way to AD programs and goals at the sub-regional level. This is a gaping hole in the design and execution of AD programming (noted quite explicitly by the head of extension services in MAIL), which needs to be expeditiously addressed, if AD interventions are intended to have more than a stop-gap impact. The inclusion of these elements in an integrated AD intervention toolkit could prove critical form the perspective of both reducing farmer risk in transitioning to licit crops (particularly higher value crops), and creating the type of sub-regional institutional linkages between key public service provision institutions and program beneficiaries that could build crucially needed social capital and buttress stakeholder buy-in. Within this context it is important to note that the research and extension agenda will need to be moved beyond its current heavy focus on basic grains, to emphasize stronger support for high value perennials and vegetable annuals.

Lack of Focus on Financial Access/Investment Leveraging Support Efforts: AD Programming has yet to incorporate and integrate sustainability-oriented focus on improving access to financial resources. This is a glaring deficiency which has crippled efforts to encourage greater risk-taking and shifting to higher value (most particularly perennial) crops on the part of farmers/farm groups. Given the operating and (in some instances) capital financing requirements needed for purposes of permanently shifting out of illicit production and into licit, higher value cropping activities, it is fundamentally important that robust program vehicles be developed that work towards the establishment of effective and sustainable linkages between program beneficiaries and market-based financial service providers. [25]

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[24] A point consistently emphasized both by researchers and by private sector stakeholders interviewed by the Pragma Team.
[25] Focus group participants put an extremely high emphasis on the absence of access to finance support as a source of frustration and a key constraint on readiness to participate in AD programs.

In the absence of such linkages, past AD programs have had at times to resort to ad-hoc service delivery mechanisms such as one-off giveaways of agricultural input supplies, and storage facility grants; in order to encourage program participation. While understandable as short-term program engagement incentives, these types of initiatives do not contribute to the development of sustainable agricultural service delivery networks, and indeed may, at times, serve to further inhibit the evolution of such networks. Within this context it is critically important to develop innovative approaches (e.g., agency/branchless banking, mobile banking, second tier-banking relationships) which can facilitate the cost-effective and agile provision of financial services to the isolated rural regions which are the focal point of AD programming.

It is also important to establish strategies for leveraging needed private investments into agricultural input, agro-processing and cold chain networks in a manner which will help promote the long-term viability of the shift towards higher value crops that AD programming has become increasingly focused on. There has been up until now somewhat limited focus on such initiatives under AD-relevant projects. Limited efforts seem underway at the moment to identify potential regional or diaspora sources of investment in the agribusiness sphere, and that could be tied to the planning/implementation of targeted AD initiatives. Again the difficulty of financial access and direct investment leveraging under the fragile institutional circumstances which have long characterized Afghanistan is hard to overstate. At the same time it is virtually impossible to envisage successful sustainable achievement of AD transitioning objectives without the inclusion of agricultural producers within formal financial intermediation service networks; without the development of at least rudimentary value chain financing mechanisms; and in the absence of strategic investment leveraging efforts which can help ensure a strong demand-pull effect for producers transitioning into higher-end licit production activities.

Fragmentation of Programmatic Support Efforts: When reviewing the description of core constraints presented above, it is startling to observe that most of the areas referenced above (e.g., rural infrastructure, extension services, agribusiness finance) include agricultural/agribusiness-relevant service provision areas in which USAID programs have to one degree or another been focused over the past decade, at times quite intensively. However what tends to stands out in this regard is that these programs have not been undertaken in a manner which has *effectively integrated* them into the pursuit of AD objectives. As has been commented on not infrequently in the AD literature of Afghanistan, at times agricultural and rural development programs have been conceptualized and implemented in a manner which has run almost parallel to the pursuit of AD goals and objectives in the same geographical areas. For instance in the case of the RADP-S Program, it reportedly has received approximately 15% of its overall funding from AD sources.

This puts the program in an extremely challenging position in terms of gearing its core service provision instrumentalities (which center around its demonstration farm programs), in a manner which can drive major AD impacts at the local and sub-regional level. Similarly the ADF program is geared towards facilitating financial access support for viable agriculture/agribusiness opportunities; but has no significant focus on AD clients/intervention zones. Trade policy reform initiatives currently in place create a potential mechanism for addressing trade/transit regulatory and institutional rigidities which may be hampering the emergence of higher value crop production/distribution activities in major AD intervention zones, but have up until now not been focused in this direction. The same could be said of MAIL budgetary/resource planning and service provision activities. This sizeable gap between the range of institutional reform and capacity building tools available, and the degree to which they have been effectively leveraged to maximize the sustainable impact of AD programs, needs to be effectively addressed if AD objectives are to be effectively pursued moving forward.

7. SHAPING A STRATEGIC ALTERNATIVE DEVELOPMENT (AD) PROGRAMMING APPROACH MOVING FORWARD

Introduction: The core elements of an impactful AD approach moving forward need to be derived from a clear and cogent recognition of what has and hasn't worked under preceding AD programs in Afghanistan; as well as a foundational understanding of what has driven successful program implementation in other complex institutional settings characterized by significant elements if institutional weakness and social mistrust. In the preceding sections we have analyzed and presented the implications of past trends in illicit crop production/distribution. We have also provided a structured synopsis of what various categories of key stakeholders have posited as the major strengths and weaknesses of the AD strategy and major programmatic thrusts implemented in the past.
This analysis provides a sharply illuminating perspective on the critical programmatic elements which will need to be in place for accelerated and sustainable progress under a "next generation" of USAID-supported AD programming. We outline these elements below, and also discuss their implications from an effective program design/coordination perspective.

Critical Features of an Impactful AD Programmatic Approach: The following key elements must be present in and seamlessly integrated into future AD initiatives, in order to create reasonable prospects for sustainable success:

Community-Level Social Contract Based Approach: This represents the fundamental institutional building block upon which a successful AD programming approach can be built. It entails development of a community-based consensus on what the key constraints are which need to be addressed in order to place farmers and other economic agents at the community level in the strongest position to turn away permanently from involvement in illicit activities. This needs in turn to be based on an ongoing dialogue with community representatives and groups regarding what those key constraints are, and a prioritized game-plan for working together to effectively address them.

Behind this type of approach is understanding that the fundamental unit of engagement and intervention is not the farm unit or a particular group of farm households, but the community level and sub-regional economy and polity. The analysis of 'drivers' must be carried out at this level, in order to facilitate effective understanding of the complex of short-term cash-flow, financial risk mitigation, security/state presence, socio-institutional 'muddling-through' pressures, and longer-range rural development constraints and opportunities which are all in play in determining vulnerability to ongoing engagement in poppy production and trading activities. In addition given the endemic uncertainty characterizing the bureaucratic competence and political legitimacy of national and regional level governance institutions, and the rampant mistrust which seems frequently to exist between inhabitants of rural communities and the state political apparatus, the development of an explicit type of 'social contract' between the community and the donor program in question regarding shared objectives and mutual obligations becomes critical in its importance. In other words, given the weaknesses of core governance institutions at higher levels of government, it is virtually inevitable that within the current Afghan institutional context, high impact engagement in AD planning can most effectively begin at the community level.

Under such circumstances, it can play a key role in building the type of social trust and shared accountability that will be required to promote stable expectations and long-run commitment to program objectives. It will thereby also serve over time to strengthen the social capital bonds that will likely be required to 'firm up' resistance to recidivist pressures. These may come from a range of extra-legal institutional actors both at the community and local/sub-regional political level (major landholders,

commercial traffickers, police chiefs, corrupt political officials), and from terrorist elements that will either directly pressure farmers to revert back to illicit activities, and/or try to incentivize rural families to increase illicit production activities in outlying areas beyond the reach of AD programming efforts.

Given the severe limitations on legitimate state institutional presence across most of the prospective AD intervention zones, this type of intensive institutional engagement approach at the local and sub-regional level will likely prove critical for purposes of creating the necessary pre-conditions for (1) effectively defining the most critical economic and institutional intervention priorities; and (2) creating the breadth and depth of institutional support required to lay the groundwork for successful long-run implementation. This type of engagement strategy effectively moves AD programming away from a narrowly-focused 'crop-substitution' or 'income flow replacement' approach, to one based on a gradual transformation of (a) socio-economic development linkages and opportunities at the community and sub-regional level, and (b) the political dynamic within the community and between the community and regional and national political institutions. Both factors are extremely important from the perspective of creating both the economic and political impetus for sustainable progress in reducing engagement in illicit activities.

Top-Down State Level Engagement: While it is extremely important that there be from the beginning an organic engagement of community level actors in the shaping and implementation of integrated AD programming efforts – both from an effective resource targeting as well as an institutional buy-in perspective – it is also important that there be an efficient top-down planning and management element built into AD programming as well. What does this effectively mean? First and foremost it means bringing to bear the institutional planning capacity and technical and financial resources of the state in supporting the key objectives of AD programming at the community/sub-regional level. This entails a combination of infrastructure investment, agricultural extension, investor outreach, and agricultural/trade policy reform activities geared towards promoting increased employment and income generation opportunities for rural economic agents in areas where significant AD programs are being planned/implemented.

It means effectively rewarding communities and local governments which move in the right direction with higher subvention levels to finance the required investments. This will buttress the unified 'messaging' which the state will need to engage in on a consistent basis to show the rural citizenry that it has a clear and focused commitment to backing up its rhetoric on combating poppy production. All of this will in turn will require effective "mainstreaming" of alternative development planning and implementation efforts into the overall strategy-setting, programmatic planning and budgetary allocation processes in key GIRoA sectorial institutions, in a manner which is clearly absent at present.

This will likely require intensive and integrated institutional dialogue/outreach on the part of USAID's AD and broader agricultural programs, as well as other relevant programs in USAID's economic growth portfolio. For instance, this could entail enhanced coordination of programs in the agricultural extension, financial sector outreach, customs and trade policy reform, and fiscal reform areas; all from the perspective of facilitating more efficient and integrated strategic and budgetary planning within key GIRoA entities to support/reinforce the impact of local/sub-regional AD interventions designed to encourage swift transition out of illicit activities. This type of programming commitment from major national and regional level institutions in turn implies an enhanced commitment on the part of the state to reinforce basic 'state presence' in vulnerable areas which are or are slated to become beneficiaries of significant AD support efforts. It is important within this context, from an incentive perspective, that this in fact represent a two-way street. In other words, for a sustainable AD programming strategy to be successfully implemented, it will be necessary for the state to build credibility at the community level by

providing the financial and institutional resources required to promote sustainable livelihood opportunities and related social and physical infrastructure services. [26]

At the same time, if the state (as well as the relevant donor AD program) fulfill their commitments and yet illicit activities continue, this creates a situation where the state may need to take 'coercive' action in order to maximize the community's disincentive to engage in illicit activities (as well as to discourage other communities from 'gaming' state resource allocations in future). We are unaware of any past institutional contexts in which AD programming alone, with no negative counter-incentives, has succeeded in sustainably reducing illicit production in countries the past. It would appear to strain credulity to assume that a strategy designed to foment sustainable reduction in illicit production can succeed without a combination of carrot and stick incentives.

It is critically important that in the first instance the state demonstrate its commitment to strongly support and reinforce the actions of communities which voluntarily take actions to move away from illicit activities. This will both reinforce positive momentum for change, and also create an air of legitimacy should the state be required to take occasional coercive action to enforce compliance with community level commitments. This is particularly important within the fragile institutional context we find at the moment in Afghanistan, where coercive actions by the state are often interpreted as arbitrary in nature and/or reflecting particularistic self-interested bureaucratic forces.

Again, given the overall weakness of state governance institutions and the traditional opacity characterizing the actions of national and regional level political actors in this regard, it is probably most realistic to assume that this will work best as a phased process, with an initial intensive focus on positive reinforcement of local action, and negative enforcement actions as a later/last resort. From the same perspective it will likely be advisable to initially shape AD strategy and related intervention programs on community level based effort. This should be closely followed by targeted efforts to shape relevant national and regional level intervention tools (e.g., MAIL extension programs, MRRD infrastructure resources) in a manner which reinforces and rewards the actions of local-level institutional partners.

Focus on Key Infrastructure Constraints: The development of an integrated AD approach will definitively require a much more concentrated and intensive focus on addressing the most critical infrastructure constraints at the local and sub-regional level which are restricting the capacity of farmers to access markets, secure competitive returns from licit production activities, and insulate themselves from excessive transitional risk when they shift from poppy to licit crop production. It appears that virtually all stakeholders were united in their identification of irrigation/water management services and related investments as the most critical infrastructure service provision area to be addressed under AD program initiatives. This has proven to be of critical importance under the recent KFZ program.

This in fact emerged from virtually all stakeholder interviews as the most critical infrastructure constraint to be addressed – in its absence, it is likely to prove virtually impossible to move effectively towards transition from poppy to higher value added annual and/or perennial crops. Other key infrastructure areas which will need to be effectively addressed include development of alternative energy sources/applications, crop storage capacity/facility enhancement, and secondary road construction/maintenance activities. Improvements in these core infrastructure service areas will be critical for purposes of enhancing permanent market linkage opportunities and creating improved and more stable licit production income flows as well as demonstrating state commitment to integration of

[26] It should also be pointed out that as licit agricultural earnings opportunities improve, there may also be an incentive for extralegal actors (including terrorist elements) to shift towards imposing "tax" levies on licit production. This again underscores the importance of significantly expanding 'legitimate' state presence – including security presence – into traditionally at risk areas.

the particular communities involved into the regional and national economy and polity. At the same time, these investments will heighten prospects for attracting private investments in downstream processing and distribution activities. This in turn will augment demand-pull impacts on licit production incentives at the local level, and help link previously vulnerable rural communities with peri-urban economic zones and off-farm employment opportunities, creating a 'virtuous cycle' of licit production-trading-private investment-off farm employment opportunities.

Value Chain Development/Off-Farm Employment Support Activities: Ultimately the sustainability of AD interventions at the farm level will be critically dependent on forging value chain linkages which can permanently 'ratchet-up' demand for higher-value added agricultural products; and which will indirectly help drive the investments in storage capacity, improved agricultural input networks, and enhanced on-farm quality management and cultivation practices which will be required to sustainably increase productivity, sales and incomes. Essentially this means tying the rural areas targeted for AD engagement with sub-regional and regional peri-urban areas and major urban centers which can drive increased demand over time, and where possible leveraging access to export markets for annuals and perennials. This in turn will require sub-regional level competitiveness analysis and targeting of types of crops that have the potential to be linked into value chain networks, and a review of the key infrastructural, cold chain, market linkage/access, quality management, and financial constraints that are limiting their development.

The resulting constraints analysis findings would then inform development of a detailed and effectively sequenced implementation game-plan moving forward; which would itself be integrated into the ongoing strategic dialogue with community groups/representatives with whom the overarching AD intervention strategy is being formulated. It also needs to be fed back of course into the dialogue with key regional and national level GIRoA counterparts. This for purposes of highlighting the infrastructure investment and trade and other related enabling environment constraints which may need to be addressed in order to leverage the private investor interest, and the market access channels, required to establish viable market development opportunities for farm producer groups engaged at the local level under AD Programs.

For instance, stimulating demand for higher value agricultural commodities in a particular sub-region could be linked to dialogue with regional authorities and MAIL about establishing, or improving the operation of an existing Industrial Park operation (e.g., Kandahar), for purposes of leveraging local or regional private investment and improving related infrastructural improvements in road construction/maintenance and energy supply access. It could alternatively be linked to the establishment under a PPP arrangement of a village/district packing center; and/or establishment of a viable cold chain network with adequate capacity along a specific transport route. It could also be tied to better targeting of and improved quality of support from a relevant regional MAIL agricultural extension office on agricultural input supply management, and/or appropriate cultivation practices. Finally, it could relate to working with MAIL and MOC on targeting key trade and/or customs rigidities limiting capacity to efficiently and time and cost-effectively manage the logistical arrangements for transporting agricultural production – fresh or processed – to a targeted regional export market.

In all these cases, multi-party stakeholder and inter-institutional GIRoA coordination is of critical importance form the earliest stages of project design and execution. This in turn underscores the importance of laying out from the beginning a clear and well-sequenced set of intervention targets, with shorter-term and long-range implementation goals, which are ultimately geared towards establishing a permanent linkage between the local agricultural area and producer groups, and downstream economic agents whose investment, informational access/quality management and market leveraging activities can create a dynamic and sustainable demand-pull impact for local beneficiaries. This is clearly a complex

dynamic, which is most relevant in those cases where the combination of agronomic conditions, market proximity, current or prospective infrastructure service access, and current or prospective state presence and security conditions creates a reasonable likelihood that the required stakeholder alliances and public and private sector technical and financial resource investments can leveraged and effectively maintained over time.[27]

Improve Extension Service Outreach Networks: A strong consensus emerged from the broad spectrum of stakeholder discussions which were held on the overriding importance of developing a viable agricultural service extension network. In this regard it appears that the prospective impact of AD programs would be dramatically enhanced if well-focused and effectively integrated extension/outreach services were available to farmers who are targeted under AD intervention activities. At this point USAID is operating 78 demonstration farms in 4 provinces under the RADP-South Program. The AAEP Program, which fundamentally represents a continuation of a prior USDA support activity, is supporting upgrading of public sector extension services, through helping operationalize an initial network of 7 regional multi-purpose agricultural extension offices, and undertaking related training of extension staff.

However these programs are not focused in any intensive or specialized manner on the effective provision of initial outreach services, and ongoing follow-up support, to producer groups being targeted under AD programs. For example the RADP-South Program includes within its broader focus demonstration farm participants who are operating in areas in which poppy is grown. However the outreach program is not designed to facilitate intensive engagement of a network of farmers in those communities in a manner geared towards generate a rapid 'critical mass' impact on cultivation practices away from poppy and towards licit crops at the community level.

