Research Article

Measuring Multidimensional Poverty Among Farm Households in Rural Pakistan Towards Sustainable Development Goals

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Abstract | Poverty is multidimensional and presents a great threat to achieving the targets of the "Sustainable Development Goals" (SDGs) across the world. This study makes contribution to the ongoing debate regarding capability, social exclusion, and participatory approaches as measuring strategies for farm poverty. This study was designed to develop a new methodological framework to measure multidimensional poverty that builds on the previous index for measuring three dimensions of poverty at the micro level, and a method to calculate the extent of poverty by using the Alkire and Foster model. The expanded dimensions of multidimensional poverty identified are wealth status, participation/empowerment, environment, health, education, and standard of living. We apply the methodology to a study in northern Pakistan. The index of multidimensional poverty demonstrates that alongside the other dimensions there is severe poverty in terms of environment, empowerment/ participation, and wealth dimensions. The measure of intensity of the poverty shows that 55% of the population was severely poor while the MPI value demonstrated that 54% of the population was severely poor. The regional and resource-related causes contributing to this poverty include isolation and remoteness of the area, low infrastructure, and poor access to markets and to social and communal services. The study suggests that multi-sectorial interventions and investment in terms of education, infrastructure, environment, financial services and agriculture development are necessary to overcome the situation and improve the likelihood of achieving the targets of the SDGs.

Introduction

The origins of multiple dimensional poverty analysis go back to Sen's (1979, 1985) capability theories, which clarifies that financial and social courses of action ought to be assessed regarding individuals' abilities and capacities to lead their preferred life.

Poverty is by and large characterized in connection to a given setting, which might be worldwide, territorial, and national, regional or personal (Daimon, 2001). Poverty is an idea that is not effortlessly characterized and measured. Further, recognizing the poor for any social mediations is normally testing with respect to precisely focusing on qualified recipients (Aryeetey

et al., 2013). The complexity of measuring poverty reflects the plural character of its definition (Bossert et al., 2013). A few conceivable outcomes have been proposed in hypothetical and experimental writing by various specialists (White, 2017), but overall the body of evidence suggests that poverty is a multidimensional phenomenon, referring to multiple aspects of well-being beyond shortfalls in income or consumption which is, a myopic perspective for understanding poverty (Alkire and Sumner, 2013; Alkire and Santos, 2010; Garroway and de-Laiglesia, 2012; Paris HLP, 2013; UN, 2013; OECD, 2013).

Poverty, being multi-dimensional in nature, is the result of different banding financial variables including handicap, lack of education, old age, household size and status, reliance, low wages of female laborers, and family unit obligations (Rahman, 2013). Poverty is related not just one with measurement i.e. income/consumption, but in addition with lacking results in regard to wellbeing, sustenance, literacy, insufficient social relations, weakness, low confidence, and feebleness (UNDP, 2015). Levine et al. (2014) noted that these deprivations also occur in ecology and poverty occurs when an individual or household experiences a number of cumulative deprivations. Very recently, it has been argued that the conceptual space of poverty includes dimensions such as hunger, powerlessness, voice-lessness, dependency, shame and humiliation, lack access to basic infrastructure, little attention for schooling, economic vulnerability, ill-health and gender inequality (UNDP, 2015; Gerlitz et al., 2015; WB, 2015).

Measuring multi-dimensional poverty generally includes the construction of an index incorporating information from a range of indicators of selected dimensions. At that point sufferings on a base number of the measurements are chosen, and soon thereafter one is viewed as poor. Laderchi et al. (2013) identified four types of approaches; i.e. monetary, capabilities, social exclusion and participation as a measurement strategy for the poverty. The Multi-dimensional Poverty Index (MPI), created by the Oxford Poverty and Human Development Initiative (OPHI), is depicted by its makers as an index of intense multidimensional poverty with respect to especially simple managements and core human functioning (Alkire and Foster, 2011a). The MPI decides multidimensional poverty not by income, but rather by deprivation on three measurements: wellbeing,

education, and way of life at the household's level, utilizing ten indicators crosswise over nations and within nations (Alkire and Foster, 2011b). Our study explores three further dimensions: Environment, participation/empowerment and wealth/assist as a measurement strategy for poverty in addition to Alkire and Foster's (2011a) three dimensions.

Environment

For participation in natural resource management (NRM) activities in rural areas one needs to consider the abundance of natural resources, and community involvement to benefit from these directly or indirectly. During the last couple of decades, community-based natural resource management has been a widely adopted mechanism to combine rural development, prevention of environmental degradation and to reduce rural poverty (Imperiale and Vanclay, 2016; Fabricius et al., 2013; Hulme and Murphree, 2001). The literature demonstrates that linkages between poverty and environment have a long history in the development world. Environment plays a critical part in the life of individuals living in poverty. The poor are more helpless against natural calamities and the effects of environmental change (Gabol et al., 2012). Their helplessness is inseparably connected with their living in ineffectively developed homes, frequently in groups presented to ecological dangers, for example, surges, avalanches or dry spells. The poor are additionally packed in regions lacking fundamental wellbeing managements or framework (Bailey and Lewis, 2009). Further, the welfare misfortunes related with environmental change are probably going to be considerably more prominent for poor nations and needy individuals (WB, 2011).

