/DWULQH 8WLOL]DWLRQ DQG $VVRFLDWHG)DFWH
'LVWULFWHVVRU(WKLRSLD

&KDQLH*HGHIDZ DQG .HWHPD .

'HEUH 0DUNRV 8QLYHUVLW\ 'HEUH 0DUNRV (WKLRSLD

&RUUHVSRQGLQJ DXWKRU 7HQDZ &KDQLH 'HEUH 0DUNRV 8QLYHUVLWWHQDZF#ODRR FRPKLRSLD 7HO

5HFHLYHG GDWH 2FWREHU   2FWREHU SHUWHG GDWH OQWKHGH GDWH

&RS\ULJKW &KDQLH 7 HW DO 7KLV LV DQ RSHQ DFFHVV DUWLFOH GLVWULEXWHG XQGHU WKH WHUPV R
XVH GLVWULEXWLRQ DQG UHSURGXFWLRQ LQ DQ\ PHGLXP SURYLGHG WKH RULJLQDO DXWKRU DQG VRXU

$EVWUDFW

%DFNJURXQGG3URSRVHDO RI KXPDQ H[FUHWD UHPDLQV D FKDOOHQJH HVSHFLDOO\ LQ
(WKLRSLD $ERXW   RI WKH GLVHDVH EXUGHQ LV UHODWHG WR SRRU VDQLWDWLRQ
FKDOOHQJHV KHDOWK H[WHQVLRQ SURJUDP KDV EHHQ ZLGHO\ LPSOHPHQWHG ORQJ
ZDV KLJKHU EXW LWV XWLOL]DWLRQ UHPDLQHG ORZHU /HYHO RI ODWULQH XWLOL
RI WKH VWXG\ DUHD ZHUH QRW NQRZQ 7KHUHIRUH   HYLGHQFH ZHUH UHTXLUHG
XWLOL]DWLRQ LQ WKH VWXG\ DUHD

2EMHFWLYH ѐ°G\ ѐ°V @WKH•WK` `0 @WKE•€ðPWKÐ 0p°WULQH PWKÀðÀÐ @pÀ 0 @WK
XWLOL]DWLRQ LQ WKH GLVWULFW ZHUH WKH IROORZLQJ

  &OHDQ ODWULQH IDFOLLW\ $25   &, >   @ EDG ODWULQH IDFOLLW\ $
FKLOGUHQ LQ WKH KRXVHKROG $25   &, >   @   WUDGLWLRQDO KDW ODW
DQG DJH RI IDPLOLHV $25   &, >   @

&RQFOXVLRQ DQG UHFRPPHQGDWLRQ /DWULQH XWLOL]DWLRQ LQ WKH VWXG\ D
     LQ 0'*V 1RW DOO FRQVWUXFWHG ODWULQH IDFOLLWLHV ZHUH XVHG)DFWRUV
ODWULQH IDFOLLWLHV VWLOO QHHG DGGLWLRQDO HIIRUWV +HDOWK HGXFDWLRQ
EHKDYLRUDO FKDQJH FRPPXQLFDWLRQ DQG JRRG VWDWXV DQG FOHDQOLQHVV RI

.H\ZRUG&/HDQOLQHVV %DGQHVV   3UHVVHMHQFHV\XRLOOROHROGGHDQG,PSDUWYHUSRXHGHM[FU
ODWULQH $JH RI IDPLOLHV

,QWURGXFWLRQ

3LW ODWULQHV DUH RQH RI WKH PRVW FRPPRQ KXPDQ H[FUHWD GLVSRVDO
V\VWHPV LQ ORZ LQFRPH FRXQWULHV DQGERWKHU XVHV LV RQ WKH ULVH DV ZHOO
FRXQWULHV DLP WR PHHW WKH VDQLWDWLRQ FUHODWHG WDUJHW RI WKH 0LOOG
'HYHORSPHQW *RDOV $ERXW   RI WKH GLVHDVHV EXUGHQ LV SHRSOH WR SUDFWLFH
SRRU VDQLWDWLRQ DQG K\JLHQH LQ WKH FRXQWU\ WUDQVPLHGLRUQGRVHEXUGHQ
SRWHQWLDOO\ WUDQVPLWWHG IURP DQ ZLWK D SRRU ZDWHU VDQLWDWLRQ DQG K\
YDULRXV URXWHV LQYROYLQJ H[FUHWH > @ RI DOO GHDWKV DQG   RI WRWDO