These observations are not intended as a criticism of these efforts – they simply reflect a recognition that these initiatives have not been set up in a manner which is designed to facilitate concentrated and/or specialized provision of services to agricultural producers in areas which are vulnerable to engagement in illicit activities. In addition there appears to be virtually no focus within MAIL on targeting agricultural extension service outreach activities – including with regards to the locational targeting of the emergent network of extension centers – in a manner which would facilitate intensive targeted provision of reasonably high quality services to beneficiaries of AD Programs.[28] As a result public sector investments in research/extension se ices are virtually segregated from efforts to effectively design and implement AD support programs within MAIL.[29]

This in turn underscores the importance of maximizing the coordinated planning and conduct of agricultural research/extension related institutional strengthening and outreach programs. These can play a vital role in helping AD program beneficiaries better access crucial information and technical/training support on agricultural input supply management, cultivation practices, water management, green-house and low/high tunnel technology, foraging technology/practices, storage technology/management, and other critically important extension related issues. The lack of institutional focus on integrating these initiatives more effectively with AD programs represents a lacunae which, if addressed in the reasonably near-term, would help USAID to significantly enhance the quality and continuity of the information provision and technology transfer services provided to AD program participants; thereby improving prospects for sustainable program impact.

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[27] We will come back to this assumption later, when we discuss the contouring of intervention strategies to reflect differences in geo-spatial, agronomic, infrastructural, and security circumstances in distinct potential AD intervention zones.
[28] In this regard the Director of Extension services in MAIL directly commented on the importance of fine-tuning extension service outreach strategy and activities I a manner which better reflected the alternative development goals of the GIRoA.
[29] A point directly confirmed by the Director of AD programming in MAIL.

Create Viable Off-Farm Employment Opportunities: In order to be viable/sustainable over the longer-term, AD intervention approaches clearly need to incorporate practical strategies for enhancing off-farm employment opportunities. This is almost by definition a corollary of the above-described focus on value chain development and infrastructure service system investment and upgrading. It is based on a fundamental recognition that over the longer-term, the creation of vibrant income-generation opportunities in the non-agricultural sector will be key to dis-incentivizing the rural population in a given geo-graphical area from turning back towards engagement in illicit activities. Certain geographic zones which are vulnerable to engagement in illicit activities are not agronomically productive areas; in which case it is not realistic to assume that most economic agents in those areas can be 'placed' in viable licit agricultural production activities over the long-term.

Moreover even in areas characterized by buoyant potential returns to commercial agricultural activities, it can be expected that only a certain percentage of existing farm families will have the financial/management/technical capacity and interest to absorb the risk entailed in the challenging transition to high-value cropping. Under these circumstances there will tend to remain for more 'marginal' farm families an incentive to remain engaged – or a vulnerability to external pressures to reengage – in illicit production activities. This could involve a decision by such families to continue growing poppy on plots located in a 'mainstream' agricultural area, or through a migratory shift towards hinterland areas. In either situation, it is important that non-agricultural sources of rural employment be generated which will provide an employment/ income-generation 'outlet' for economic agents who otherwise may face significant economic pressures to remain engaged in illicit production/distribution.

The creation of such opportunities will also create fresh socio-institutional linkages between these families and a wider network of economic actors at the sub-regional and (at times) national level; as well as greater exposure to public sector service provision entities and activities at the district level and beyond. In this sense a focus on off-farm employment and related investment leveraging support activities can serve an important dual purposes: First, providing an immediate and sustainable source of alternative income; and, second, altering over time the socio-institutional perceptions of and dynamic between the rural family in question and 'legitimate' state and private sector institutional actors. Both infrastructure service provision and value chain linkage activities serve to directly and indirectly create immediate employment opportunities, while also creating ongoing socio-institutional linkages between previously isolated communities and the regional and national economy and polity. This creates a positive dynamic both from an income-generation and a social capital development perspective, which can play a major role in promoting the long-term sustainability of the impact of AD initiatives.

Again it will be critically important that the initial sub-regional competitiveness analysis undertaken at the initial AD program planning/development stage incorporate a strategic yet practical focus on off-farm employment opportunities. This should again be linked in an integral manner to the value chain development approaches which are reviewed and prioritized. Depending on agronomic, geo-locational and infrastructure capacity factors, high impact agribusiness investments such as canneries, drying centers, tanneries, dairy farms/processing facilities, packing centers and cold storage mini-hubs may be possible to promote/leverage.

Successes in some of these areas over the past decade in Kandahar, for instance, indicate that this need not represent a quixotic vision, even under the current extremely challenging institutional circumstances found in Afghanistan today. More ambitious value chain development initiatives, such as cashmere and wool processing, and garment manufacture, are longer-term possibilities that warrant further analysis as well. Since these initiatives will often require both public and private sector investment leveraging, fresh value chain financing approaches, and (at times) legal/regulatory reforms; they need to be carefully conceptualized and sequenced within the context of an overall AD strategic approach in a given

intervention zone. However their effective articulation can in and of itself provide a major impetus for both local community, and well as broader private and public sector stakeholder buy-in, and thereby help to build institutional momentum for effective program implementation. It is also difficult to envisage the sustainability of targeted AD interventions in the absence of this program component.

Create Robust and Sustainable Financial Sector Access Platforms: The implementation of past AD programs has as noted earlier been undertaken in the absence of an integrated and sustainability-focused access to finance strategy. This has in turn had a crippling impact of the viability and scale-ability of these initiatives. In the absence of viable financing vehicles, for instance, a number of past programs have featured massive 'giveaways' of inputs that have complicated efforts to develop viable market-based agricultural input supply markets; and (according to anecdotal information, including a number of private and public stakeholders interviewed for this research initiative) at times redirected towards illicit production activities. In addition the absence of viable agricultural financing instruments has significantly complicated efforts to shift towards higher value added crops, and most particularly perennials. These require lengthy gestation periods before income from their production can be realized, and therefore generate relatively high operating capital requirements for participating producers who have no access to sources of commercial finance.

There is virtually no agricultural finance available from commercial banks. The USAID-supported Agricultural Development Fund reportedly has approximately $25 million in loans out to agricultural producers and processors; of which a small proportion is allocated to AD-related activities. A handful of microfinance organizations are active at the regional level, but these reportedly have engaged thus far in limited agriculture/small scale agribusiness lending activities. In short, an almost complete vacuum in formal agriculture/agribusiness lending exists at the moment in Afghanistan.

In order to promote a viable AD strategy for the country, sustainable linkages have to be developed which, directly and/or indirectly, create the institutional capacity for provision of core financial services to the rural families who are the 1st tier beneficiaries of AD Programs. It is important to point out in this regard that it would be best to avoid the temptation to try to respond to this need on an 'emergency' basis by setting up a special purpose lending vehicle to do so – this strategy has achieved an impressively consistent track record of failure at the international level, and should be avoided at all costs within the existing extraordinarily fragile institutional and governance environment found in Afghanistan. Given the limited technical capacity and the extreme vulnerability to rent seeking incentives which exist currently, it would be a fundamental error to depend on such a vehicle as a core element of a financial access intervention strategy.

On the other hand, there are practical market-focused rural financial access approaches which, if activated, could both take effective advantage of existing financial sector service delivery vehicles, and encourage a "demonstration effect" impact that would yield robust financial access benefits over time. The first element of a viable access strategy would be searching for a viable institutional partner potentially interest in expanding it rural lending activities. A strong potential partner might be found, for instance, in AIB Bank, which is among the most progressive financial institutions in Afghanistan, and which directly indicated to the team during stakeholder discussions its potential interest in jumpstarting agriculture/agribusiness lending activities.

The key here is working at a strategic level to demonstrate the potential impact of increased rural lending and broader financial intermediation service delivery on the overall client expansion and profitability objectives of the banking institution in question, and promoting its incorporation as a core element in the strategic and business plans of that organization. In other words, the institution needs to be shown that there is a major market opportunity that it is missing out on at the moment which could

significantly improve its market position; simply as a result of its unnecessarily risk-averse posture towards rural lending in general and agricultural lending in particular. This would be followed by the sculpting of client identification and loan analysis and management processes and techniques which facilitated efficient and administratively time and cost-effective rural and agricultural lending decisions; and design of relevant lending products for agriculture and agribusiness clients (e.g., cash-flow based short-term lending products, receivables and other contractual finance products, LOC-based loan products). In addition design of longer-term lending instruments to foment investments in long-gestating crops would be developed, and longer-term warehouse receipts-based financing instruments would be explored.[30]

A second element in a strategic approach moving forward would be to foment development of 'second-tier' funding relationships between commercial banks and MFI's whose decentralized institutional presence and financial outreach skill sets place them in a stronger position to rapidly identify viable clients and provide efficient and cost-effective intermediation services to AD-relevant clientele. These institutions could thus serve as an effective 'indirect' service delivery vehicle to AD clients, and in the process tap-into the substantial under-utilized financial resources of selected commercial banking institutions. In this regard AIB bank again has referenced its initial prospective enthusiasm at exploring this type of intervention approach; and also mentioned that it could well be worth exploring potential broader sectoral interest in this service outreach option with members of the Banking Association (which is a heads up at the moment).

A third key element of a practical intervention approach could be to focus on remote or 'branchless' banking opportunities. This would entail an effort to work with one for more formal financial institutions to identify rural economic agents – for instance, pharmacies, retailers, barbershops, AgDepots – which would serve as representatives of the financial institution, and initiate client engagement. This could be combined with or supplemented by a mobile banking outreach approach. Ultimately these service outreach mechanisms would be utilized to facilitate initial engagement of clients for transactional service provision purposes, with lending outreach to follow based on follow-up loan analysis and decision activities undertaken by regional loan officers. A hybrid approach of these last two program elements could also be considered, with a particular MFI serving as both the first stage intermediation 'agent' of a commercial bank, and also providing lending analysis and perhaps even out-sourced loan management services for that institution.

The ADF represents a fourth distinct potential target of focus for AD-related financial outreach strategy and implementation efforts. As a direct USAID-supported financial outreach platform in the agricultural sector, this institution has developed a specialized skill set and organizational structure focused on efficient mid-to-larger end agriculture and agribusiness lending processes and products; including longer-term lending arrangements than those offered by most other commercial finance institutions. It also has engaged to a limited degree in provision of second-tier financing to some microfinance institutions. In addition, it now is under the direct governance oversight of the MAIL. As such, it provides a potentially unique vehicle for rapidly expanding financial service availability in a best practice consistent manner towards targeted AD beneficiary groups.

This in turn would entail a strategic determination to allocate a certain proportion of its available funding (it currently has approximately $65 million in financial assets) towards viable AD lending opportunities, which should be allocated to projects which meet core market viability criteria. As a nonbanking institution, the ADI would for instance be able to assume somewhat greater risk in relation to financing AD-related long-gestating crop investments, than would commercial banking institutions

[30] A number of these options would require related legal/regulatory reforms, which are elaborated further below.

subject to standard Central Bank provisioning requirements (more on this below). Similarly the AD would be uniquely situated, both given its technical capacity and its Mission Statement, to promote development of innovative agricultural value chain financing products than any commercial banking institution. It could therefore potentially play a vanguard role in a potential integrated AD financial market outreach strategy.

Finally, actualization of a high impact AD financial access strategy will require a focused legal/regulatory reform and advocacy efforts. This would need to focus primarily in three areas: First, although the legal/regulatory framework for the use of a broad array of moveable assets (including dematerialized assets) is reportedly in place, and a comprehensive electronic registry for movables exists, there is next to no appetite among commercial finance institutions for utilizing moveable assets for lending product design and risk analysis/loan approval purposes. The reason for this is the Central Bank has put in place draconian provisioning requirements which, according to FAIDA financial sector experts, effectively ignore the risk-mitigating features of registered moveable assets; thereby essentially negating the utility of using them as collateral against lending activities.

Second, the legal/regulatory framework for bankruptcy remains under-developed in Afghanistan. This in and of itself inhibits the readiness of commercial finance institutions to utilize moveable or immovable assets for risk mitigation purposes, and would need to be addressed in order to activate direct commercial bank lending to the agriculture/agribusiness sector on a major scale. This will in turn require a major overhaul of bankruptcy legislation, and related systematic reworking of key regulatory and procedural provisions.

Finally, judicial enforcement capacity continues to be extremely limited in Afghanistan, which creates massive uncertainty for commercial finance institutions looking to repossess secured assets when faced with overdue loans. This in turn heightens the risk-aversion focus and club-lending instincts of most commercial banking institutions, and further inhibits focus on development of innovative risk-mitigation instruments, particularly for an inherently risk-laden area such as agriculture (and even more so when the focus is on agricultural lending in rural areas with a tradition of engagement in illicit production/distribution activities).

It will be critically important that a focused effort to address these core legal/regulatory constraints be effectively undertaken, if AD-focused financial outreach efforts are to succeed on a scale-able and sustainable basis. The most critical near-term constraint to be addressed is the overly rigid regulatory treatment provided to moveable assets for provisioning purposes, which will require intensive dialogue with the Central Bank. Resolution of this issue could provide a significant impetus to increased agriculture/agribusiness lending, in combination with the technical/institutional strengthening outreach activities described above. Targeted legal/regulatory reform efforts in the bankruptcy and judicial enforcement areas are obviously much longer-term efforts, which could be important from an AD Program sustainability perspective, though of course they would also have wider overall benefits or agricultural and business lending overall. Technical support/policy dialogue outreach activities in these areas would presumably be handled on a coordinated Basis through the FAIDA and/or ACE programs.

Long-Term and Effectively Sequenced Programmatic Focus: The program strategies and intervention mechanisms which have been described above must be designed in a manner which reflects a core understanding of the long-range rural development needs of the area in which the programs are implemented. Too often in the past the programs have been planned and implemented with short-term farmer outreach and poppy production displacement goals in mind, and have not been conceptualized in a way which addressed the complex of socio-economic constraints limiting the capacity of the local/sub-regional rural economy to provide a viable licit livelihood to program beneficiaries on an ongoing basis.

In addition, the programs have not been typically designed in a manner which would address in an effectively sequenced manner the core informational, infrastructure, and market development constraints required to promote sustainable progress in helping farm families turn away permanently from engagement in illicit activities.

In this regard it is, for instance, extremely important to ensure that initial agricultural extension/demonstration farmer outreach and seed supply programs are effectively complemented over time by enhanced provision of public/quasi-public extension service networks in the localities/sub-regions being targeted by AD efforts; as well as by institutional strengthening efforts designed to promote development of functioning private input supply and distribution/marketing channels. It is equally important that shorter-term technical support on improved on-farm water management techniques be complemented by longer-term efforts to improve core rural infrastructure services, including irrigation, energy provision, rural storage capacity, and secondary roads. This in turn will further enhance productivity, protect/stabilizes short-term income gains, and create prospects for longer-term expansion in licit crop demand and improved off-farm employment opportunities.

In addition it will prove critically important to achieve much stronger linkages between farm-level technology transfer/cultivation practice enhancement programs and agribusiness value chain development initiatives – this is again fundamentally important for purposes of ensuring the long-term viability of farm and community level intervention programs. Developing and carefully shaping application of a menu of intervention mechanisms of this nature by definition requires a sound diagnostic analysis of the rural competitiveness "drivers" at the local and sub-regional level; and a holistic and effectively sequenced program design that can effectively unleash those drivers in a manner which can create robust employment growth opportunities – on and off-farm – on a sustainable basis. All of this in turn requires a longer-term planning horizon than has often characterized USAID AD programs – again 3-5 years represents an absolute minimum in this regard. Where longer contract are not possible, projects should be designed with intermediate contractual deliverables that contribute to a long term program where the economic benefits and measurable returns are planned for follow-on efforts after the contractual end date of the project. This may require that many of the contractual indicators are inputs and outputs rather than impacts.

In a fundamental sense implementation of this type of approach would optimally require an organizational framework for program planning and implementation which by the nature of its set-up will help avoid the type of resource planning and management stove-piping which has plagued implementation of AD programs up until now. On the GIRoA side, this would mean that the AD strategy-setting and program planning and budgeting process would entail proactive collaboration with and prioritization by all major functional areas within MAIL and MRRD – for instance including rural infrastructure, research/extension, financial sector access (MAIL has a predominant governance role to play in the operation of ADF), investor outreach, and agricultural policy reform activities. On the USAID side, this would entail intensive efforts to examine/prioritize synergistic elements of, and effectively link up, a range of major agriculture/agribusiness and broader trade and fiscal reform support initiatives to its core AD programmatic initiatives.

Within USAID this could be achieved through the formation of a permanent AD working group which cuts across the Agriculture and Economic Growth Offices. This unit could develop cross-cutting activity management priorities and activity plans which are tied to annual and multi-year AD program goals and objectives. On the GIRoA side, this could be achieved through significantly further strengthening the organization of public sector planning and implementation processes and programs related to the NPP on reducing/replacing poppy production with licit income generation activities. In effect, this would require a type of "Plan Colombia" organizational framework which would allow the GIRoA to effectively

prioritize AD programmatic objectives at an inter-ministerial level; and galvanize the strategic and budget planning processes and resources required to streamline decision-making processes and reduce stove-piping pressures.

This would seem to be the most viable organizational approach available at the moment to achieve the long-sought "mainstreaming" of AD programs into the overall agricultural and rural strategy-setting and budget planning processes. Although certainly no panacea, and subject to potential bureaucratic and political economy efforts to 'marginalize' or 'compartmentalize' a new or revised AD-specific organizational structure or working group, it would appear that such a structure would have a greater chance at building a planning & implementation system for AD programming which has some chance at sustainable success, particularly in relation to the status quo in agricultural/rural public policy formulation. This is particularly likely to be the case, in light of the fact that policy interest in the success of AD programming seems much stronger at the presidential level than it does among sector ministry leadership.