Participation

In the multidimensional view of poverty, the poor are compelled in their workplace characterized as "what the individual is allowed to do and accomplish in quest for whatever objectives or qualities he or she sees as vital" (Sen, 1985). The idea of workplace is applicable in every single social experience, incorporating into the instance of participation in development activities (Kohl-Arenas, 2011; Ansoms, 2013). The literature on participatory approaches explains that this form of development involves participation of stakeholders such as government, beneficiaries, donor agencies and NGOs, and the local residents (Khan and Bibi, 2011). Recipients' awareness about development organizations is also important for

getting the maximum benefits from development and poverty reduction activities (Carrillo et al., 2007; Gibson, 2015). Cooperation and neediness decrease have as of late increased impressive significance in the dialect of traditional improvement (Cornwall and Brock, 2005; Dhakal et al., 2007). The literature points to a close positive association between poverty and participation, and to long relationship with social developments and with the struggle for citizenship rights and voice (ILO, 2002; Cohen and Uphoff, 1980; Salole, 1991).

Wealth

Wealth and household welfare are positively related and in this case land possession, household's head's profession, presences of physical assets, and cultivated land availability play an important role (Mosites, 2016; Israr et al., 2013; Li et al., 2014).

Health

Health dimensions have been measured according to the indicators of the number of ill and disabled persons in the household, access to a hospital in terms of time taken, and access to maternal health services at the local hospital (Holmer at al., 2015). The relation between health and poverty is negative and high health is associated with low poverty. Lengthy ill-health, disability in the household, absence of access to health managements and maternal health are motivations for poverty spirals and, thus poverty can make and sustain weakness status (Holmer at al., 2015). The importance of household health status can be seen by the fact that the UN new development agenda Transforming our World, 2030 defines health in goal 3 of the SDGs as to "ensure healthy lives and promote well-being for all at all ages," and advances 13 targets to be achieved by 2030 in order to reduce health poverty in all its forms.

Education

Education is fundamental in schools and for kids, as well as for individuals of any age. This is placed as goal number 4 of the SDGs, and the Millennium Development Goal (MDG) of general primary education has been extended with 10 SDG targets tending to all areas of education (WHO, 2015). The fulfillment of fundamental education is additionally generally viewed as basic to education, numeracy and educated citizenship. Households with poorer educational achievement are at great risk of poverty (Hills et al., 2010). Education is firmly connected to better wellbeing. In the literature, negative relationship

amongst poverty and kids' subjective capacities and social-enthusiastic competence has been identified (Mayer, 2002).

Living standards

The literature also demonstrates that individuals living in poverty will probably encounter the vast majority of the types of house quality issues. Low quality housing may make the danger of poverty, or intensify the impacts of poverty, on expectations for everyday comforts and life opportunities (Tunstall et al., 2013). The dominant part of individuals living in developing nations need consumable water in the house, flush toilets, good quality fuel to use, cooking facilities and lighting facilities. They also tend to have less satisfactory and stable house structures, and lack home ownership (Tunstall et al., 2013; Azpitarte, 2010).

The current study

This study fills a gap in the multidimensional poverty literature by establishing that the extreme poverty of the poor regularly depends straightforwardly or in a roundabout way on biological systems and the assorted variety of services they give, as well as uncertain rights of the poor to ecological assets, lacking access to natural data, markets and basic leadership. These factors limit their ability to guarantee the sustainable earth system and enhance their occupations and comfort. Ecological hazard factors represent up to one-fifth of the aggregate weight of ailment in developing nations (WHO, 2009). This is because the complicated connection between human prosperity, environment services and biodiversity requires a coordinated approach including associations between common society, health, education, and wealth and public/private sector.

This study follows the MPI procedures developed by Alkire and Sumer (2013) which offer flexible methods for identifying the poor, severely poor and extremely poor in a two stage approach. The newest income poverty estimates, the 2015 MDGs report (Sachs et al., 2016) and the SDGs for the next 15 years have accelerated discussions in academia and among policy makers in developing countries about the need for measures of poverty that better reflect the multiple dimensions of poverty and deprivation (Sachs et al., 2016). According to the World Bank Global Monitoring Report (2015) in Pakistan, the multidimensional poverty rate in 2013–14 was 44%, while the income based poverty was 13%,

showing noteworthy contrasts in the two methods of measurement.

This study was designed for rural Pakistan, to study the context of multidimensional poverty by increasing the number of dimensions examined, and translating to a micro level, within a region. The study has the following objectives:

1. To develop and improve a methodological framework to measure multidimensional poverty.
2. To measure the extent and severity of poverty at the micro-level in northern Pakistan.