3RRU H[FUHWD GLVSRVDO SUDFWLFHEHQDODWH SKRHLGSHRQWLHFOHKLRJIHODRVLV $PRHEL
SURSRUWLRQ RI WKH ZRUOG V LQIHFWLRQRXU \GLFRVHPDVRH DEXG GHULRXQGLOWWKH
LQHUUXSW WKH WUDQVPLVVLRQ RI IHFFRPRUDOO GLVHDVHYHDWHERQ\V VXPRHOODWSURUW
VRXUFH E\ SUHYHQWLQJ KXPDQ IHFDO FSURQWDPLQDWLRQ PDGHHDLWHQH UHDGXFLVRO FK>@G

+XPDQ H[FUHWD DUH WKH VRXUFH RI PDQ*LQWHFWLRXV GLVHDVHV DJHEHW OLYH
D UHVXOWGHGRLSHSORDWLRQ SUDFWLFHV KXPDQ H[FUHWD FRQWDPLQDWH

GLDUUKHDO GLVHDVHV UHVSLUDW WXRSUREOHPV DQG PDOQXWULWLRQ
ZHHN SUHYDOHQFH RI GLDUUKHDO GLVHDVHV ZDV   DPRQJ FKLOGUHQ XQGHU
}YⁱHHDUV RI DJH > @

    2YHU   LQIHFWLRQV DUH SRWHQWLDOO\ WUDQVPLWWHG IURP DQ LQIHFWHG
SHUVRQ WR D KHDOWK\ RQH E\ YDULRXV URXWHV LQYROYLQJ H[FUHWD :RUOG
ZLGH   ODFN RI VDQLWDWLRQ UHVXⁱHFWD VHULRXV KHDOWK SUREOHP ,W
ELOOLRQV RI SHRSOH HVSHFLDOO\ WKH SRRU > @ /DFN RI VDQLWDWLRQ FRPSHO
SHRSOH WR SUDFWLFH RSHQ GHIHFDWLRQ ZKLFK LQFUHDVHV WUDQVPLW LRQ RI
GLVHDVHV > @ $ERXW   PLOOLRQ SHRSOH GLH HYHU\ \HDU GXH WR GLDUUKHDO
GLVHDVHV RI ZKLⁱFⁱKLOGⁱUXⁱHQGⁱHU@

    ,Q $IULFD   SRSXODWLRQ KDV DFFHVV WR LPSURYH VDQLWDWLRQ IDFLOLW\
EXW   RI WKH SRSXODWLRQ KDV QRW DFFHVV WR LPSURYHG VDQLWDWLRQ ,Q
RWKHU ZRUGV   RI UXUDO DUHDV LQ GHYHORSLQJ FRXQWU\ KDV DFFHVV WR
LPSURYH VDQLWDWLRQ IDFLOLW\ ZKHUH DV   KDV QRW > @ ,Q 6XE 6DKDUDQ

3RSXODWLRQ

6RXUFH SRS%ODWLRQ KROGV ZLWK ODWULQH IDFLOLWLHV LQ WKH UXUDO FRPPXQLWLHV RI $QHGHG 'LVWULFW

6WXG\ SRSXODWLRQ KRXVHKROGV ZLWK ODWULQH IDFLOLWLHV LQ WKH }YHVHOHFWHG NHEHOHV RI UXUDO FRPPXQLWLHV LQ $QHGHG GLVWULFW ZHUH LQFOXGHG LQ WKH VWXG\