Within USAID, optimal implementation of this type of AD programming framework would imply the establishment of a multi-pronged rural institutional strengthening and capacity enhancement program geared both at improving opportunities for transition to high value licit crop production; and creation wherever possible of vibrant value chain linkages to regional and national markets – and, where possible over time, export markets. These would be tied to efforts to improve extension service provision and targeted rural infrastructure development activities; and market-based provision of suitably-scaled financial access services. Efforts would also be made to target specific policy/regulatory reforms which might be required to reduce trade/transit costs and improve prospects for profitable trading activities. This would help further insulate low-income producers from the high levels of risk associated with shifting into licit production activities. This type of integrated programmatic focus could be intensively applied in rural areas which are relatively close to major urban consumption areas. For areas that have significant agronomic potential but are located somewhat farther from major urban centers, and which exhibit more fragile infrastructure and market access conditions, the programmatic focus will likely need to be more selective and sequential in nature, focusing more heavily initially on infrastructural and basic market linkage upgrading (e.g. storage facilities, basic input supply linkages). Subsequently greater focus could be placed on product quality improvements and agro-processing linkages.

For more distant and vulnerable hinterland areas in core intervention zones, heavy emphasis would be placed on determining whether such areas provided viable opportunities for limited infrastructure investments, and for relatively simple technology transfer/enhanced cultivation practice support activities (most probably basic grain-focused). Strong emphasis would be placed on defining off-farm employment opportunities which could drain off labor supply form these areas as well (closely linked to the sub-regional value chain development aspects of the strategy). All of these strategic intervention efforts would be based upon a prior rapid diagnostic analysis of transition constraints and opportunities at the local and sub-regional level. This aspect of the strategy will prove critical from the perspective of functioning to minimize "balloon effect" impacts at the regional level over the medium-term.

It would then be concretized through a community-level agreement on AD intervention strategy and programmatic efforts, and shared responsibilities between the program implementer, community participants, and relevant public sector interlocutors. This in turn would be tied to public sector agreement to focused allocation of cross-cutting resources in critical areas (e.g., research/extension, irrigation infrastructure, road construction/maintenance) that would both support effective program execution, and build social capital/shared bonds of expectation at the community level. In addition it would be fundamentally important that state security presence be enhanced – particularly in the relevant

hinterland areas – in order for program legitimacy to be reinforced and social capital bonds effectively developed.

However it is quite possible that the GIRoA may, in certain instances, prove incapable of mustering the institutional will/wherewithal, and the budgetary capacity, needed to successfully implement this type of resource and institutional leadership-intensive AD approach in key at-risk sub-regions. It may most particularly not have the budgetary and institutional resources required to ensure strong state security presence in such areas. If/when such conditions hold, it may prove more viable to implement a type of 'AD-Light' approach, which focuses on establishing a type of demonstration effect impact by implementing the above-described implementation strategy in areas that are touched by but not engulfed by illicit production activities.

Program implementation under such circumstances would also entail community level agreements and a multi-pronged resource leveraging and institutional engagement approach. However it would almost by definion not focus on significant short-term targets for net reduction in illicit production, and would serve more as a "testing ground" for AD initiatives. These could at a later stage be expanded out to more vulnerable regional areas, particularly as public sector resource delivery and security/state presence capacity expands. Both approaches could of course be applied on a targeted basis within distinct regional contexts; their application driven by donor and GIRoA resource envelopes and state presence conditions within a particular region/sub-region.

8. PILOT RECOMMENDATIONS

As noted in our analysis of strategic pathways forward, we have differentiated for heuristic purposes between program design/implementation scenarios for three distinct intervention settings of AD programs:

- Areas with strong agronomic potential, relatively adequate core infrastructure characteristics and located close to a major urban center.
- Areas with viable agronomic potential, more fragile basic infrastructure, and with some access to peri-urban markets.
- Isolated "fringe or hinterland" areas with little agronomic potential, poor basic infrastructure conditions and no means of accessing urban centers or peri-urban areas in a time and cost-effective manner.

It can be assumed that security conditions would become increasingly precarious the farther we move out from urbanized areas. We discuss below how the strategic recommendations outlined earlier might be fleshed-out within the context of next-stage "pilot programs" implemented under USAID auspices. We have attempted to differentiate these recommendations in accordance with the distinct political economy and market circumstances likely to be found in these particular geo-spatial and institutional settings. Ultimately the intensity and scale of engagement under each scenario would of course be impacted by budget resource availability (USG and GIRoA), as well as security circumstances. Pilot applications could themselves provide valuable information about the cost parameters which would prospectively be relevant for broad-based implementation of this type of program structure. The analysis is presented below:

- **Components of a Strategic Approach in Agricultural Areas Featuring Good Transport and Market Structure, and Close Proximity to Urban Centers:**

In areas of concentrated poppy production, such as in the Provinces of Kandahar, Helmand and Farah, agricultural areas adjacent to major regional urban centers most clearly meet these criteria. In these areas a Pilot Program could be articulated with the following core elements:

- **Complete Diagnostic** of what alternative income pursuits would be viable in this environment, i.e. what would be competitive with poppy, from a physical infrastructure perspective - including irrigation, energy and roads; from an agronomic perspective – soils and climate, economic analysis of productivity/profitability, from a market linkage constraints perspective – informational, cold chain, agro-processing constraints/opportunities, trade/transit policy and regulatory rigidities; and from a non-farm/off-farm employment constraints and opportunities perspective.
- **Community Engagement Meetings/Process** – A core element of this approach would be a series of discussions with community leaders and farm group representatives regarding their socio-economic aspirations and related licit crop production/market linkage opportunities; as well as their prioritized sense of major institutional and market constraints that need to be addressed in achieving these goals. These would be preceded/accompanied by engagement of district and local political and patrimonial leaders to facilitate initiation of the engagement process. However the main ongoing focus would be on proactive community-level engagement and partnership. This approach would essentially be reflective of the program planning strategy embodied in the KFZ community level outreach program. It would culminate in joint community/village level, GIRoA and USAID Program agreement on mutual responsibilities for program planning and implementation

and correlated service delivery activities. It would also entail a commitment to steer clear of poppy production activities at the community/village level form the start of the program implementation period.

- **Irrigation Component –** Using KFZ as the model, design and implement irrigation infrastructure construction, extending canals and establishing water delivery systems to individual fields, so that all farmers in the area have adequate access to irrigation. An on-farm water management component would need be included in the program, to assist farmers in organizing fields into raised bed row cultivation, furrow irrigation, spills and siphons for water movement between rows, sluice gates, gated pipes and flumes for field delivery of water and in-field ridging for directing water flows.
- **Energy Component -** If the electrical grid can be extended to this area that should be part of the infrastructure program. If it cannot, then fossil fuel for various systems of wells and pumps could be installed, as well as the development of solar energy farms for the community. Lack of energy availability was cited as a major constraint by all those interviewed.
- **Crop Production (Annuals, Vegetables) and Field Introduction (Extension) –** Various alternative crops have been demonstrated at the RADP-S demonstration farms, which have significant potential for outperforming poppy on a regular basis, especially vegetables in the near-term. However, packaging these technologies and introducing them at the farm level is lacking. In collaboration with the local DAILs, this component would develop extension materials showing farmers how to prepare for and develop the land preparation for intensive annual horticulture crop production, i.e. vegetables, spices, herbs, etc. In a second stage activity, low tunnels and high tunnels would be introduced to assist in seedling production and to provide for full-term production of protected agriculture through the off-seasons and winter period (November to March). These on-farm assets will need to be financed through financial sector linkage programs.
- **Crop Production (Perennials, Fruits and Nuts) and Field Introduction (Extension) –** In addition to the vegetables, herbs and spices demonstrated in the sites established by RADP-S, orchards and vineyards are demonstrated. Grape vines are trellised, and fruit trees and nut trees are grown from saplings. Since it takes several years for these vines and trees to mature sufficiently enough to bear fruit, the demonstration effect of their yields will not be ready during the time of these projects. Nonetheless their projected yield levels can be shared with the farmers and intensive outreach activities undertaken to build awareness that if they follow the cultivation practices demonstrated on these farms, they should expect to generate the yields predicted.

  It should also be noted that the demonstrations established by RADP-S have rented a jerib of land from a landowner in 78 locations, evenly distributed across the four provinces of RADP-S. Under the type of pilot program envisaged, the 20 Neighbor Farmers who under RADP-S have been selected to participate as formal trainees for the Lead Farmer who is hired to run a given demonstration activity, could be asked to help establish open field production of the vegetables from seedlings, and to also set up seed beds for saving seeds and reproducing for seedlings. In addition, these farmers would be expected to have low tunnels for seedlings and short season leafy greens – spinach, basil, radish, coriander, cress, etc. and high tunnels for the trellised vegetables, as shown in the demonstrations. The procurement of the tunnels, both low and high, could be done as 'extended demonstrations' for the 20 Neighbor Farmers (this would be similar to a system being implemented under RADP-W). The Neighbor Farmer tutors, who would then mentor 20 Observer Farmers, making a group or association of 400 farmers for the particular demonstration. The KFZ project has a different structure, and could use it to expand its program of grape vines on trellises with basil and other crops in the rows. The key to this program would be the capture of the farmer's interest to grow the vegetables in rapid sequencing as demonstrated at the demonstration sites. This would in a given pilot be worked explicitly into the community/village-level agreement with USAID.

- **Marketing and other Value Chain Activities** – After the rapid adoption of non-wheat vegetables, legume and other grains during AVIPA Plus South, SRAD offered grants to traders who would establish packing centers in the districts with a cold room ($30,000 10m x 6m), packing tent, stainless steel packing table, and a Hohenheim-type solar drying table. Six were distributed under SRAD in the fall of 2012. Other grants were also distributed, such as the Nut Roasting machine to Amin Karim Trading Company (which subsequently has indicated that they cannot keep up with orders received for roasting almonds, pistachio and walnuts). Box-making machines and plastic packing boxes (currently being produced in Herat and Kandahar) would be needed for packing fruit and vegetables.

  The Indian Government built a large cold store near the Kandahar Airport in the Industrial Zone, but its design has not lent itself to practical use. It stores pomegranate after the harvest for several months (with good profits) but has not been used effectively since its inception. New facilities are programmed by the private sector and are being constructed. This provides a strong indication of the type of intervention priorities that could emerge form a SWOT analysis of value chain/market linkage constraints and opportunities; with a particular focus on defining near-term targets of opportunity in the storage capacity, cold chain development, and agro-processing linkage areas.

- **Commodity Associations** – Kandahar has long standing fruit associations, namely the Kandahar Fresh Fruit Association (KFFA) and the Kandahar Dried Fruit Association (DFA) both of which are also members of the Kandahar Afghan Chamber of Commerce and Industry (ACCI). Under the umbrella of ACCI, these two commodity associations and another one to concentrate on fresh and dried vegetables, could be included as institutional partners to take center stage to promote the products of the Region.

- **Financial Access Support Approach** – Each of the RADPs has a Grant window for $10 million. Grants can be in-kind for equipment, machinery, on-farm asset development (drip irrigation, trellising, raised beds, seedbeds, greenhouses or high or low tunnels) or working capital. However, consideration might be given under a pilot initiative for targeting grants (perhaps on a matching and/or in-kind basis) for use in agribusinesses, farmer associations, or qualifying individual farmers. In addition cross-programmatic linkages with ACE/ADF and FAIDA could be explored to assess opportunities for developing innovative financial access pilot initiatives. These could, for example, include a targeted lending outreach program in the pilot geographic zone through ADF; an ACE/FAIDA-sponsored effort to expand AIB's agriculture/agribusiness lending analysis/outreach capacity and facilitate enhanced lending activities in the pilot area; or an ACE/ADF sponsored effort to provide second-tier funding to an NBI working in the pilot geographic zone, which in turn would provide on-lending resources on a market oriented basis for farming activities in the target zone.

- **Off-farm Employment** – There are a number of potential types of opportunities for off-farm employment which could be explored, their potential relevance tied to the exact location of the pilot program(s):
  - Cannery (for fruit and vegetables)
  - Tannery (for sheep and goat skins, & cattle hides)
  - Dried Fruit, Nuts and Vegetables
  - Juice Factory
  - Raisin Factories
  - Packing Centers with Cold Stores
  - Airport Staging Area at KAF
  - Oil Presses and Soaps
  - Wool and Cashmere

- Cotton Ginneries
- Nasaji (Textiles) of Kandahar
- Dairies
- Dairy Farms
- Jams and Jellies
- Woodlots with Poplar
- Furniture, Doors, Windows and Tongue and Groove Flooring

Again the targeting of these and related higher-end agricultural/agribusiness opportunities would require tight coordination/interlinkages with value chain focused programs, such as CHAMP, in order to facilitate a joint analysis of opportunities and related resource needs (technical and financial) in order to effectively realize them within the prospective timeframe of the pilot initiative (e.g. 1-2 years). This would in turn imply close cross-program collaboration from the earliest stages of the pilot initiative, including during the initial stages of dialogue at the community level. It could also entail focused inter-program outreach activities toward potential investors (including diaspora investors) to pursue targeted resource leveraging opportunities. It also implies a strong level of inter-program coordination from the beginning on major cross-cutting policy issues (e.g. fiscal, trade/transit, financial regulation, investor rights) that may inhibit realization of the market linkage objectives of the program. All of these considerations also underscore the importance from the beginning of establishing a cross-cutting GIRoA collaboration mechanism, either through MAIL or at an inter-ministerial level, to facilitate effective public sector planning and fiscal resource support for implementation of the pilot initiative(s), across the range of relevant intervention areas enumerated above.

- **Components of a Strategic Approach in Areas with Viable Agronomic Potential, More Fragile Basic Infrastructure, and with Some Access to Peri-Urban Markets. (e.g., Meiwand, Marjah, Nad e Ali, etc.)**

- **Complete Diagnostic** of what alternative income pursuits would be viable in this environment, i.e. what would be competitive with poppy, from a physical infrastructure perspective - including irrigation, energy and roads; from an agronomic perspective – soils and climate, economic analysis of productivity/profitability, from a market linkage constraints perspective – informational, cold chain, agro-processing constraints/opportunities, trade/transit policy and regulatory rigidities; and from a non-farm/off-farm employment constraints and opportunities perspective.
- **Community Engagement Meetings/Process** – A core element of this approach would be a series of discussions with community leaders and farm group representatives regarding their socio-economic aspirations and related licit crop production/market linkage opportunities; as well as their prioritized sense of major institutional and market constraints that need to be addressed in achieving these goals. These would be preceded/accompanied by engagement of district and local political and patrimonial leaders to facilitate initiation of the engagement process. However the main ongoing focus would be on proactive community-level engagement and partnership. This approach would essentially be reflective of the program planning strategy embodied in the KFZ community level outreach program. It would culminate in joint community/village level, GIRoA and USAID Program agreement on mutual responsibilities for program planning and implementation and for related service delivery activities. It would also entail a commitment to steer clear of poppy production activities at the community/village level form the start of the program implementation period.
- **Irrigation Component** – This will probably be the most critical element in the strategy for this type of intervention zone. Without irrigation (water) production will be limited and farmers will revert to poppy for security. Although the degree of irrigation may not be as robust as it might be for the first area, it must be significant. Since the vegetables being considered can be grown on small

fields, with furrow or drip irrigation and trellises, using minimal water, irrigation for the annuals and perennials should be sufficient.

- **Energy and Electricity** – Presumably the electric grid will not reach out to these areas, and hence fossil fuel or solar energy-type solutions may be required. Solar energy farms could represent a potential opportunity.
- **Crop Component – Annuals** – The key to replacing poppy in these areas is to have alternative crops that can be demonstrated as quickly earning sufficiently more than poppy, so that the farmers will not have to resort to poppy for income security within the context of fragile market linkages and uncertain market sales opportunities. For this reason, a comprehensive program for the introduction of seedlings for open-field production accompanied by both low tunnels for seedling production, and high tunnels for off-season-over-winter production, would be a potential priority.
- **Crop Component – Perennials** – This component is complementary to the Annuals Crop Component, in the sense that fruit maturity after transplanting saplings will not occur for several years. Also, since the development of cold stores may be more limited in these areas, those crops that lend themselves to fresh production and drying, might be the preferred selection. This would be a preference for grapes (for raisins), almonds, pistachio, walnuts, apricots (dried and sulphurized), plums (prunes), cherries, figs and mulberries.
- **Marketing and Other Value Chain Activities** - In order to make the alternative crops viable in these less endowed areas, there would be an initial focus on "close-to-farm" storage and input supply linkage activities; with more ambitious marketing and value chain activities being gradually extended to them. In this regard establishment of an appropriately-scaled packing center might be encouraged (including via a matching grant and/or commercial finance linkage activity) in the central zone of a given intervention area, with strong linkages to the larger centers in the peri-urban areas of the Pilot I program. In addition, the Commodity Associations referenced earlier could reach out to these areas as well, to promote eventual tie-in for exports, to Kabul or foreign markets.
- **Grants and Financial Access Services** – Once again, consideration might be given under a pilot initiative in this type of intervention zone for targeting grants (perhaps on a matching and/or in-kind basis) for use in agribusinesses, farmer associations, or qualifying individual farmers. In addition cross-programmatic linkages with ACE/ADF and FAIDA could be explored to assess opportunities for developing innovative financial access pilot initiatives. These could, for example, include a targeted lending outreach program in the pilot geographic zone through ADF; an ACE/FAIDA-sponsored effort to expand AIB's agriculture/agribusiness lending analysis/outreach capacity and facilitate enhanced lending activities in the pilot area; or an ACE/ADF sponsored effort to provide second-tier funding to an NBI working in the pilot geographic zone, which in turn would provide on-lending resources on a market oriented basis for farming activities in the target zone.
- **Off-farm Employment** – Some of the types of agro-business and other off-farm investment leveraging activities described earlier could also be relevant for these 'secondary tier' locations, although it the majority of them would be for more likely to locate in centralized areas with better infrastructural access, such as the Shorandam Industrial Park in Kandahar. Once again, the targeting of these agricultural/agribusiness opportunities would require tight coordination/interlinkages with value chain focused programs, such as CHAMP, in order to facilitate a joint analysis of opportunities and related resource needs (technical and financial) in order to effectively realize them within the prospective timeframe of the pilot initiative (e.g., 1-2 years). This would in turn imply close cross-program collaboration form the earliest stages of the pilot initiative, including during the initial stages of dialogue at the community level. It also implies a strong level of inter-program coordination from the beginning on major cross-cutting policy issues (e.g., fiscal, trade/transit, financial regulation, investor rights) that may inhibit realization of the market linkage objectives of the program. All of

these considerations also underscore the importance from the beginning of establishing a cross-cutting GIRoA collaboration mechanism, either through MAIL or at an inter-ministerial level, to facilitate effective public sector planning and fiscal resource support for implementation of the pilot initiative(s), across the range of relevant intervention areas enumerated above. In addition, there would need from the beginning in these areas to be a coherent commitment from the GIRoA to promote adequate security conditions in the pilot area(s) targeted for this type of intervention zone.