Materials and Methods

Study area

In Pakistan poverty is a long term problem with its incidence at 28%. Levels of poverty vary among the provinces, regions and districts, and also among the groups of the population. Family units headed by uneducated people working in less paid jobs are poorer than households headed by educated people, who tend to have well-paid jobs.

The area of Khyber Pakhtunkhwa comprises 26 districts with various societies and languages, and is the smallest of the four territories of Pakistan in terms of area but the third largest in terms of population. The zone is exceptionally differing, involving the high mountains of the Hindu Kush in the north and the Indus plain in the south. Khyber Pakhtunkhwa has differing environmental frameworks, from the snowy, forest covered mountains to bone-dry reaches. It stretches out from the infertile slopes of the tribal regions to the fertile rural Peshawar valley. The study location comprised four purposively selected districts of the northern areas of Khyber Pakhtunkhwa province of Pakistan (Figure 1): Shangla, Battagram, Kohistan and Tor Ghar. These were selected as they hold the top positions in the poverty and other development indicators of Human Development Index among the 26 districts of the province, and also because 100% of their populations are rural and depend mainly on subsistence farming and associated activities for livelihood. The incidence of poverty in the selected provinces is 38% (Irfan, 2011).

Developing additional dimensions for poverty measurement

This method followed here replaces the traditional unidimensional measure of poverty and generalizes the standards income poverty measures of Foster et al. (1990) which are the poverty gap, squared poverty, and the headcount ratio, by proposing their analogs in a multidimensional setting. Poverty gap, squared poverty, and the headcount ratio are all unidimensional in nature, and make it difficult to identify the poorest of the poor. The method suits the measurement of the multidimensional aspects of poverty as it can incorporate ordinal, discrete and categorical data. It can apply to various units of analysis: the individual, households, and countries. The method essentially takes two steps, (1) identifying who is poor, then (2) incidence, depth of severity of poverty (Alkire and Foster, 2014). This method uses a two cut-off for the identification of the multi-dimensionally poor, i.e. a deprivation cut-off (the level on each dimension of poverty upon which an individual or household is deemed to be 'deprived') and a multidimensional poverty cut-off (verse category), based on the minimum number of dimensions on which a person needs to measure as 'deprived' in order to qualify as multi-dimensionally poor (poverty cut-off) (Alkire and Foster, 2014). Following Alkire and Foster (2011), it measures the deprivation count on each dimension of poverty (deeming an individual as poor, or not-poor, according to a cut-off), then creates an aggregate deprivation value showing how each unit (e.g. person or household) is situated with respect to all of the dimensions of poverty, taken together. This explains that people are identified as poor/not poor on each dimension, using the cut-off (identification step), then an aggregation measure is created which is an overall measure of multi-dimensional poverty (aggregation step).

This investigation depends on the Multidimensional Poverty Index (MPI) approach created by Alkire and Foster (2011), which is based on two major steps; namely identification of the occurrence of being 'poor' (who is poor) on the part of each individual on each dimension, and the aggregate deprivation value of poverty across the multiple dimensions.

Let us consider $i=1,2,3……n$ as the number of households in the selected population, $i=1,2,3……L$ is the multiple dimensions of poverty with the condition that $L \geq 2$, and $j=1,2,3……d$ with a condition that $d \geq L$, be the indicator representing the dimensions. Let y_{ij} represent the achievement of Household i in indicator j in the selected population that $y=[y_{ij}]$ is a $n×d$ matrix of achievements. The row vector y_i has all achievements of household i, while a column

of the aggregate poverty the adjusted headcount or intensity of poverty is used, which considers the extent of deprivation faced by the poor. To overcome this problem, the MPI approach used the intensity of poverty which is measured as the average weighted deprivation faced by the households who fall below poverty line. This is also the fraction of possible dimensions *d* in which the multi-dimensionally poor are deprived.

The MPI measure is the product of two components, i.e. incidence and depth or severity.

$$MPI = H \times A$$

Where;
H= Percentage of people who are poor, or i.e. the share of the population that is multi-dimensionally poor (incidence measure) and *A* = Average percentage of dimensions in which poor people are deprived, i.e. the weighted deprivation share of multidimensionally poor households (severity measure).

The principal segment is known as the multidimensional headcount proportion (H) and it is $H = q/n$, where the *q* is the quantity of households who are multi-dimensionally poor and *n* is the aggregate population, while *A* is the normal deprivation score of the multi-dimensionally poor households;

$$A = \frac{\sum_{i=1}^{n} ci(k)}{q}$$

Here $c_i(k)$ is the censored deprivation score of household *i*, and *q* is the number of households who are multi-dimensionally poor. The *k* value provides the information about the severity and vulnerability of poverty. The aggregate cut-off point lower than the poverty line *k* identifies the poor in severe poverty, while the aggregate cut-off point, slightly lower than *k* provides the headcount ratio vulnerable to poverty. This means that people scoring beyond the first cut-off are classified as in severe poverty, and those between the first and second cut-offs are classified as vulnerable.