- **Components of a Strategic Approach for Areas in Remote or Isolated Locations in Outlying Areas with Limited Arable Land, Absence of Basic Infrastructure and Poor Linkages to Urban Centers – 'Balloon Effect' Areas**

- Given the limited agronomic possibilities and severe limitations in infrastructure service access in these areas and the presumed high cost of improving service availability; most of the core agriculture/agribusiness outreach activities outlined above are unlikely to prove viable under a pilot program(s) in this type of intervention zone, It is more likely within this context that agronomic intervention programs would need to focus primarily on straightforward technology transfer and cultivation practice enhancement support for enhanced grain production – wheat, barley, corn, legumes - to help meet basic auto-consumption and income security goals. Some focus on enhancing core infrastructure conditions at a basic level would also be important, including as a means of displaying state commitment to the socio-institutional development of the area in question; I order to consolidate community commitment and enhance social capital ties. Perhaps the most important program component in this type of area would be the establishment of direct linkages with 'off-farm' employment opportunities in order to attract poor farm families, landless laborers and rural workers back from these isolated areas and into licit non-farm employment. In short off-farm employment out of these areas may have to be the major focus of a pilot initiative(s) in this type of intervention zone.

- It is extremely important that a pilot initiative in this type of area incorporate again a strong element of community/village level dialogue and clearly articulated joint commitments. Social capital is in essence being built up from scratch in these areas, so proactive outreach and some display of competence and commitment in expanding basic infrastructure service capacity is critical. It will also be quite important for public sector security presence to be significantly enhanced for a pilot program in these more isolated regions. In the absence of enhanced security conditions, it will likely prove quite difficult in such areas to prevent expansion (or resurgence, depending on the particular case at hand) of illicit activities, particularly given the limited income generation potential of alternative crop production activities.

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ANNEXES

ANNEX I
LIST OF MEETINGS/INTERVIEWS HELD

PHONE INTERVIEWS:
David Mansfield, AD Expert and Researcher
Gary Kuhn, President, Roots of Peace
Richard Brittan, Managing Director, ALCIS
Jeffrey Robertson, INL
Richard Bielock, INL

MEETINGS HELD IN KABUL, AFGANISTAN

USAID/ Office of Agriculture
Mike Martin, Office Director
Mac Homer, Deputy Office Director
Paul Crawford, Senior Agriculture Advisor
Corey Fortin, RADP-South COR
Abdul S Ahmadzai, KFZ-Alternate AOR

MCN (Ministry of Counter Narcotics)
Mohammad Osman Frotan, General Director of Planning and Policy
Abdul Khaliq Mahjoob, Alternative Livelihood Director
Nazirqul Mirza, Minister's Office Director

UNODC/ Afghanistan Country Office
Anubha Sood, Senior Program Officer
Sadruddin Saraj, AL Adviser

INL - Kabul
Walter S Reid, INL/ Director
Heide Bronke Fulton, INL/CN Team Leader
Masami Tanaka, INL/CN Officer

IRD/KFZ (Kandahar Food Zone) Program
Zarko Draganic, Acting COP
Ligia Carvajal, Chief of Party (COP)
Dilip Wagh, Shamal Director
Wayne Minehart, Infrastructure Director
Martin Connaughton, Crop Production

MAIL (Ministry of Agriculture, Irrigation and Livestock)
Hamdullah Hamdard, General Director (Extension)
Shakir Majeedi, Strategic Planning Advisor
Hanif Sofizada, Advisor – Acting director for Private Sector Development
Saboor Shirzad, Alternative Livelihood Officer

Additional Meetings
Sanzar Kakar, Afghan Holding Group
John Corrigan, USAID FAIDA
Chuck Lambert and Fatima Mohammadi, RADP-S Enabling Environment
Gary Kuhn and Rod Carvajal, USAID CHAMP
Zdravko Shami, ABADE

MEETINGS HELD IN KANDAHAR, AFGHANISTAN

Frans Botha, Production Advisor, RADP-S
Hikmatullah Hikmat, Value Chain Manager, RADP-S
Abdul Ali Shamsi, Kandahar Deputy Provincial Governor
Ahmad Shah Roshan, Director of DAIL
Abdul Hakim Hakimi, Director of Sectorial and Technical Affairs
Gull Mohammad Shokran, DCN Director
Abdul Qayum, PRRD Director
Haji Fazal Mod, Panjwayi District Governor
Sayed Jamal Agha, Zahri District Governor
Abdul Rashid Hakimi, Vice Chancellor, ANASTU
Eng. Rosah, Mayor of Kandahar
Haji Naik Mod, DDA Head
Mohammad Yousaf, DDA Head
Muhammad Rahim Rahimi, Economic department Director
Hedayatullah Ramati, Head of AISA
Nasrullah, Director of Kandahar ACCI
Ahmad Ullah Faizi, Director of Kandahar Airport

FOCUS GROUPS

Traders Focus Group:
Hamid Helmandi, Businessman
Obaidullah Roshan, SSISCO Seed Company

Kandahar Farmer Focus Group:
Muhibullah, Lead Farmer
Amir Mohammad, Lead Farmer
Haji Hayatullah, Lead Farmer
Khairullah, Lead Farmer
Amanullah, Lead farmer
Abdul wahab, Lead farmer
Abdul Sabor Nasari, ADA (subcontractor to RADP-S)

Helmand Farmer Focus Group

ANNEX 2

FOCUS GROUP MEETING NOTES

Kandahar Farmer Focus Group – Twelve farmers were interviewed during this focus group session, and their participation in the discussions was very enthusiastic. They first explained the cropping pattern that has evolved in Kandahar. Wheat is grown over winter, and vegetables are grown from March to October-November. Different vegetables are grown at different times – some for the spring, some for the summer, and others for the fall. Some vegetables are dried for the winter months. In the past, the vegetables available in the market in Kandahar were from Pakistan, but now all of them are from Afghanistan. (This appears to reflect in part the impact of the AVIPA-SRAD projects).

They all mentioned that greenhouses were springing up all over the area, and this was visible in our visit to the city center. No greenhouses were present in 2010 around the city and now several are visible. The greenhouse technology is being demonstrated at the Amtex Farm as well as at all of the demonstrations. Another significant discussion point was that there is no cold storage for their grapes and pomegranates, due principally to the fact that there is very little electricity. [1]

Their biggest complaint, however, was the fact that they could not get proper diagnosis of their plant's diseases and bug infestations. They wanted a 'plant doctor'. It was agreed that what they most needed was a PFU (Plant Field Unit) similar to the VFU (Veterinary Field Unit) that would have para-agronomists, who could diagnose the diseases and pest, recommend the proper treatments, and have in stock the appropriate medicines. MAIL and DAIL are responsible for developing a diagnosis service for plant protection and plant health, insect detection and disease analysis, and to order the correct medicines, but they do not have the level of training that would allow them to do this, and relevant services are not available. Watermelons have melon fly, and pomegranates have a particular fly that eats them. Wheat has three diseases/pests - rust, iron deficiency and aphids.[2]

There was a farmer who was a member of the ANNGO (Afghan National Nursery Growers Association) who spoke about the importance of further expanding nurseries in the area, of which there are more than a dozen.[3] The farmers were asked if they had more water would they increase production and their answer was a resounding 100%. If they had more water no one would come to the city – they are happy on their farms. They consistently emphasized the importance of water, greenhouses, drip irrigation and demonstration farms. They mentioned saffron and basil as two new relatively crops with significant potential.

When they were asked what happened to the saplings planted by AVIPA in 2010, they answered that about 20% dies in the transplanting, but the rest were doing well and they were quite grateful. AVIPA also carried out pruning in their cash-for-work program, and in that regard the farmers mentioned that they all now do the pruning themselves.

The farmers indicated that they engage in drying activities for grapes, apricot, figs, plum and mulberry. In addition all expressed a wish for more processing for tomatoes and other vegetables, like they used to

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[1] From comments during the session as well as other anecdotal information, it appears clear that the large Indian Cold Store in the Industrial Park is not managed efficiently, and does not currently seem to serve the sector well. Both Grapes and Pomegranate could be stored for three to four months in order to garner a significantly higher market price.

[2] This request was a common theme throughout the interviews in all locations.

[3] AVIPA-SRAD distributed and planted over 1.3 million saplings from 2010 to 2012, all from local nurseries. Over 35 kinds of saplings are generated in Kandahar, ranging from the fruits pomegranate, plums, peaches, cherries, pears, mulberry, and grape cuttings, plus almonds, walnuts and pistachios. (Mohammed Helmandi brought pistachio scions and root stock from California some 10 years ago and is providing scions for grafting. RADP-W obtained 1,000 scions from his nursery last year.) The two year-old saplings that are transplanted take 2-3 years to bear fruit and five years to reach full maturity. Hence, they do not act as a poppy replacement-substitute during this period. But what the farmers wanted was more training on budding and grafting, which the RADP team is providing.

have with the cannery (which was abandoned some 20 years ago and then torn down for the KPRT). One farmer mentioned an old proverb 'you can't clap with one hand', referring to the need for downstream processing. They mentioned that there were now a few dairies in Kandahar.[4] They repeatedly referenced the urgent need for cold storage. They all additionally emphasized as well the importance of enhanced security.

Regarding livestock, it was referenced that if the year is 'green', the sheep are good; if not then cows are better. The sheep give lambs once or twice a year. Alfalfa is grown March to September, with from 7 – 10 cuttings.

The farmers emphasized their tradition of and interest in growing crops and vegetables. They also emphasized the importance of post-harvest processing, since a high percentage of fruit is damaged. They referenced the need for packing centers, cold storage capacity, grading rooms, and training in harvesting techniques. Their list of priorities emerged as 1) water, 2) security, 3) electricity/power, 4) cold storage, 5) plant veterinary support. They additionally emphasized the lack of credit access. They referenced in this regard that fifteen years ago there was credit, but not anymore. They need mechanization, preferring 2-wheel tractors because they cannot afford the large tractors they had 20 years ago. And lastly they mentioned the dilemma of 'improved seeds' for vegetables. Hybrid seeds, which appear in the market, cannot be reseeded, which means the farmer would have to buy new seeds each season, which is too costly for them. And they complained that imported vegetable seeds are often adulterated.[5]

[4] SRAD gave pasteurizing machines to four dairies in 2012) And again they repeated their need for cold storage.

[5] It appears in this regard that certified vegetable open-pollinated seeds are needed, as are certified virus free fruit and nut tree saplings.

Value Chain Agents Focus Group – Several companies and organizations were represented. The first major issue they referenced was with vegetable and non-wheat seeds. They noted that early on Afghanistan did not have a seed law. It was finally written and introduced around 2010-2011. The law responds to the interests of the EU on the proprietary issues of seeds, which is fairly universal. But now new seeds have to go through a propagation, testing and screening process in order to get released. MAIL certifies seed companies for carrying out this process with inspections to certify new seeds. At the moment, however, many of the seeds being brought in are hybrids, F1s, and they cannot be replanted. Hence, it is not effectively possible to test and screen the new seeds. Of course, this works against the farmer also, because then they have to buy new seeds every year.[6]

The seed companies underscored their interest in assistance in order to develop locally grown and tested, open-pollinated seeds. The seed companies would have interest in contracting with local lead farmers to outgrow their foundation or certified seeds, obtain MAIL verification and provide seeds and seedlings to their neighbor farmers.

It was noted that wheat and corn are the most important crops for consumption, but fruit and vegetables are for the market, with about 90% being exported. The participants indicated greenhouses have been adapted to the region and are spreading rapidly. Approx. 35-40 a year are being established, compared to none five years ago. Greenhouses are good for cucumbers, okra, eggplant, tomato, bell peppers, green beans, and many other vegetables, trellised or non-trellised. There are over 150 greenhouses in the area now. The greenhouses are put together with local materials, using PVC pipe and steel pipe. Plastic is ultra-violet treated, generally lasting a few years, depending on the wind. Several sizes are common, 120m2, 200 m2, 300m2 and even larger. A major issue currently according to participants is the cost of purchase. The small greenhouses are roughly $2,500 to $3,000. The larger ones are comparatively costlier. A key issue is credit for the purchase. Some greenhouse suppliers provide credit but 20% fail to pay back.

It was reported that one business man brought in pistachio from California and is providing scions for grafting, 23,000 scions have been grafted in the last few years, and they are better than those from Iran.[7] It was noted that the locally grown pistachios in Kandahar are tastier and 20% higher in price than the wild pistachio of Samangan, Balk and Badghis.

It was also noted that mechanization has expanded greatly in the last few years. Seed rills, land leveling, and regular plowing are all more accessible/available now. Massy Ferguson, Tafea and New Holland tractors are available. But it was emphasized that farmers need to be demonstrated the benefits of tractors and effectively trained in their use.

It was mentioned that one company is developing solar energy farms and building solar panels for local use.[8] Drip irrigation is another service that these companies are now reportedly providing, both spray pumped drip and gravity drip. It was noted that the most prevalent use of these systems are for orchards and vineyards, and greenhouses. In addition it was referenced that with the formation of farmer associations and cooperatives, there is the potential of bulk purchases for fertilizer and other inputs. The participants also emphasized that soil analysis is lacking, and there is a need for a local laboratory. The security environment was recognized as a general constraint to progress across these areas generally.

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[6] RADP-S has in this regard reporded that much of the seeds brought in are adulterated and have a high degree of trash in the cans

[7] Scions have been provided through RADP-W this year.

[8] AVIPA distributed 3,000 solar panels in 2011.

It was referenced that Afghanistan imports chicken on a significant scale.[9] The Kuchi's have sheep and goats, but the breeds are poor. It appears that new breeding stock is required. They want new embryos, not AI. The Boer goats have white hair, and Merino sheep are desired.[10]

It was reported that the biggest problem for livestock was the lack of alfalfa and clover for feeding over winter. Hay strae from wheat is used but is clearly not sufficient. Alfalfa and clover is grown after the wheat, and can get 7-10 cuttings. It was agreed that mechanical cutting machines and windrow balers are needed.

[9] Under RAMP there were hatcheries and poultry production, but this seems to have essentially disappeared again. This appears to represent a large opportunity, to produce poultry for eggs and meat.

[10] Dorper sheep also represent a good alternative – this is a recent RADP initiative.

Helmand Farmer/Enterprise Focus Group – Ten farmers traveled to Helmand for this discussion group meeting. In the introductions, they mentioned they represented greenhouse operators, farm service centers, vegetable producers and seed companies. The Farm Service Center had been in operation for 27 years, and a producer association had 32 members. The Greenhouse group had 22 greenhouses. They came from Gareshk, Nad e Ali, Lashgar Gah and Nawa.

When asked what were the biggest issues they faced in improving their livelihoods, the participants emphasized extremely poor security, lack of functioning markets, and limited irrigation facilities. They also referenced lack of open-pollinated certifies vegetable seeds as a major constraint. At the same time they have noticed new technology adoption, more high and low plastic tunnels being used by farmers, significant adoption of green-housing, some mechanization of agriculture, and a greater variety of vegetables being produced. [11]

The referenced greenhouses produce cucumber, okra, peppers, tomato and eggplant. A mixed seed packet sells for $100 US dollars. A key problem seems to be the above-referenced lack of local seed production. The Farm Stores sell a range of agricultural inputs – scissors, plastic, pruning shears, 4-wheel, 3-wheel and 2-wheel tractors, and many other items. Tractors can be leased.

It was reported that wheat, cotton and corn used to be the staples, but now all kinds of vegetables and fruits are being grown. There are still over 200 private cotton gins, and two large ones – the Government's Bost gin and a new private Pakistani gin. A new association has been created for 'mint' growers' for making mint oil. Grapes are still grown on mud slopes but trellises have been introduced. Watermelon and musk melon are the major open field vegetables. Along with tomatoes, cucumbers, eggplant and onions. Approx. 500 farmers are now growing soybeans. The cucumber seeds come from Turkey but they are F1 hybrids.

[11] Low tunnels were distributed with vouchers in 2009-2010, and now there are many throughout the Province.

Governor's Council - The Deputy Governor of Kandahar chaired the meeting, and the two District Governors of Zhari and Panjwayi were present. The Deputy Governor made a plea for donor projects to focus on outlier districts and include them in the development process – Argestan, Shah wali Kot, Kakrez, Spin Boldak, etc. He pointed out the difference between the KFZ Program and other donor projects, most of which he felt were Kabul designed and directed. He emphasized that KFZ, on the other hand, meets with and takes direction from the local Shura Council. He underscored his view that this is the way it should be done, to cooperate with the local shras, DAIL and local economy.