Dimensions, indicators and cut–off points
Health, education, and the standards of living are the three dimensions used by researchers such as Alkire and Sumner (2013) and the UNDP (2017) in Human Development Reports, for measuring the extent of multi-dimensional poverty across the world, among the different countries, and within countries. It is very difficult to include particular dimensions and indicators to study and measure poverty, because the choice is difficult as some of the concept is difficult to measure. This study used the MPI 2010 (Alkire and Santos, 2010) criteria for the inclusion of different dimensions and indicators, as these were derived from participatory studies providing value judgments to select capabilities (Alkire and Santos, 2010). This study also includes three other dimensions i.e. participation, environment and wealth in addition to the commonly used health, education, and standards of living. Table 1, present the details of the dimensions, indicators, weights and deprivation cut-offs chosen for this study.

Poverty line
The MPI calculations of Alkire and Santos (2010), Alkire and Foster (2014) adopted a poverty line of 33% of the weighted whole of deprivations, which infers that families confronting hardship of 33% of the weighted aggregate of measurements are viewed as poor people. Since this study included six dimensions, the equivalent figure is 17%, this study involved a preservationist destitution line of 17% of deprivations as shown in Table 1. This implies family units confronting deprivation of 30% or to a greater extent a weighted total of measurements is viewed as poor. Also, this study used separate cut-offs for the measurement of severe poverty and vulnerability. Family units denied in 40% or a greater amount of the weighted totals of measurements are considered extremely poor, while households deprived in 31-39% of the weighted sum of dimensions were considered vulnerable.

Pakistan procedure for data collection and analysis
From each district, 20 households (a combined total of 80) were selected through a staged sampling procedure using Google maps as a sampling frame. First, areas in each district were selected where there had been the highest numbers of development interventions during the past decade, whether from the government or other development organizations. These had varied objectives, from participatory development to poverty reduction. Within these purposefully selected areas. Google maps were used to locate dwellings, and so by dropping pins on random location and selecting the dwelling closed to the pins positions. The unit of analysis was the household, and the household head was interviewed through face-to-face interviews

Results and Discussion

Dimensions and indicators of multidimensional poverty
The descriptive statistics on multi-dimensional poverty on different dimensions and indicators presented in Table 2 show the access of and vice versa of different dimensions and indicators of the households. These dimensions are environment, participation, wealth, health, education and standards of living. The first dimension was the environment one of the pillars of sustainable development and a key to the SDGs. This was measured through indicators of erosion on farms, land degradation, threats of deforestation, and application of farm inputs, availability of irrigation water and adaptive and mitigative measures for climate change. The findings in Table 2 show that the households were deprived according to these indicators and hence this contributes to multidimensional poverty. The perceptions of household of the different indicators of environmental dimensions shows that, it is negatively associated with farm erosion, land degradation, deforestation and adaptive mitigate measure to climate change.

The second dimension of poverty examined was the participation/empowerment of the local population in the development of the area. The indicators were that the HH have the knowledge of any major development program in terms of government or NGO aid in the area and its affect on the HH socio-economic status, awareness about the different development organizations, participation of the HH in a development activity, and also in the management of natural resources. The data about the indication of second dimensions (see Table 2) shows that the HH are mostly deficient in indication of this dimension. The highest probability distribution values (C.V) pointed out that in this dimension the HH having comparatively less access to different participatory development activities in the areas.

The indicators of wealth and assets, the third dimension were land possession, profession, presence of cultivated land, possession of different physical assets, and the possession of livestock among the capital (due to the suitability of the area for the grazing and rearing of livestock). In the area the majority of the population have less than 1 hectare of land. Subsistence farming is the main primary profession, and low holding of physical and natural assets contributes to the poverty in the area.

The fourth dimension of the health status, higher ill health from the normal one for the total population in Pakistan reported in the literature, as well as higher disability indicators (Hyder and Marrow, 2000). The PDMA (2016) report shows that in the Khyber Pakhtunkhwa there were 112000 disabled people, amongst whom 66000 were physically disabled. The ratio was higher in the area selected for this study due to the high magnitude earthquake of 2005, followed by the flood of 2010 and other natural disasters in the area. Access to the different health services in the area was also insufficient due to its dispersed settlements and the reduced availability of physical and human assets for the provision of these services.

The indicators for the fifth dimension, education, were literacy status, educational achievement and children's enrollment in schools. According to Haq (2015) the literacy rate in Pakistan was 85% while in Khyber Pakhtunkhwa it was 35%. According to the estimate of the UNSD (2016), among the total population of Pakistan 60.4% are aged between 15-64 years, so if this proportion of population in Khyber Pakhtunkhwa has missed out on education due to teacher shortages, absenteeism, poor school environments, shortage of nearby schools, poor teaching quality, family poverty, insecurity, natural disasters and other factors, this leads to multidimensional poverty. Moreover, 35.4% of the total Pakistan population is under 15 years of age, and anyone not enrolling in school between the ages of 5-14 years might be adding to the future poverty in the area.