Referring to past projects, he mentioned that seeds are not enough without irrigation. The Dahla Dam services 7 districts of Kandahar. The reservoir has decreased 40% in 50 years. New canals and channels along with small check dams are needed.

It was recognized that security has improved over the last several years, especially in the nearby districts. It was, however, noted that enhanced security conditions have not been established in the outlying districts.

A representative of ANASTU was present, the new University across from KAF, and close to Tarnak Research farm (the ex-home of Osama bin Laden's training camp). Since the canals and dams in Zhari district were destroyed by the war, the District Governor place great emphasis on the need for repairing them and building new ones.[12] He also mentioned as a key needed support area on-farm water management technologies, and recognized the importance of the trellising programs of KFZ for grapes. He noted that the trellising leads to faster growth, more growth, lower disease and less water. He also underscored the potential importance of a processing plant for pomegranate juice.

The District Governor of Panjwayi agreed with his colleague from Zhari on the priority need for improved access to water resources. He also emphasized the potential of saffron. The need for enhanced cold storage access was also prominent in his comments. He urged repair of the regional dam – the locks were destroyed in the war. (He was referring to the Dahla dam, under repair by the Canadians). In addition emphasis was placed on the need for improved plant veterinary services.

He noted that the old cannery factory stopped producing 20 years ago (where the KPRT was established), and that a new cannery is urgently needed. He noted that pistachio is growing well in Daman and can be spread further out, as can olives. And that greenhouses are a must, as they would reduce dependency on vegetable imports in the winter.

He put great emphasis on the importance of ending monoculture activities, and the related importance of expanding associations, and promoting diversification and multiple cropping. He mentioned that basil could lay a role in supplanting poppy.[13] The critical need for refrigerated trucks was also referenced. In addition he noted that Afghanistan has great history of sheep and goats, and focused on the need to expand activities in this area.

A great deal of disappointment was expressed in the perceived lack of impact of training and extension activities – "Farmers forget in a month." There was a strongly felt view that training is not well-organized and effective, because outsiders come in to do it. It was noted in this regard that KFZ has been effective by focusing intensively on on-farm work and applications. And training is not well-organized according to MAIL because outsiders come in to do it.

Kandahar has 17 districts, of which 4 are insecure. The participants felt that at this time developmental support activities could be conducted in the remaining 13 districts.

[12] Reportedly KFZ is currently doing this.
[13] KFZ appears to be having good initial results with basil.

ANNEX 3

Descriptive Materials of KFZ Crop Measurement Methodology

Quality Assessment – KFZ Field Survey & Crop Classification April 2015

Assessment of the field survey points:

Total Points Collected	**898**
Total Field Parcels Visited	**830**
Duplicated Points (Visited by more than 1 team)	**68**
Points more than 20m Away from Indicated Field	**27**
Data Collection Location Accuracy (%)	**97%**
Data Collection Total (of Original 1000 selection)	**83%**

Points Collected

Crop Type	Collected Points
Wheat	293
Vineyard	224
Poppy	117
Bare	94
Other	56
Pomegranate	48
Alfalfa	18
Tomato	14
Okra	4
Corn	3
Watermelon	2
Graveyard	2
Egg Plant	2
Sweet Basil	1
Onion	1
Mulberry	1
Mint	1
Apricots	1

As can be seen for the table above, the numbers of points collected by crop type for the crops we are classifying are:

Crop Type	Wheat	Poppy	Alfalfa
Collected Points	293	117	18

Additionally we are classifying bare ground, this is easy to determine and is used in the MLS process to differentiate against individual crops.

QA/QC Checks on MLS Processed Data

1. Image Training Carried out using Field Survey Information (Ground Truth) – Approximately 30 – 50 points selected for this process for Bare, Wheat and Poppy, all the points collected for Alfalfa were used.
2. Visual Inspection overlaying all collected points was used to ascertain if the MLS Classification had been performed correctly. Additionally a 100% QA/QC was carried out using the High Resolution imagery to determine if the process had attributed the polygons with the correct crop type.
   Note: Due to the relatively small area of interest a 100% visual check is feasible. This may not be the case over larger areas. Larger areas will require a statistical sampling check to be developed. Due to the surprising/unexpected results in low numbers of hectares of Poppy, the whole processes was run 4 additional times to ensure we did not get this wrong, and to check our processes and procedures, including the 100% visual check.

3. A total of 69,598 polygons were created for the KFZ AOI 2015 dataset. The comparison between the years is indicated below, which show the farmers continually change the landscape to fit their growing patterns.

Year	Number of Polygons
2013	64,533
2014	76,885
2015	69,598

4. Accuracy of Ground Truth vs MLS

KFZ Classification 2015				
Crop Type	Alfalfa	Bare	Poppy	Wheat
Number of Crop Polygons	152	1,419	8,338	15,299
Field Survey Points	18	94	117	293
Number of Incorrect Classifications	0	0	9	12

The incorrect poppy classification are attributed to intercropping in Orchards/Vineyards due to the mixed results that are delivered, this was fixed during the visual QA/QC as it is determinable.

Incorrect wheat classifications were attributed to early ripening of the wheat in some small cases. The majority of the wheat is still in the dark green visual phase; however some has started to ripen and is turning golden, and was therefore missed by the MLS process. The MS Imagery is dated 25 & 26 April 2015, whereas the high resolution imagery is dated 17 April 2015.

Overall less than 90 polygons were changed, outside the indicated table above, where visual QA/QC indicated something else.

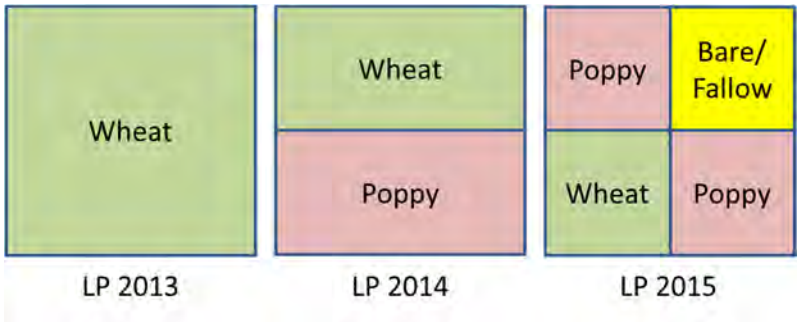
The report sent to USAID indicated an 80% confidence level in the data as this was our first attempt to classify crops across our Area of Influence. Internally as you can see the confidence in the data is higher, but we did not want to be over confident in our analysis the first time around, further development and analysis, with field work included, should allow us to refine this process. It is hoped the 2016 data will be available shortly, and a more detailed study will run alongside the analysis to extract all required metrics. This was not the case for the 2015 data, as it was not a requirement, and we were running the 2013 & 2014 visual analysis at the same time (MS Data for 2013 & 2014 was not made available). The use of Sentinel 2 data will also ensure we are getting the results cross checked; as it is of high enough resolution and spectral depth to enabled this cross reference. Landsat was used during the 2015 analysis, but purely as a visual representation/pattern analysis on screen.

Explanation of KFZ Crop Classification Methodology

There are several steps taken to determine this, and they all work in conjunction with one another in the attempt to eliminate areas or contention. 2 of these steps are key to this process, and could not work separately. Unfortunately the 1 major mis-communication is exactly what you are asking, and taking it out of context from other process steps makes it difficult to understand how it works and what is it doing. This is something I have never had the opportunity to fully brief, but really show as this would have removed all issues a long time ago.

I have mentioned we capture the polygon data first, this is key. We capture this data visibly, using field boundaries and crop boundaries.

Below if you can imagine a single land parcel (Field), in 2013 the farmer grows wheat as a single crop, in 2014 he splits his field in half, and grows both wheat and poppy, we capture this a 2 polygons, and then he further sub divides this in 2015, and we capture this as 4 polygons. Therefore what we are doing is not only capturing what we see on the ground, we are assisting the subsequent process to be able to analyse individual packets without having to decide the 51% rule, as each polygon is 100% the same crop. I hope that makes sense so far.



Now the reality presents itself when using imagery. Lets look at a single field.

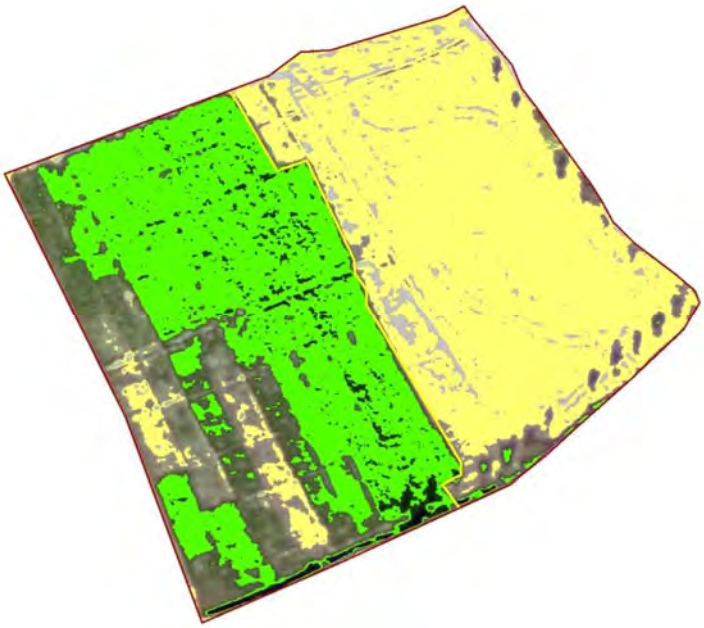
As you can see in the left, the field in the middle has a daffinate boundary. There are some crops to the left of the field, and the right is prepared, but no crops are visible.

If we assume that the visible crops on the left are the same across the entire left had side, just at different levels of growth, this would be captured as 2 separate polygons.

As you can see, the capture process is based on crops, not the field boundaries, so if the farmer sub divides his parcels, this is captured as separate fields/crops.

Now the issue of the majority capture. As discussed we are capturing fields based on visible crop types, and therefore we have a single crop per polygon. The tool that captures this data, and then adds the value to the polygon does not determine if the crop is Wheat or Poppy as this will never be the case.

A farmer will not grow a line of wheat followed by a line of poppy, he will separate his field into a block of wheat and a block of poppy, and we have already captured this in the first step. This is critical to remember. As you can see above, the 2 fields on the left and right are separate blocks/polygons. The one on the right will almost entirely display as bare ground (Image to the right), where the field on the left will display differing returns, even though we can easily assume that the farmer has planted the same crop, as the growth rates are different, possibly due to inadequate irrigation methods etc. We capture using the majority rule and the whole polygon is given the same crop type, which in this case could be wheat. The area calculation is carried out on the polygon and does not use the crop classification processes at all.
As you can also see, even though the field on the right was entirely bare ground, the returns have picked out the trees scattered along the edge, and there are visible gaps in the data, the Mode tool basically clears up this 'Clutter' in the data to return a value. The values are numerical, ie. 1=Wheat, 2=Poppy etc, once these values are assigned to each polygon, we can convert them to text.



Intercropping:
I would also like to clear up the issue of intercropping, I beileve this word has been possibly used in an incorrect context over the years. We use it to indicate where 1 crop is planted in the same field in the

winter cycle, followed by a secondary crop during the summer cycle. As mentioned the farmer will not mix up crops in the same field, but will plant in separate blocks.
We use this word to indicate where Poppy is planted in a Vineyard/Orchard as both these crops are summer cycle crops, and Poppy is a winter cycle crop, so essentially poppy is mono cropped in the winter and the Vineyards/Orchards are Summer crops without any other crop competing in the same space and at the same time. When it come to the imagery light rflectance analysis, the only crop visible in the winter cycle would be poppy, because the orchards/vineyards will not have started growing/showing leaves to therefore return a signature. However we know that both orchards/vineyards are established/invested over a longer term, and they are visible to the naked eye, so we can indicate where this practice is occuring .

Crop Capture:
To answer your questions further, it is possible to break down the 'Other Crops' however this will require a lot more time and effort, as well as research and data to achieve. Unfortunatly many vegetable crops are also short lived, and similar in their reflectance values. We rely on NGA to provide us the data, and imagery is really a snap shot in time. If we had access to many scenes over time, we would be able to achieve this in a much more detailed way.
The same applies to the summer cycle, so far there has been little interest in this crop cycle, I guess because poppy is not grown then, and the quantity is also greatly reduced due to lack of water in the summer months. However doing this would greatly enhance our understanding of the whole picture, rather than half of it.

As for the UNODC estimates, my comments are about extrapolation of our figures against theirs, of course this is fraught with danger. An example of this would be the following and can only be based on our data capture compared to theirs.

The graph lines have a very similar slope (2013-2015) however the UNODC line is much higher on the chart. Taking the difference in % between our actual measurement and the UNODC Estimate, and interpolating that % difference across the country, the figures reach what we discussed. Again as mentioned, this would not be the correct way to do this, and is fraught with danger, but it was a facinating insight into the differences between the methodologies.

Islamic Republic of Afghanistan
Ministry of Counter Narcotics

KANDAHAR FOOD ZONE PROGRAM
(KFZ)

KFZ – Crop Classification Methodology

Semi-Automated Classification from Imagery

Research: Ahmad Shah Frahmand MSc

7/8/2015

Dilip Wagh

This document will provide a detailed description on the methodology designed and developed by KFZ to extract Crop Data from multiple imagery sources, using GIS techniques combined with data manipulation processes.

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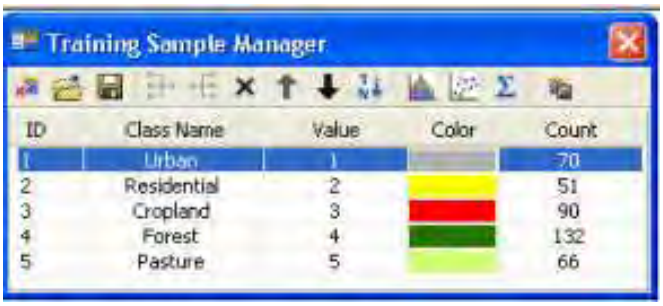
Glossary of Technical Terms

1. ***Supervised Classification*** *- Supervised classification is much more accurate for mapping classes, but depends heavily on the cognition and skills of the image specialist. The strategy is simple: the specialist must recognize conventional classes (real and familiar) or meaningful classes in a scene from prior knowledge, such as, personal experience with the region, by experience with thematic maps, or Ground truth. Supervised classification uses the spectral signatures obtained from training samples to classify an image. These training samples have been extracted from the ground truth data obtained from the* ***KFZ Field Survey run in April 2015****. With the assistance of the Image Classification toolbar, you can easily create training samples to represent the classes you want to extract. You can also easily create a signature file from the training samples, which is then used by the multivariate classification tools to classify the image.*

2. ***Unsupervised Classification -*** *Unsupervised classification is where the outcomes (groupings of pixels with common characteristics) are based on the software analysis of an image without the user providing sample classes. The computer uses techniques to determine which pixels are related and groups them into classes.*

3. ***Training Sample Manager*** *- The Training Sample Manager is the mechanism for managing training samples. With it, you can edit the class name and value, merge and split classes, delete classes, change display colour, load and save training samples, evaluate training samples, and create a signature file.*



The following table lists all the buttons on the manager and their functions:

Tool	Tool name	Function
	Clear Training Samples	Clear existing training samples and begin a new supervised classification session.
	Load	Load the training sample set from a feature class.
	Save	Save the training sample set to a feature class.
	Merge	Merge the selected training samples into a single multipart training sample.
	Split	Split a multipart training sample into its individual, component features. Each training sample will now be its own polygon.
	Delete	Delete the selected training samples.
	Up	Move the selected training sample up one row.
	Down	Move the selected training sample down one row.
	Reset Class Values	Renumber class values in ascending order (from 1 to n).
	Histograms	Evaluate the selected training samples with histograms. This button will be grayed out if there is no training sample created, or if the image is stored as a floating-point raster.
	Scatterplots	Evaluate the selected training samples with scatterplots. This button will be grayed out if there is no training sample created, or if the image is a single-band raster.
	Statistics	View statistics for the selected training samples. This button will be grayed out if there is no training sample created.
	Create Signature File	Create a signature file for use in further classifications.

4. ***Maximum Likelihood Classification*** *- The algorithm used by the Maximum Likelihood Classification tool is based on two principles:*

   - *The cells in each class sample in the multidimensional space being normally distributed*
   - *Bayes' theorem of decision making*

   The tool considers both the variances and covariance of the class signatures when assigning each cell to one of the classes represented in the signature file. With the assumption that the distribution of a class sample is normal, a class can be characterized by the mean vector and the covariance matrix. Given these two characteristics for each cell value, the statistical probability is computed for each class to determine the membership of the cells to the class. When the default EQUAL A priori probability weighting option is specified, each cell is assigned to the class to which it has the highest probability of being a member.

   If the likelihood of occurrence of some classes is higher (or lower) than the average, the FILE a priori option should be used with an Input a priori probability file. The weights for the classes with special probabilities are specified in the a priori file. In this situation, an a priori file assists in the allocation of cells that lie in the statistical overlap between two classes. These cells are more accurately assigned to the appropriate class, resulting in a better classification. This weighting approach to classification is referred to as the Bayesian classifier.

   By choosing the SAMPLE a priori option, the a priori probabilities assigned to all classes sampled in the input signature file are proportional to the number of cells captured in each signature. Consequently, classes that have fewer cells than the average in the sample receive weights below the average, and those with more cells receive weights greater than the average. As a result, the respective classes have more or fewer cells assigned to them.