The sixth dimension of the MPI, the standards of living, was measured using 7 indicators of housing poverty. The results show that half of the population lacked their own home due to tenancy/subsistence farming, and had poor access to potable drinking water, lacked flush toilets, used wood as a cooking fuel, had inadequate cooking facilities, lacked suitable lighting facilities and had a mud or soil floor. Thus, the above situation constitutes a situation of poverty, and if this continues the SDG's objectives will not be achieved.

Overall the reasons for the multidimensional poverty are manifold and particularly the dimension of environment and wealth contributes to it and hence creates a challenge for the different sustainable development goals in the area.

Measurement results of multidimensional poverty
The results of the multidimensional poverty index suggest that there is severe poverty in the study area,

findings of Jamal (2009), who used three dimensions (human poverty, poor housing, and economic and HH assets poverty) with 16 indicators of poverty while studying secondary data of the 2004-2005 and 2008-2009 Pakistan Social and Living Standards Measurement (PSLM) surveys. He found that in the province of Khyber Pakhtunkhwa overall, non-income multidimensional poverty was 56.10% while that of rural residents was 60.00%. According to the finding of Jamal (2009) regarding the proportion of residents that are multi-dimensionally poor in the selected districts: Shangla (76.50%), Battagram (48.81%), Kohistan (95.53%), and Torghar (65%) confirmed our finding in Table 3 for the study area. Thus, it was confirmed that there is severe poverty in the region, and the slight difference in the value of MPI and the percentages of the population in poverty may be due to the increased number of dimensions and indicators in this study coupled with the use of primary, more recent, data for this analysis.

Causes of multidimensional poverty

The survey asked the respondents opinions on four possible regional and resource related causes of poverty: the isolation and remoteness of the area, lack of infrastructure, poor access to markets and poor access to social and communal services (Table 4). Among the regional causes poor access to social and communal services was the most important reason followed by lack of infrastructure and poor access to markets. This was mainly because in the whole area there are 100 % scattered population with little or no access to services. The chi- square values are significant with respect to three of the four regional characteristics, isolation (36.70), infrastructure (21.93), and poor access to social and communal services (75.03). The

resource causes include lack of cultivated land, land degradation, weather and environmental conditions. The Chi-square values are significant with respect to two resource of multi-dimensional poverty causes; i.e. lack of cultivated land and weather condition. Land degradation was the most important reason of resource causes of multi-dimential poverty while the environmental and weather conditions also contributed to this end. This is because that the quality of land was degraded very severely in the last few years due to a flood, an earthquake, and thunderstorms in the area.

Table 3: *Incidence and Intensity of Multidimensional Poverty, by district (n=80).*

District name	Headcount ratio (H)	Inten-sity (A)	MPI	Poor HH	Vulnera-ble HH	Severely poor HH
Shangla	1	0.54	0.54	0	0	20
Battagram	1	0.59	0.59	0	0	20
Kohistan	1	0.48	0.48	0	0	20
Torgher	0.95	0.58	0.57	0	1	19
Average	0.99	0.55	0.54	0	0.25	19.75

Source: *Field data and statistical analysis.*

Conclusions and Recommendations

The extreme poverty of the poor regularly depends straightforwardly or in a roundabout way on biological systems and the decent variety of services they give, and additionally questionable privileges of the poor to natural assets, markets and decision-making. This study expands the range of dimensions used in a MPI, and tests the approach in rural Pakistan. All six dimensions of multidimensional poverty were observed, i.e. environment, empowerment/participation, wealth, health, education and standards

Table 4: *Multidimensional poverty causes.*

| Regional Causes	Very high (%)	High (%)	Moder-ate (%)	Not an-swer (%)	S. Dev.	Vari-ance	C.V	Rank	Chi-Square	P-val-ue
Isolation/remoteness	(47)	(35.0)	(11)	(6.3)	0.89	0.79	50.46	4	36.70	<0.001
Less infrastructure	(47)	(44)	(9)	(0.00)	0.64	0.42	40.07	2	21.93	<0.001
Poor access to market	(25)	(26)	(31)	(18)	1.05	0.10	43.60	3	3.10	0.3765
Poor access to social and communal services	(2)	(78)	(0)	(1.3)	0.48	0.23	26.47	1	75.03	<0.001
Resource Causes										
Lack of cultivated land	(51)	(41)	(8)	0 (0.00)	0.63	0.40	40.53	4	25.23	<0.001
Degraded quality of land	(21)	(49)	(30)	(0.00)	0.72	0.51	34.25	1	9.48	0.0088
Weather conditions i.e. drought and monsoon	(46)	(29)	(16)	(8.8)	0.99	0.97	52.57	2	25.80	<0.001
Environmental conditions (Earth quake and flood)	(40)	(45)	(15)	(0.00)	0.70	0.49	40.15	3	12.40	0.0020