   When a maximum likelihood classification is performed, an optional output confidence raster can also be produced. This raster shows the levels of classification confidence. The number of levels of confidence is 14, which is directly related to the number of valid reject fraction values. The first level of confidence, coded in the confidence raster as 1, consists of cells with the shortest distance to any mean vector stored in the input signature file; therefore, the classification of these cells has highest certainty. The cells comprising the second level of confidence (cell value 2 on the confidence raster) would be classified only if the reject fraction is 0.99 or less. The lowest level of confidence has a value of 14 on the confidence raster, showing the cells that would most likely be mis-classified. Cells of this level will not be classified when the reject fraction is 0.005 or greater.

5. ***Multivariate Classification*** *- The goal of classification is to assign each cell in a study area to a class or category. Examples of a class or category include land-use type, locations preferred by bears, and avalanche potential. There are two types of classification: supervised and unsupervised. In a supervised classification, you have a sampling of the features. For example, you know that there is a coniferous forest in the northwest region of your study area, so you identify it by enclosing it on the map with a polygon (or with multiple polygons). Another polygon is created to encompass a wheat field, another for urban buildings, and another for water. You continue this process until you have enough features to represent a class, and all classes in your data are identified. Each grouping of features is considered a class, and the polygon that encompasses the class is a training sample. Once you have identified your training samples, multivariate statistics are calculated on them to establish the relationships within and*

between the classes. The statistics are stored in a signature file. In an unsupervised classification, you do not know what features are actually at any specified location, but you want to aggregate each of the locations into one of a specified number of groups or clusters. What determines to which class or cluster each location will be assigned is dependent on the multivariate statistics that are calculated on the input bands. Each cluster is statistically separate from the other clusters based on the values for each band of each cell within the clusters. The statistics establishing the cluster definition are stored in a signature file. There are four steps in performing a classification:

a. *Create and analyse the input data.*
b. *Produce signatures for class and cluster analysis.*
c. *Evaluate and, if necessary, edit classes and clusters.*
d. *Perform the classification.*

There are two input types to the classification: the input raster bands to analyse and the classes or clusters into which to fit the locations. The input raster bands used in the multivariate analysis need to influence or be an underlying cause in the categorization of the classification. That is, slope, snow depth, and solar radiation can be factors that influence avalanche potential, while soil type may have no effect. A class corresponds to a meaningful grouping of locations. Examples of classes include forests, water bodies, fields, and residential areas. Classes derived from clusters include deer preference or erosion potential. Each location is characterized by a set or vector of values, one value for each variable, or band entered in the analysis. Each location can be visualized as a point in a multidimensional attribute space whose axes correspond to the variables represented by each input band. A class or cluster is a grouping of points in this multidimensional attribute space. Two locations belong to the same class or cluster if their attributes (vector of band values) are similar. A multiband raster and individual single band raster's can be used as the input into a multivariate statistical analysis. Locations corresponding to known classes may form clusters in attribute space if the classes can be separated, or distinguished, by the attribute values. Locations corresponding to natural clusters in attribute space can be interpreted as naturally occurring classes of strata. The Spatial Analyst image classification toolbar can help you with the multi-step workflow required to complete a classification. With the toolbar you can create and analyse classes and clusters, create and validate signatures, and perform a classification in an integrated environment.

6. ***True Colour Imagery** – This format of imagery is based the rendition of an object's natural colours of an image and uses a 24-bit colour depth to display an RGB image. (Red, Green & Blue)*

7. ***Multi Spectral** - A multispectral image is one that captures image data at specific frequencies across the electromagnetic spectrum. The wavelengths may be separated by filters or by the use of instruments that are sensitive to particular wavelengths, including light from frequencies beyond the visible light range, such as infrared. Spectral imaging can allow extraction of additional information the human eye fails to capture with its receptors for red, green and blue. It was originally developed for space-based imaging.*

8. ***ArcGIS** - ArcGIS is a geographic information system (GIS) for working with maps and geographic information. It is used for: creating and using maps; compiling geographic data; analysing mapped information; sharing and discovering geographic information; using maps and geographic information in a range of applications; and managing geographic information in a*

database. The system provides an infrastructure for making maps and geographic information available throughout an organization, across a community, and openly on the Web.

9. ***SENESCENCE/STRESS MAPPING -*** *The long-wavelength side of the chlorophyll absorption (~0.68 to ~0.73 micron) forms one of the most extreme slopes found in spectra of naturally occurring common materials, plant or mineral (see Figure 1). The absorption is usually very intense, ranging from a reflectance low of less than 5% (near 0.68 micron) to a near infrared reflectance maximum of ~50% or more at ~0.73 micron). The properties of reflectance spectra (e.g. Clark and Roush, 1984) indicate such an absorption band is "saturated." In such a case, the absorption band minimum will not change much with increased or decreased absorption, but the wings of the absorption will change. When the chlorophyll absorption in the plant decreases, the overall width of the absorption band decreases. The short wavelength side of the chlorophyll absorption is not observed in reflectance as is the long wavelength side because of other absorptions in the ultraviolet (UV). The result of this combination appears as a shift to shorter wavelengths as the chlorophyll absorption decreases. This has popularly become known as the "red-edge shift" or the "blue shift of the red edge" and can be caused by natural senescence, water deprivation, or toxic materials (e.g. Collins et al., 1983; Rock et al., 1986).*
The ratio of two spectra, one shifted in wavelength, the other not, and each with steep slopes as seen at the "red edge," will produce a spurious feature when there is only a small shift between the two. If the blue shifted spectrum is divided by an un-shifted spectrum, a peak will be observed in the ratio. For a spectrum of green vegetation (from Figure 1a), a 1 nm shift will produce a residual feature of about 6%. The AVIRIS data have a signal to noise of several hundred in this spectral region, so red-edge shifts of less than 0.1 nm are possible to detect. We used field spectrometer spectra for the San Luis data set, and computed a ratio cube which would show a peak when a shift occurs.
The red-edge shift was mapped using the tricorder algorithm (Figure 5). The fact that the resulting image shows no horizontal scan line striping attests to the superb wavelength stability of the AVIRIS instrument. As indicated earlier, the senescence/stress crop fields are those which have been harvested, sprayed with a defoliant, deprived of water, or may have other toxic influences. The area covered by this scene is not affected by acid mine drainage from the Summitville mine, thus it provides a control for the region of what might be expected for normal conditions. There is a curious senescence/stress indication along the banks of the stream that enters the image at the top middle of the image to the lower left (stream flow is to the southeast). The other stream, flowing from the bottom middle of the image to the right middle edge (also flowing to the southeast) shows no similar anomaly. The cause is as yet undetermined.

CONCLUSIONS

Vegetation species mapping is possible with high precision using spectral feature analysis of data from airborne imaging spectrometers. Once calibrated, and after reference spectra have been selected, species mapping, along with senescence/stress indicator mapping can be achieved in less than 1 second of CPU time per square kilometre per species (or soil/mineral) on a 10 million floating point operation per second (MFLOP) workstation.
Imaging spectroscopy data can be used for environmental application, monitoring vegetation cover and its health, monitoring vegetation species, and providing a rapid overview of large areas. When applied to large areas, the cost to derive these maps is low in cost relative to field checking and monitoring on the ground. The species maps might be used for more accurate crop yield predictions

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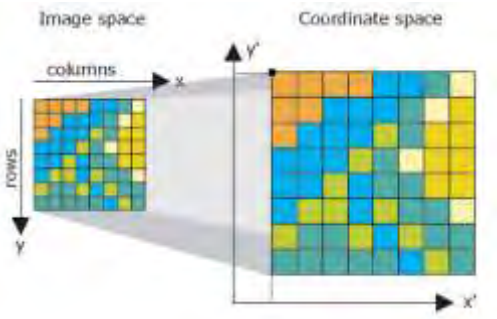
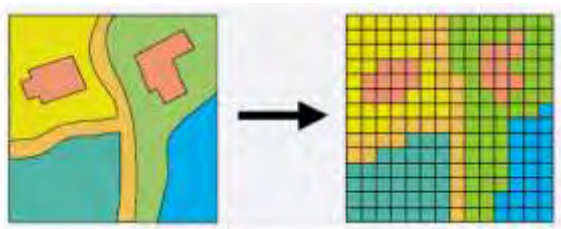
10. ***Raster Data (Imagery)*** *- Raster datasets represent geographic features by dividing the world into discrete square or rectangular cells laid out in a grid. Each cell has a value that is used to represent some characteristic of that location, such as temperature, elevation, or a spectral value.*



Raster Dataset Diagram

Raster datasets are commonly used for representing and managing imagery, digital elevation models, and numerous other phenomena. Often raster's are used as a way to represent point, line, and polygon features. In the example below, you can see how a series of polygons would be represented as a raster dataset.

A vector diagram represented as a raster



Raster's can be used to represent all geographic information (features, images, and surfaces), and they have a rich set of analytic geoprocessing operators. In addition to being a universal data type for holding imagery in GIS, raster's are also heavily used to represent features, enabling all geographic objects to be used in raster-based modelling and analysis.

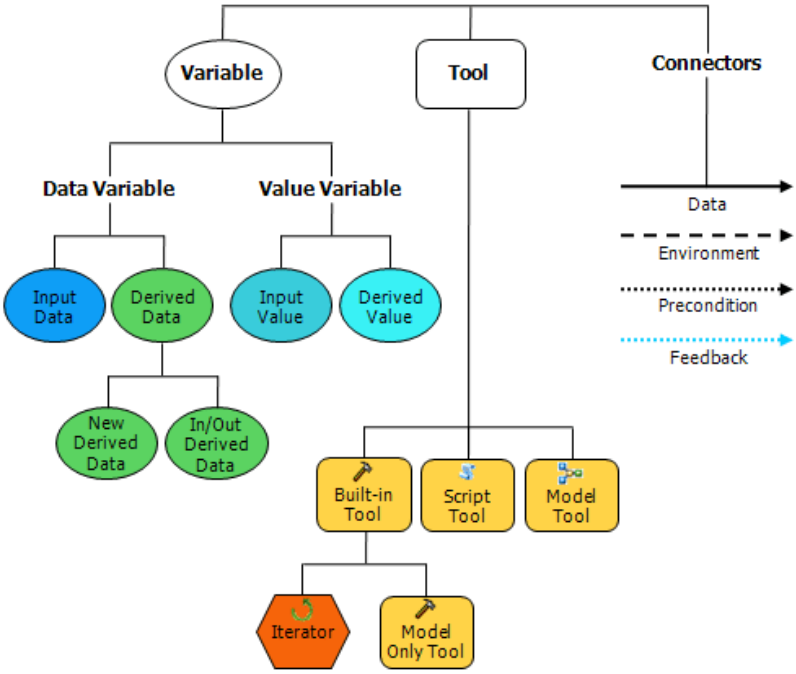
11. ***Vector Data*** *- In a GIS, geographical features are often expressed as vectors, by considering those features as geometrical shapes. Different geographical features are expressed by different types of geometry:*
    - ***Points*** *- A simple vector map, using each of the vector elements: points for wells, lines for rivers, and a polygon for the lake. Zero-dimensional points are used for geographical features that can best be expressed by a single point reference—in other words, by simple location. Examples include wells, peaks, features of interest, and trailheads. Points convey the least amount of information of these file types. Points can also be used to represent areas when displayed at a small scale. For example, cities on a map of the world might be represented by points rather than polygons. No measurements are possible with point features.*
    - ***Lines or polylines*** *- One-dimensional lines or polylines are used for linear features such as rivers, roads, railroads, trails, and topographic lines. Again, as with point features, linear features displayed at a small scale will be represented as linear features rather than as a polygon. Line features can measure distance.*
    - ***Polygons*** *- Two-dimensional polygons are used for geographical features that cover a particular area of the earth's surface. Such features may include lakes, park boundaries, buildings, city boundaries, or land uses. Polygons convey the most amount of information of the file types. Polygon features can measure perimeter and area.*

    Each of these geometries is linked to a row in a database that describes their attributes. For example, a database that describes lakes may contain a lake's depth, water quality, pollution level. This information can be used to make a map to describe a particular attribute of the dataset. For example, lakes could be coloured depending on level of pollution. Different geometries can also be compared. For example, the GIS could be used to identify all wells (point geometry) that are within one kilometre of a lake (polygon geometry) that has a high level of pollution.
    Vector features can be made to respect spatial integrity through the application of topology rules such as 'polygons must not overlap'. Vector data can also be used to represent continuously varying phenomena. Contour lines and triangulated irregular networks (TIN) are used to represent elevation or other continuously changing values. TINs record values at point locations, which are connected by lines to form an irregular mesh of triangles. The face of the triangles represents the terrain surface.

12. ***Process Automation*** *– This is a feature of modern software which enables a developer to model a complex process with many individual steps into a single semi-automated or automated entity. Within this document we have employed 2 distinct process modelling tools. Imagery is processed within ArcGIS and the built in Modelling Tool. The process to convert/extract Raster values into the KFZ Field Parcel Vector Polygons uses FME (Feature manipulation Engine, from Safe Software). This software has better modelling tools available to define the entire process. Both these tools remove the need for repetitive manual processing of data. Both tools can be run fully automated or in semi-automated environments.*

    - ***ArcGIS Model Builder –*** *Model Builder is how you create models and model tools. A model is nothing more than a sequence of tools and data chained together; the output*

of one tool is fed to the input of another. When you save a model, it becomes a model tool.
The diagram below shows how model elements are classified in Model Builder:



- ***FME -*** *FME (formerly known as the Feature Manipulation Engine) is an integrated collection of Spatial ETL (Extract, Transform & Load) tools for data transformation, data translation & Modelling. FME has over 450 'Transformers' (Tools) and can read and write to almost any form of data, this powerful tool allows many complex models to be designed visually with the ability to also connect models to each other.*

13. ***Imagery Used –*** *KFZ is using Imagery acquired from NGA (National Geospatial Intelligence Agency, US) as well as NASA & USGS Online Portals. New datasets are due to be released that may prove useful via the ESA (European Space Agency) Sentinel Satellites'. Once available a further study will be undertaken to assess the usability of this data. Below is a list of data used to date:*

Name	Data Type	Resolution	Source
World View 2	*True Colour*	*0.5 meter*	*NGA*
World View 2 MS	*Multi-Spectral*	*5.0 meter*	*NGA*
World View 3	*True Colour*	*0.3 meter*	*NGA*
World View 3 MS	*Multi-Spectral*	*0.5 meter*	*NGA*
Landsat 8	*Multi-Spectral*	*30.0 meter*	*USGS*

14. ***NGA –*** *National Geospatial Intelligence Agency - https://www.nga.mil*

Data Extraction Methodology

Introduction

KFZ is a USAID Funded program designed to provide technical assistance to rural livelihoods in 7 districts in Kandahar, and to educate farmers in transitioning to licit agriculture. The program will also assist individual farmers and provide technical assistance in the field. To this end, KFZ requires detailed cropping patterns at the field parcel level, to aid in analysis and developing the technical assistance of the projects.

Aim

The aim of this document is to detail the methodology for extracting pixel base information from a true colour, Multi –Spectral, Landsat 8 or other available Imagery based on a semi-automated Image Classification method using different algorithms and databases along with field survey data.

Methodology – Phase 1

KFZ is employing 2 distinct Phases in processing image data for Crop Classification. Phase 1 uses ArcGIS which provides both Supervised and Unsupervised classification tools. Phase 2 will be detailed later in this document. The image classification toolbar in ArcGIS provides a user-friendly environment for creating training samples and signature files used in supervised classification. The Maximum Likelihood Classification tool is the most robust classification method. A signature file, which identifies the classes and their statistics, is a required input to this tool. In the following workflow the signature file is created using ground survey/truth data and land parcels captured by KFZ staff.

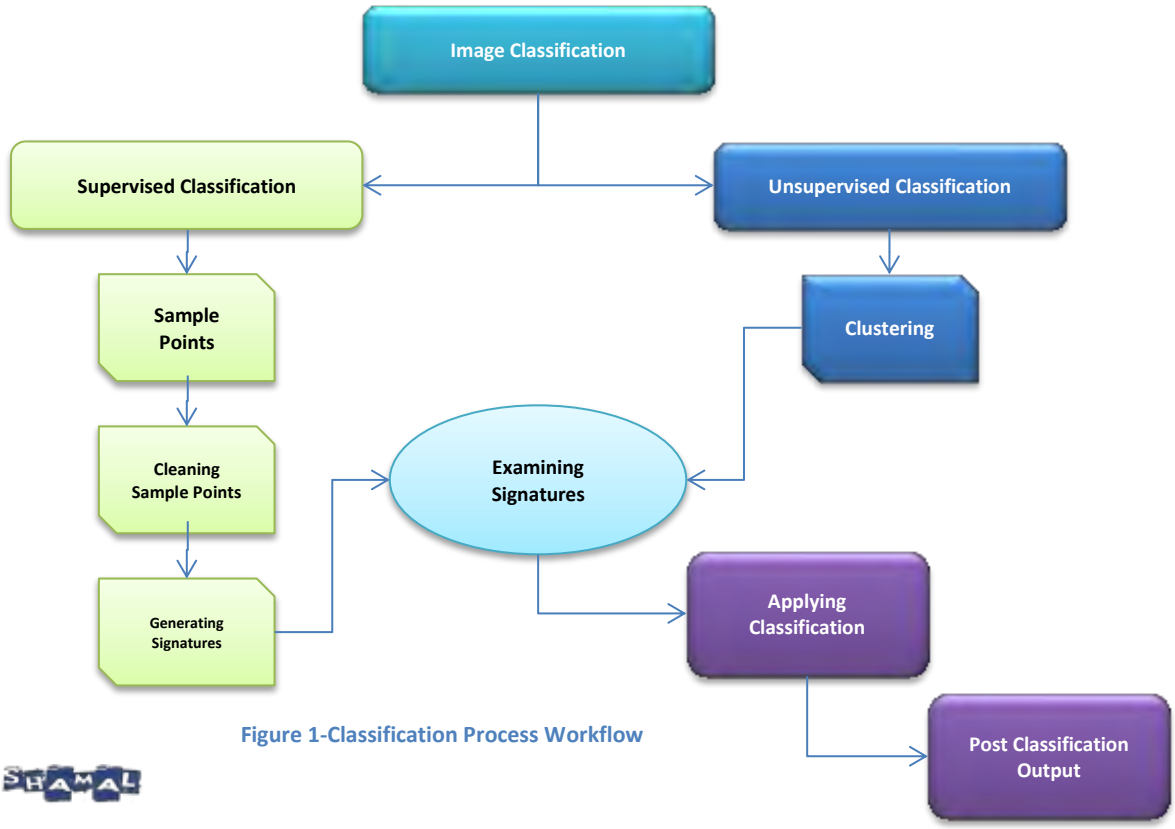


Figure 1-Classification Process Workflow

Supervised Classification

Supervised classification is much more accurate for mapping classes, the image analyst must recognize conventional classes (real and familiar) or meaningful classes in a scene from prior knowledge, such as, personal experience with the region, by experience with thematic maps, or by Ground Truth. This familiarity allows us to choose and set up discrete classes (thus supervising the selection) and then assign them category names. So the image analyst will locate Training Sites[3] on the image to identify the classes. In this study the training sites were created based on Field Survey Data (Ground Truth).