Source: *Field data.*

Links Researchers
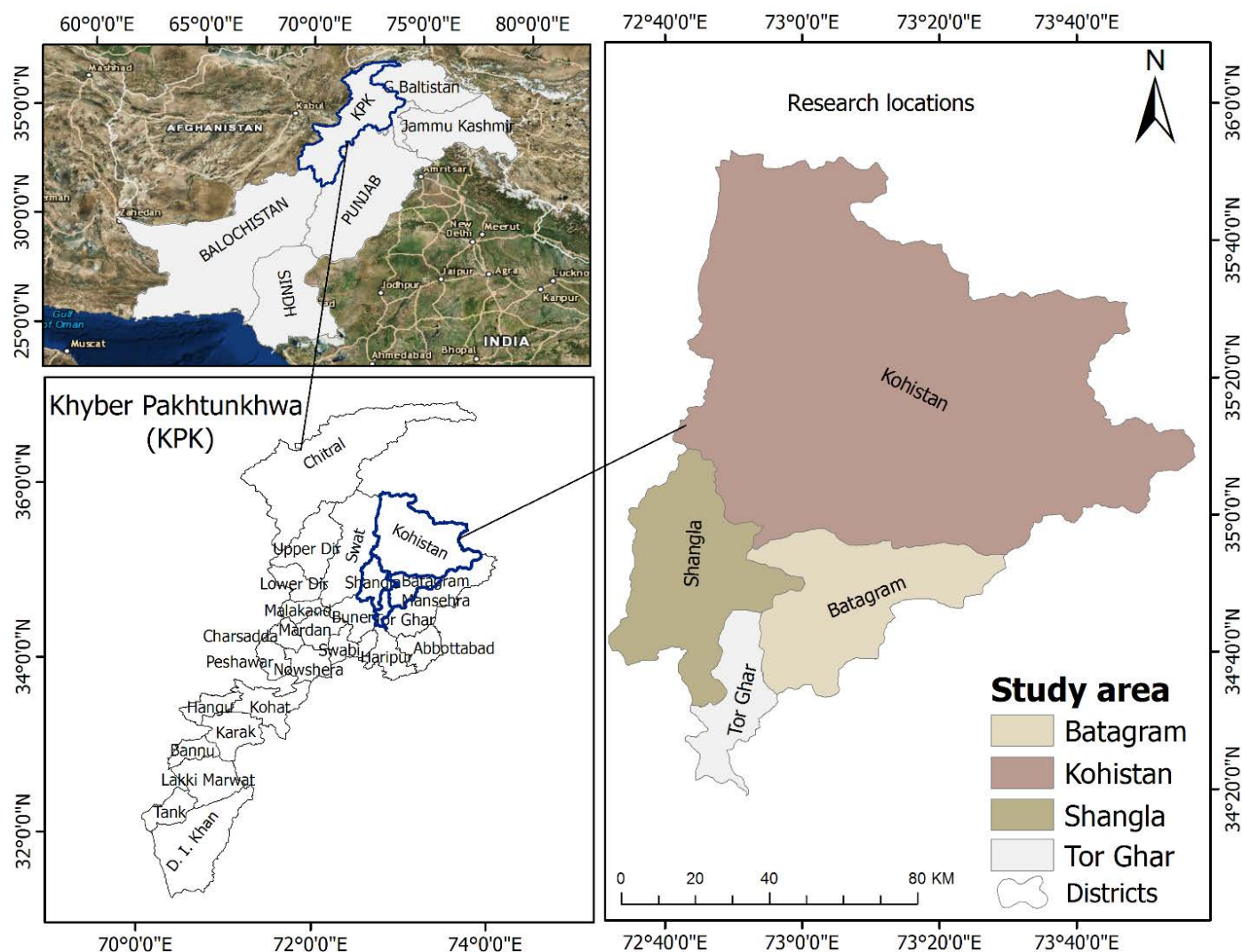
Figure 1: *Map of Pakistan and Khyber Pakhtunkhwa showing the research locations*
Source: adapted from Google base maps.

vector y_j is the distribution vector of dimensions j for each household. A household has different levels of achievement over the dimensions, ranging from minimum to maximum values. In this situation, there is a need for a cut-off point to decide which households are deprived in a particular dimension. When the household's achievement is below the cut-off point, that household is declared as deprived (verse)/poor on that dimension. More than one cut-off may be used, for instance to differentiate households considered as deprived or multi-dimensional poor.

Let us also consider that Z_j be the specific predetermined poverty thresholds below which a household is measuring as poor destitute in the j, where z is a $(1×d)$ vector of the poverty threshold. Let w_j denote the weight suggesting the relative importance of indicator j with the condition that $(w_j>0)$, such that $(\Sigma^d_{j=1} w_j=dI)$; w is a $(1×d)$ matrix of weighting. If a household is deprived in the indicator j, so that $(y_{ij}<z_j)$

only a matrix of deprivation g is constructed by using this identification function i.e. $g^o = [g_{ij}]$ denotes the $(n×d)$ deprivation matrix. This implies that $g^o_{ij} =1$, if $y_{ij} \le z$ and $g^o_{ij} =0$, if $y_{ij} > z$. Let c_i $(0 \le c_i \le d)$ present the sum of weights for the indicators in which the household i is poor. This is the submission of all the entries in the ith row of g^o and is the $(n×1)$ matrix of deprivation counts. The vector c is simply multiplied with the vector of weights associated with each dimension. Households will be identified as multi-dimensionally poor if $c^0_i \ge k$, where k $(0 < k \le d)$ specifies the second cut-off for the measurement of household poverty.

Identification of the proportion of poor within the population uses the 'head count ratio' H. This is the extent of populace that falls underneath the poverty line selected through the cut-offs that is the poor or the deprived, poor plus the deprived. $H=H (y, z)$ such that $H=q/n$, where $q(y, z)$ is the number of all poor households in the population z_k. For the measure

Table 2: *Descriptive statistics on dimensions and indicators of multidimensional poverty.*

Dimensions (Weight)	Indicators	HH having access/ possession (%)	HH having no access/ posses-sion (%)	Mean of person	St. Dev.	Vari-ance	Co-effi-cient of variation
Environment	Erosion on farm plot during last 5 years	(43.75)	(56.25)	0.44	0.49	0.25	114.1
	Land degraded during the last 5 years	(11.25)	(88.75)	0.89	0.32	0.10	35.83
	Deforestation faced in the area	(42.50)	(57.50)	0.43	0.49	0.25	117.7
	Farm inputs applied during for each seasons crop	(40.00)	(60.00)	0.40	0.49	0.24	123.3
	Irrigation water available	(22.50)	(77.50)	0.34	0.84	0.70	249.2
	Adoptive and mitigative measure for climate change taken	(16.25)	(83.75)	0.16	0.37	0.14	228.5
Participation in/ Empowerment	Major development in felt in the area	(66.25)	(33.75)	0.63	0.48	0.23	71.82
	Major changes affect on socio-economic status of the HH	(67.50)	(32.50)	0.68	0.47	0.22	69.83
	Awareness about the development organizations working in the area	(50.00)	(50.00)	0.50	0.50	0.53	100.6
	Whether ever participated in development activities in the last 5 years	(10.00)	(90.00)	0.10	0.30	0.09	301.9
	Current participation	(5.00)	(95.00)	0.05	0.22	0.05	438.7
	Participation in NRM activities	(22.50)	(77.50)	0.23	0.42	0.18	186.8
Wealth	Land possession	(56.25)	(43.75)	0.56	0.49	0.25	88.75
	Profession	(37.50)	(62.50)	2.70	2.38	5.68	88.28
	Cultivated land	(45.00)	(55.00)	0.13	0.33	0.11	266.2
	HH physical assets	(58.75)	(41.25)	0.45	0.50	0.25	91.02
	HH natural assets(livestock)	(61.25)	(38.75)	0.61	0.49	0.24	80.04
Health	Long-term ill person in household	(85.00)	(15.00)	0.15	0.36	0.13	239.6
	Disabled person in household	(77.50)	(22.50)	0.23	0.42	0.18	186.8
	Access to health care services	(36.30)	(63.80)	0.38	0.49	0.24	126.5
	Access to maternal health services	(38.75)	(61.25)	0.36	0.84	0.23	133.5
	Children death	(67.50)	(32.50)	0.33	0.47	0.22	0.22
Education	Literacy status	(53.75)	(46.25)	2.71	1.30	1.70	48.08
	Educational achievement	(33.75)	(66.25)	0.34	0.48	0.23	140.9
	Status of children enrolment	(62.50)	(37.50)	0.63	0.49	0.23	77.95
Standard of living	Potable water availability	(43.75)	(56.25)	2.55	1.78	3.16	69.73
	Availability of flash toilet	(16.25)	(83.75)	3.04	2.34	2.34	50.36
	Fuel used for cooking	(18.75)	(81.25)	2.86	2.80	2.80	58.49
	House ownership	(58.75)	(42.25)	2.39	3.30	3.30	76.13
	Cooking place	(37.50)	(62.50)	2.96	1.60	1.60	42.78
	Lighting facilities	(30.00)	(70.00)	2.25	1.55	1.55	55.46
	Types of floor	(43.75)	(56.25)	1.92	0.73	0.73	44.34