Field Survey Data Collection

In supervised classification, training samples are used to identify classes and calculate their signatures. Training samples can be created interactively using the training sample drawing tools on the Image Classification toolbar. Creating a training sample is similar to drawing a graphic in ArcMap except training sample shapes are managed with Training Sample Manager instead of in an ArcMap graphic layer. For this process we used KFZ Field Parcels with the Field Survey Data (April 2015) as ground truth points and based on the collected points & parcels, 'trained' the image for a

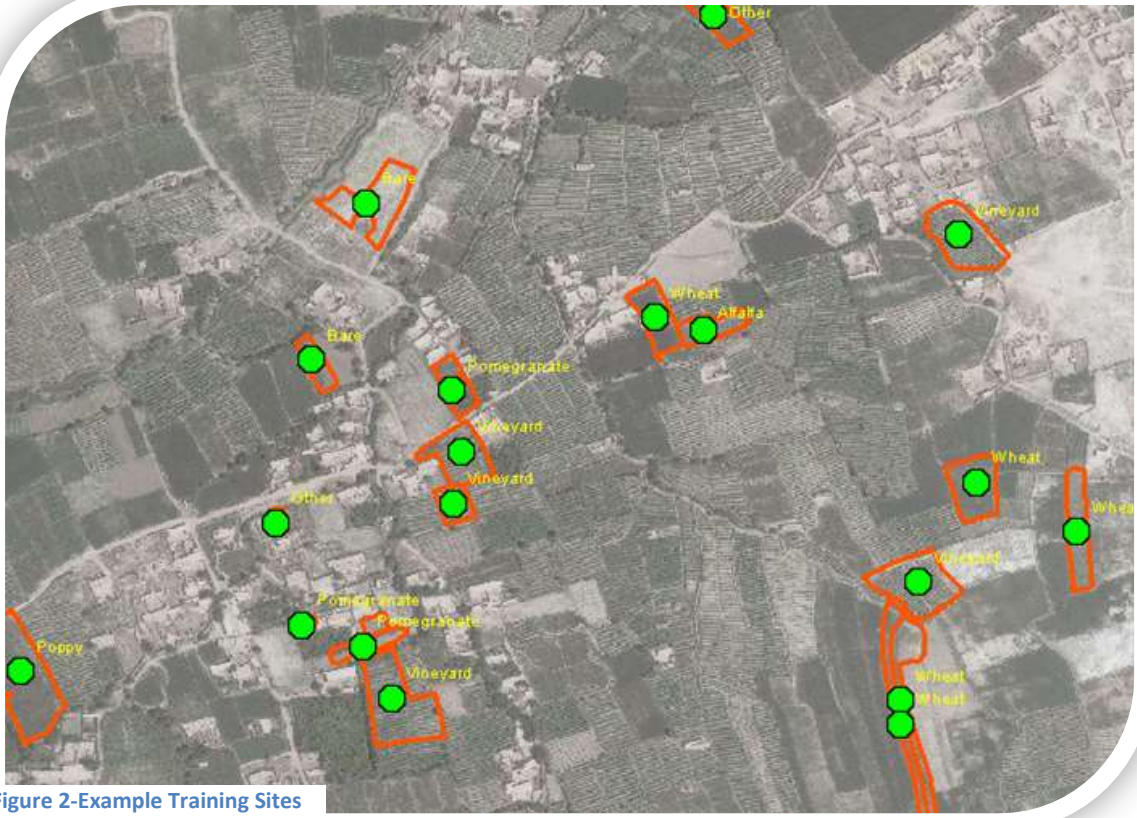


Figure 2-Example Training Sites

classification. Additionally some areas were digitized for additional vigour. At least 30 training sites were recorded for each class to ensure a robust signature gathering exercise can be performed.

Cleaning Field Survey Data

Field Survey data captured during the April 2015 survey task required some cleaning to ensure the correct points/polygons are used. For example if the surveyor stood outside or a small distance from the field to be captured, the polygons will need to be attributed with the information from the

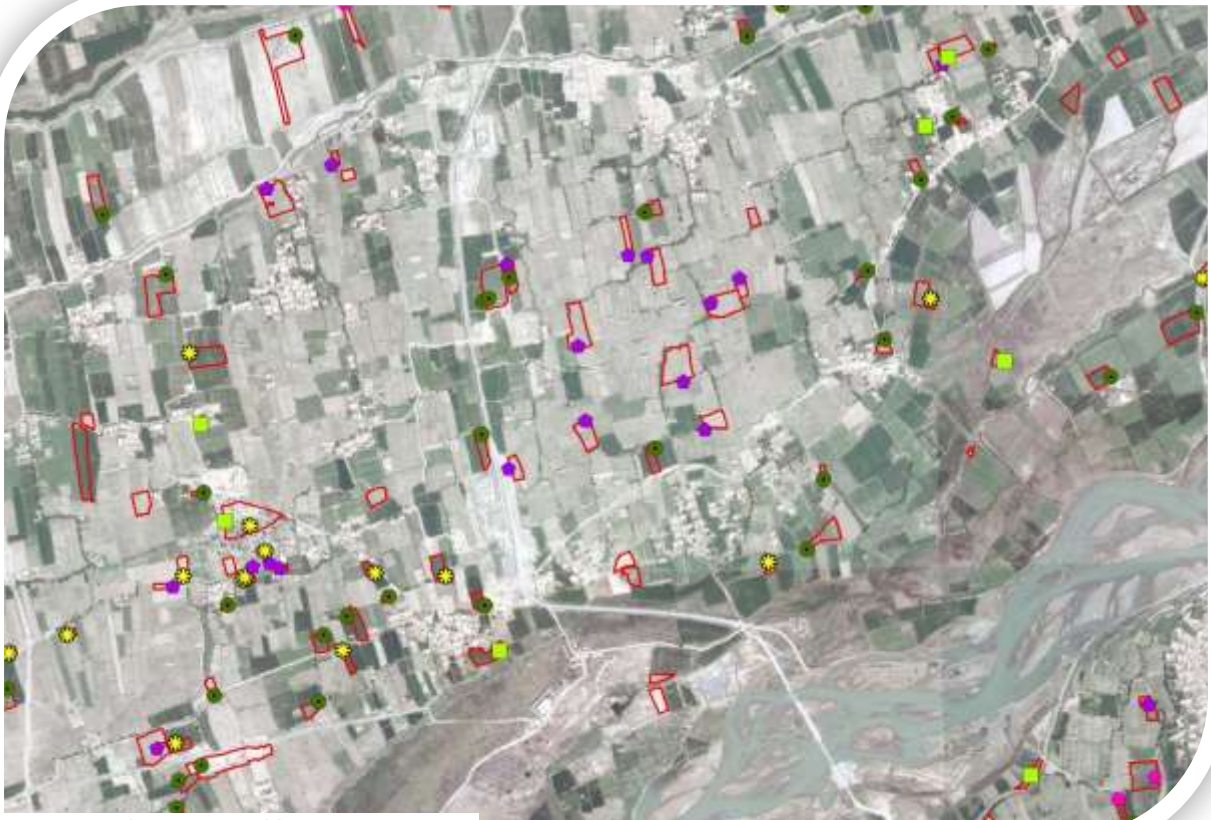


Figure 3-April 2015 KFZ Field Survey Locations

points, to exactly match the field boundaries.

Creating Signatures

This step in the supervised classification is the heart of the analysis; a signature file is required to classify an image. In this case all the created and cleaned polygons derived from the KFZ Field Survey April 2015 were used to classify the image. They are loaded into the Training Sample Manager Tool, and values generated for each class type, this will be reflected in the final raster output.

Training Sample Manager

ID	Class Name	Value	Color	Count
1	Urban	1		556
2	Residential	3		150
3	water	6		814
4	agricultural	10		466
5	other vegetation	11		455

Figure 4-Example Signature Creation

Examining the signature file

After the creation & attribution of all created and cleaned training sites, a visual inspection of all sites is completed. This ensures all sites are inspected and no sites have been selected in error.

Executing the Maximum Likelihood Classification Tool

Once the operator is satisfied with the selection of training sites, the Maximum Likelihood Tool is run. The output is a classified raster file with the pre-selected values. This can be displayed as required within ArcMap. This data is subsequently checked against the imagery to determine if the classification has been executed correctly, in some instances further training sites may be required to generate a correctly classified output.

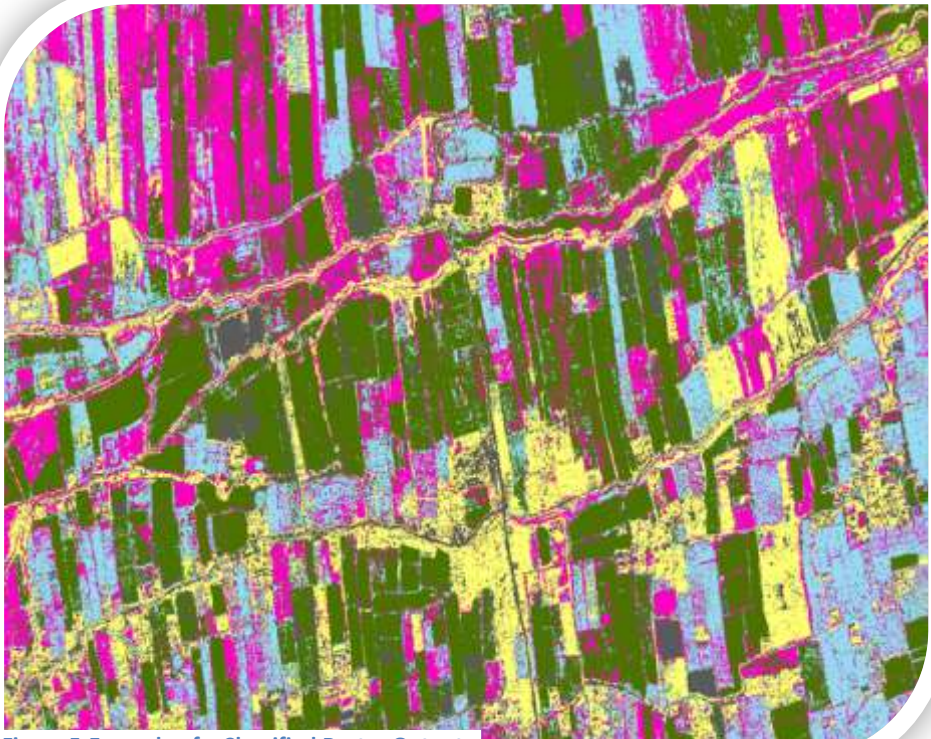


Figure 5-Example of a Classified Raster Output

Algorithm Selection

As mentioned earlier, there are different methods of classifying raster data available, the choice of using each individual method entire depends of the available data at any given time. The Maximum Likelihood method generates the best available result, when using several data sources, and as KFZ have ground truth data *(KFZ Field Survey April 2015)* available, these results are reflected in the outputs, giving maximum probability that they are based on reality. The maximum likelihood method has an advantage from the view point of probability theory, utilising ground truth datasets.

Maximum likelihood method employed produces results as close to reality as possible. There are some variances, but these can be attributed to double cropping, poor or unhealthy crops or crops on an earlier or later growth cycle. This would result in a small number of cases considering that most crops would be on a fairly even growth cycle.

During the research phase several methods were tested and compared against the ground truth datasets, Maximum Likelihood extracted the best results.

Process Automation

Process automation is used to increase the speed of generating outputs, but also removes possible human error when repetitive processing is manually carried out, and ensures the same process is run each time. The current KFZ Area of Influence has approximately 25,000 hectares of agriculture, and data sizes can reach up to 10's of Gigabytes. Image data have so far varied over different areas, and therefore each series of images with the same data have to be run independently to ensure the signatures correspond to the relevant dates. Automating this process assists in generating the correct resultant outputs. The first part of this process (Working with Raster Data) is executed in ArcGIS; subsequent processing is executed using FME (Converting the Raster into Vector Data)

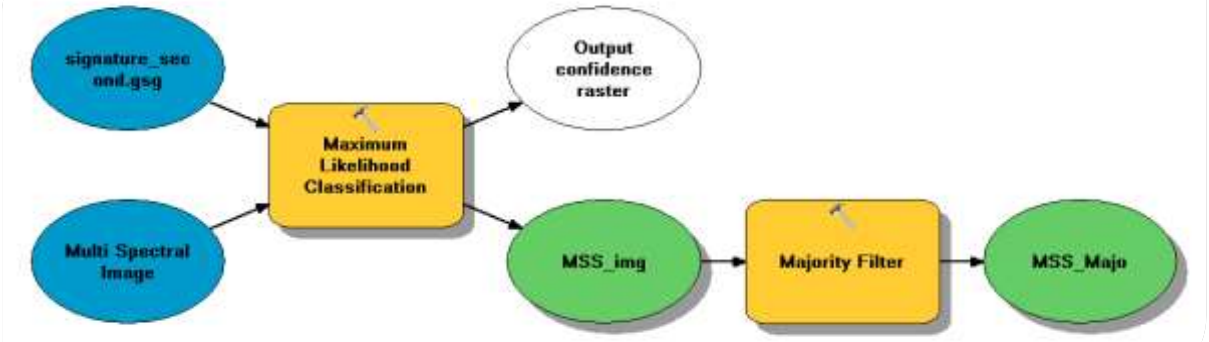
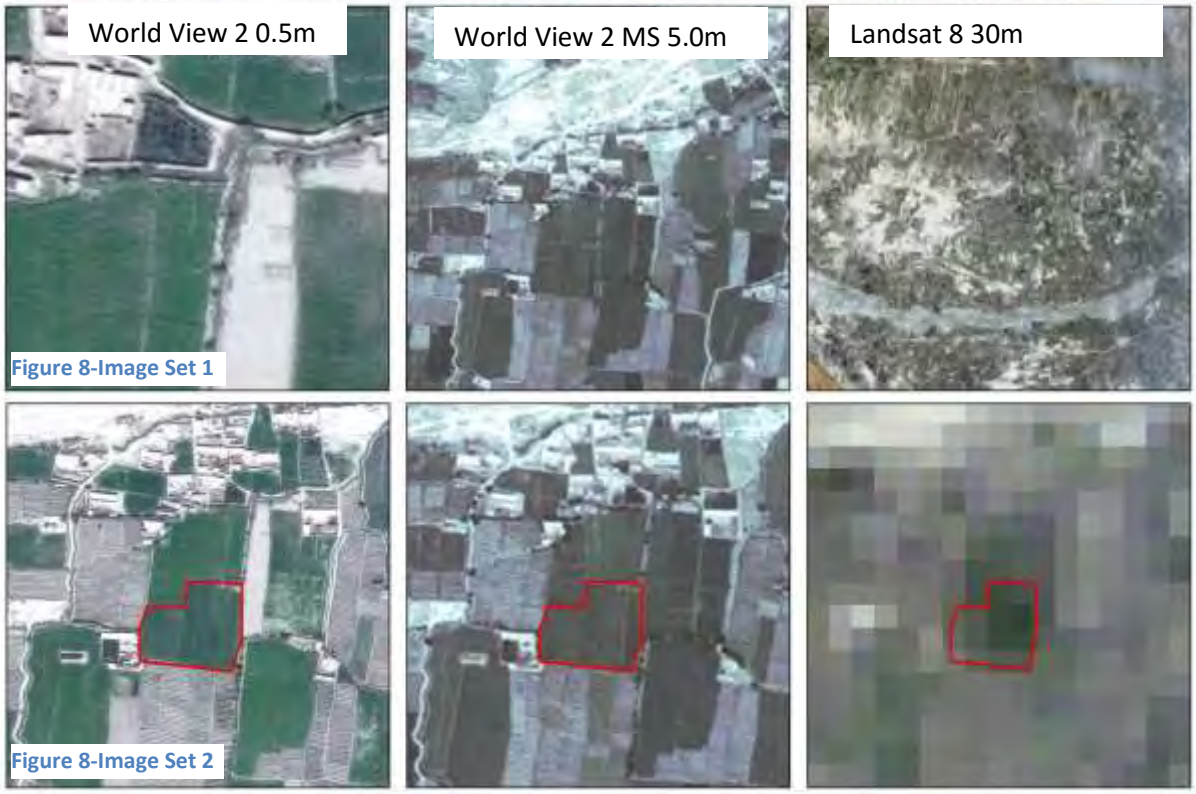


Figure 6-ArcGIS Classification Model

Imagery Used for Processing

All of the above examples have used high resolution imagery 0.5 meter or better in True Colour or 5.0 meter resolution Multi Spectral imagery. There is always a chance that NGA Imagery will not always be available due to potential cloud cover or other natural phenomena, other data sources are available (different satellites), but could be expensive to purchase as they are not owned by the US Govt. IR Sat (Indian Remote Sensing), Spot (French) etc.

Of course the best possible resolution will always output the most accurate results, but this data may not be available, using Landsat 8 at 30 meter resolution is possible (Landsat data is free to use). Accuracy is affected by resolution, and can cause pixel bleed across individual land parcels, but the data extracted could be used if nothing else of higher resolution is available, and returns acceptable results. The subsequent processing in Phase 2 (FME) attempts to clean much of the pixel bleed using resampling techniques.



The set of images above attempts to demonstrate the effect of image resolution. As you can see in Set 1, the images have been zoomed to their native resolution (1:1) the centre point is at the same location, and in Set 2, they have been zoomed to the same scale at the same location, the Land Parcel polygon is the same in each image. World View in each case can be used with confidence, the Landsat 8 images details the existing issues we have about image bleed.

Landsat 8 Trial

The following image shows the results from a Landsat 8 Image, and the results are very similar to that achieved using high resolution imagery, the difficulty is extracting this information accurately

and attributing the Land Parcel polygons. Phase 2 of the image processing will attempt to detail how this can be achieved.

Methodology – Phase 2

There are 2 distinct process steps in the KFZ methodology, both using different software, to facilitate an accurate, logical and measured approach in transferring the data to an operational working format which is used in multiple applications.

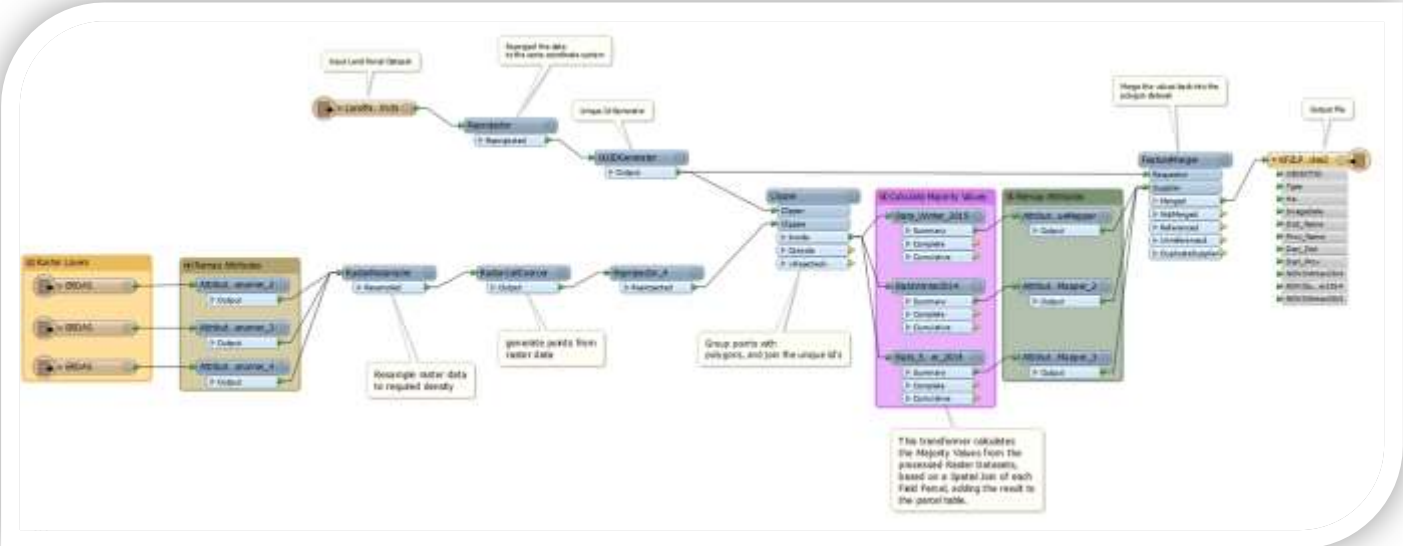
Data Extraction

The first step in the process is to generate the crop classification from Imagery (Phase 1), this produces a raster data output, and therefore in GIS terms, is defined as dumb data, as in it does not store any information above the pixel values and geocoding, the values are what has been assigned by the earlier classification processing steps and are numerical values (Figure 4). To add value, enable data mining and relational searching, the pixel values need to be added to the land parcel vector data KFZ has generated. A simple raster to vector conversion does not yield great results, this has always been a limitation of using raster data.

To overcome these limitations, KFZ has developed the second process step, which further extracts raster values deemed crucial from the raster data, and adds them to the Land Parcel dataset. This is a process designed and run using FME (a data modelling tool).

Land Parcel Attribution from Raster Data

Extracting information from the raster classification datasets requires a more complex set of tools, which are not available in ArcGIS, FME allows this to be developed more than other software, and can also be automated. The following model developed allows this data to be extracted and updates the Land Parcel dataset accordingly.



The model can be broken down into distinct groups, and will be explained by the following:

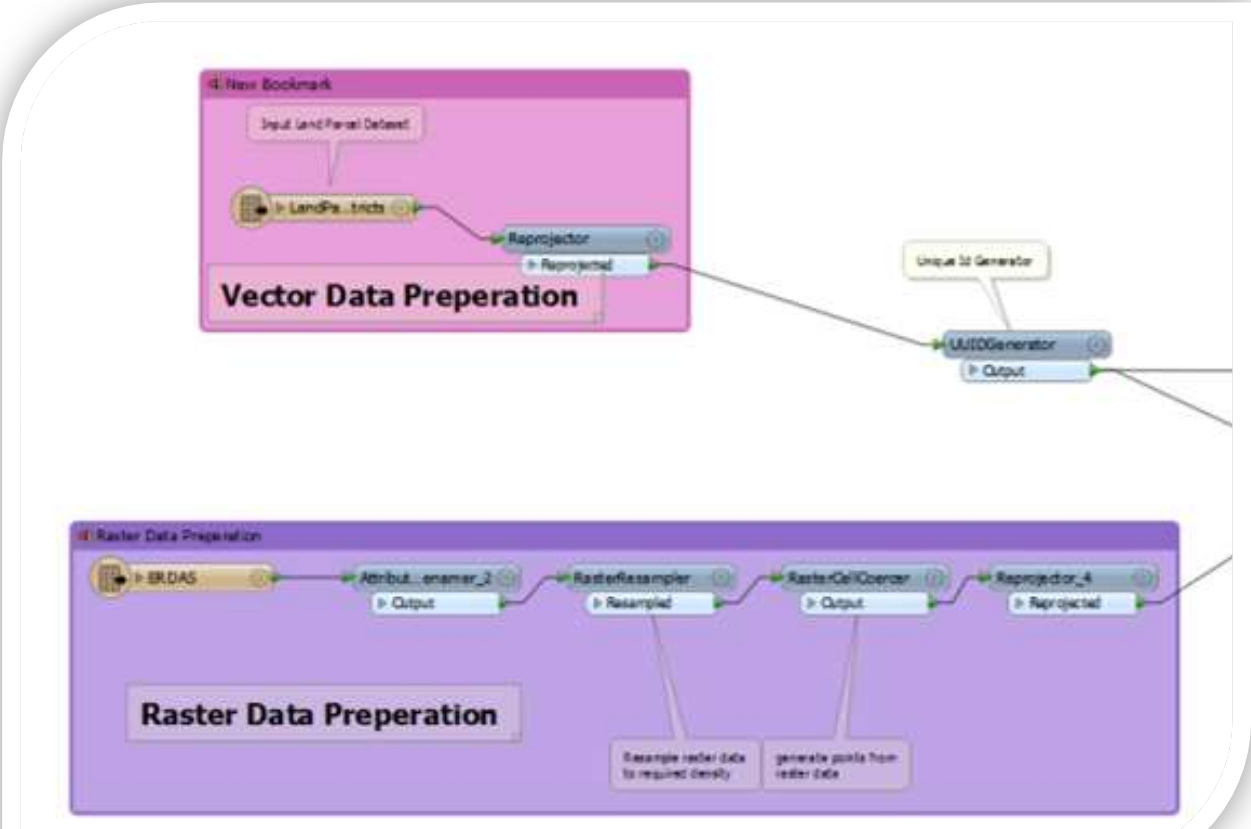
Input Datasets

There are 2 main input datasets for this model, the Classified Raster Data & the Land Parcel Vector Data

Workflow Steps

There are several complex steps in this workflow as can be seen in the highlighted image.

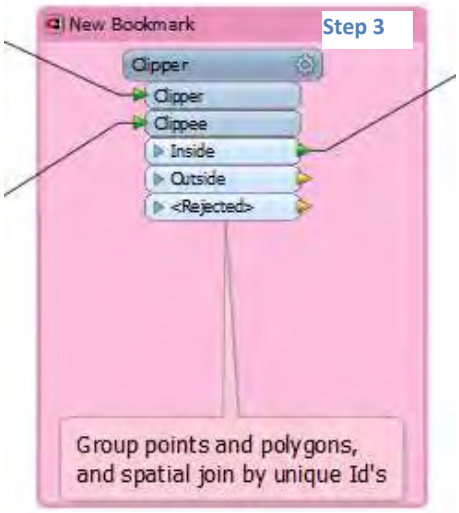
1. The input data needs to be prepared for its processing within FME as well as ensuring the



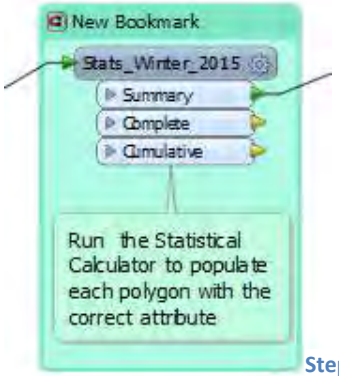
Steps 1 & 2

spatial relationships will be geographically coincident; therefore the data needs to be in the correct geographic projection. The vector data is also assigned unique values, which are subsequently used to facilitate the join in the final stage of the workflow.

2. The raster data is pre-processed and then each pixel is converted to a vector point feature. Depending on the input resolution, the data is resampled to the required parameters. This only applies to medium and lower resolution datasets to ensure that the values required are spread evenly across all areas (Landsat 8 for example).
3. The next step creates a spatial join of the data by each land parcel, joining the unique IDs to each point that lies within a land parcel. This ensures only points inside each parcel are carried forward to the next step, which helps to negate some of the image bleeding occurring with the lower resolution images.

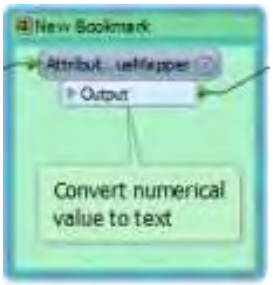


4. The next step is the heart of the operation, which determines which is the correct value to transfer from the point data into the land parcel polygon data. The methodology used is as follows: *'All points coincident to an individual land parcel are calculated and aggregated by their raster value. A table is generated in memory which then selects the value based on the highest count'*.



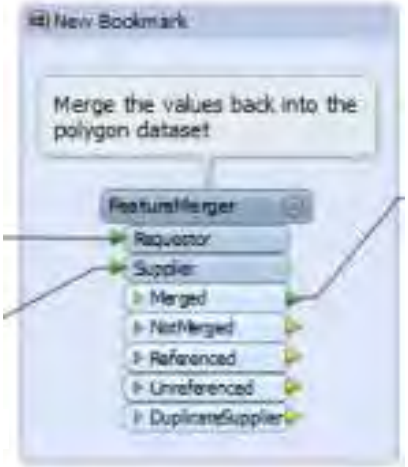
Step 4

5. This transferred value is converted into text in this step, making it easier to read the data.



Step 5

6. The final process step combines the newly generated values which are in table form with each holding a unique id, and re-joining based on the unique id. This results in a fully attributed polygon land parcel dataset, with all the resultant raster values.



Step 6

Final Analysis

Once the Vector dataset has been processed a further visual inspection is carried out to ensure there are no errors, and that the process and built in logic have executed correctly.

There are some areas where scattered results are being returned, this is to be expected in raster data classification, and the Phase 2 process has been built to differentiate between this, returning a majority count on Crop Types per Polygon. There is a case for potential of double cropping, however experience shows that this is usually between 'Winter' and 'Summer' cycles, rather than double cropping of 2 crops in the same field parcel in the same growing season. Crop Classification using remote sensing is being used across the world, and is a reliable source of data, accuracy is important, and the process KFZ has designed takes advantage of the technology to enhance accuracy and remove the possibility of human error as much as is practical. The results have shown that using these tools with ground truth data increases the confidence of the final datasets.

Process Visual Sequence

Below are example graphics showing each stage in sequence.

Figure 10Raw Imagery (World View 2 Multi-

Figure 9-Land Parcel Data

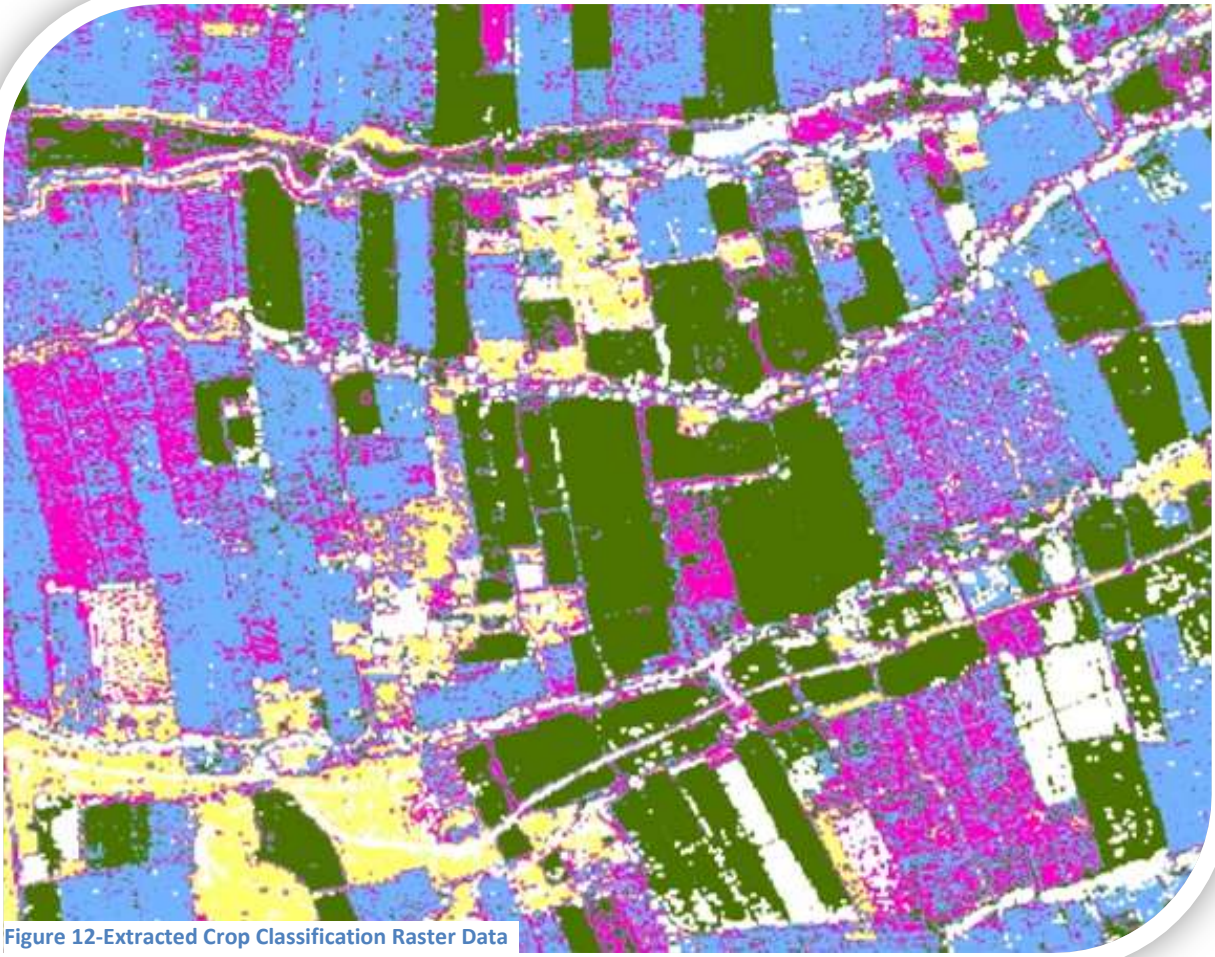


Figure 12-Extracted Crop Classification Raster Data

Figure 11-Final Vector Output

Next Steps

As previously mentioned, once we have the base data as a Vector Dataset, many other applications can use this data outside of a GIS System. Shamal is able to use this to aggregate information based on many different aspects, such as District, Crop Type, Association - either Tabular or Spatial and generate graphs/charts or other detailed analysis. Further information has been introduced such as Quality of Crops and Water Content Indices', which further enhances the information this dataset holds.

The program is also using this data in planning activities across all AL/AD & Infrastructure projects, which greatly enhances the planning cycle as well as implementation on the ground.

Recommendation

Employment of these processes will greatly enhance understanding of the reality of Agriculture in Afghanistan, and will not only facilitate Program/Project planning and design, but will also have the ability to influence the real implementation of projects in the field, with accurate and timely data, which is essential if assistance for change is to be achieved.