Source: *Field data.*

across all six dimensions. The households were severely poor in terms of participation/empowerment, environment, and wealth, in addition to health, education, and living standards. The head count ratio (showing incidence of multidimensional poverty) suggests that all of the population is living below the poverty line, and results in this regard were almost the same in all the districts. The measure of intensity of the poverty implies that 55% of the population is severely poor, and thus according to the MPI value (as presented in Table 3), 54% of the population was severely poor. These findings are in line with the

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Table 1: *Dimensions, indicators, weights, and deprivation cut-off of multiple-dimensional poverty.*

Dimensions (Weight)	Indicators	Weight	Depravation cutoff
Environment (0.167)	Erosion on farm plot during last 5 years	0.278	Deprived if reported erosion
	Land degraded during the last 5 years	0.278	Deprived if land degraded
	Deforestation faced in the area	0.278	Deprived if deforestation reported
	Farm inputs applied during this season	0.278	Deprived if inputs not applied
	Irrigation water available	0.278	Deprived if irrigation water not available
	Adoptive and mitigative measure for climate change taken	0.278	Deprived if not taken any measure for climate change
Participation/em-powerment (0.167)	Government or NGO Aid programs, projects or activities in the area	0.278	Deprived if not reporting major development pro-grammes
	Changes affect socio-economic status of the HH	0.278	Deprived if not reporting changes affecting HH
	Knowledge about the rural poverty or environment developmental programme	0.278	Deprived if not aware about the poverty reduction or environmental degradation prevention program
	Whether ever participated in develop-ment activities in the last 5 years	0.278	Deprived if had not participated in development activities
	Current participation	0.278	Deprived if not currently participating
	Participation in NRM activities	0.278	Deprived if had not participated in NRM activities
Wealth/Assets (0.167)	Land possession	0.033	Deprived if having no land
	Profession	0.033	Deprived if unemployed or a domestic worker
	Cultivated land	0.033	Deprived if having no cultivable land
	HH physical assets	0.033	Deprived if having no car, sewing machine, fridge, radio
	Livestock	0.033	Deprived if having no livestock of any kind
Health (0.167)	Long-term ill person in household	0.033	Household having one or more ill members for more than three weeks is deprived
	Disabled person in household	0.033	Deprived if having one or more members with a dis-ability, irrespective of its type
	Access to health care services	0.033	Deprived of this indicator if its take more than 45 minutes to reach the nearest public/private hospital for treatment
	Access to maternal health services	0.033	Deprived if the mother was not medically examined two times in the pre and postnatal stage of pregnancy.
	Child deaths	0.033	Deprived if one or more children died in the last five years
Education (0.167)	Literacy status	0.056	Deprived on this indicator if the heads are illiterate
	Educational achievement	0.056	Deprived on this indicator if none of its members attained primary, secondary or further education
	Status of children's school enrolment	0.056	The household is declared deprived if any child of age 5-14 is not enrolled in any school
Standard of living (0.167)	Potable water availability	0.024	Deprived if having no access to potable water
	Availability of toilet	0.024	Deprived if there is no toilet in their home
	Fuel used for cooking	0.024	Households using solid fuel i.e. wood, dung, char-coal and crop residue are deprived
	House ownership	0.024	Deprived if not having own house
	Kitchen availability	0.024	Deprived if kitchen is not available
	Lighting facilities	0.024	Deprived if electricity and gas are not light sources
	Types of floor	0.024	Deprived if the floor is made of mud and stones

Source: *Field data.*

method. A questionnaire with both closed and open-ended questions, covering the six dimensions of multi-dimensional poverty chosen for this study and indicators for each, and some personal variables, was designed and pilot tested. The data were analyzed by using descriptive statistics, parametric and non-parametric tests, and the Alkire-Foster (2011) method for multidimensional poverty measurement assessment (see above).

of living. However, the dimensions of environment, empowerment, and wealth were where the most severe poverty was found. The head count ratio (incidence of poverty) suggested that all of the population was living below the poverty line, while the severity index showed that 55% of the population was severely poor. The causes of this poverty include the isolation and remoteness of the area, low-quality infrastructure, poor access to markets and to social and communal services. Therefore, we believe these three dimensions also need to be included in the measurements of multidimensional poverty due to their contribution as causes of poverty in one way or the other and also due to their important role in the sustainable development process. Thus, it is a great challenge for the officials and policymakers in Pakistan and at international organizations to achieve the targets of the Sustainable Development Goals of the UN to overcome this multi-dimensional poverty.

Acknowledgements

Novelty Statement

This study contributed to the expanded dimensions of multidimensional poverty in terms of wealth status, participation/empowerment, environment, health, education, and standard of living in the context of farm level households in northern rural Pakistan as implication for sustainable development.

Author's Contribution

Muhammad Israr: Conceived the idea and wrote the paper.
Helen Ross: Supervised the overall research.
Shakeel Ahmad: Helped in designing and formatting of figures.
Nafees Ahmad: Helped in the data collection.
Urooba Pervaiz: Contributed to the theoretical background.

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