,QFOXVLRQ FULWHULD

$OO KRXVHKROGV ZLWK WKHLU RZQ IXQFWLRQDO ODWULQH IDFLOLW\ DW WKH W... RI GDWD FROOHFWLRQ

6DPSOH VL]H

H UHTXLUHG VDPSOH ZDV FDOFXODWHG XVLQJ SRSXODWLRQ SURSRUWLRQ IRUPXOD ZLWK DVVXPSWLRQ RI S YDOXH WR PD[LPL]H VDPSOH VL]H DQG PDUJLQDO HUURU Z D VWDQGDUG = VFRUH RI   FRUUHVSRQGLQJ WR FRQ}GHLOQFHOWHHYUYDO +DVHRWRGHVLZQLFK FRXOG EH GHWHUPLQHG E\ LWV RZQ IRUPXOD RU QXPEHU RI VWDJHV EXW LQ WKLV VWXG\ LV...

H H[SHULHQFH IURP SUH WHLWWKDLVHUDHZBDUVFKDUHG WR
WRROV

'DWD SURFHVVLQJ DQG DQDO\VLV

'DWD ZDV FOHDQHG FRGHG DQG HQWHUHG E\ XVLQJ (SL GDWD Y   DQG
H[SRUWHG WR VSVV YHUVLRQ   'HVFULSWLYH VXPPDU\ XVLQJ IUHTXHQFLHV
SHUFHQWDJHV JUDSKV PHDQ DQG VWDQGDUG GHYLDWLRQ ZHUH XVHG IRU VRFLR
GHPRJUDSKLF DQG RWKHU UHOHYDQW YDULDEOHV

'DWD ZDV FRPS\OOHPDQDQGHG XVLQJ ELQDU\ DQG
PXOWLYDULDEOH ORJLVWLF UHJUHVVLRQ PRGHO %LQDU\ ORJLVWLF UHJUHVVLRQ
GRQH IRU &25 DQG PXOWLSOH ORJLVWLF UHJUHVVLRQ ZDV DSSOLHG WR FDOFXOD
$25 IRU YDULDEOHV WKDWH FHUWGWKDQS YDOOXXHVWHG
RGGV UDWLRV ZLWK WKFRLRQ}FROOHWHUSYROOGVLQHHU
FRPSXWHG $ S YDOXH   ZDV FRQVLGHUHG WR GHFODUH D VWDWLVWLFDOO\
VLJQL}DDQWRFLDWLRQ ZLWK GHSHQGHQW DQG VHOHFWHG LQGHSHQGHQW
YDULDEOHHUHVXOWV ZHUH SUHVHQWHG LQ WH[W DQG WDEOHV EDVHG RQ WKH
W\SH RI GDWD

(WKLFDO FRQVLGHUDWLRQ

(WKLFDO FOHDUDQFH ZDV REWDLQHG IURP WKH LQVWLWXWLRQDO UHVHDUFK

$ S U

$ X J

!

' R P H V W L F D Q L P D O V W \ S H

< H V

1 R

: K L F K G R P H V W L F D Q L P D O V   Q

7DEOH /DWULQH FRQGLWLRQ DQG IHFHV GLVSRVDO FKDUDFWHULVWLFV RI UHVSRQGHQWV LQ UXUDO FRPPXQLW\ RI $QHGHG 'LVWULFW $PKDUD 1RUWKZHVW (WKLRSLD

6RFLR FXOWXUDO &KDUDFWHULVWLFV

0DMRULW\ RI KRXVHKROGV FODLPHG WKDW ERWK PDOH DQG IHPDOH FDQ XWLOL]H WKH VDPH ODWULQH WRJHWKHU 6LPLODUO\ RI KHDG RI KRXVHKROGV UHVSRQGHG WKDW IHPDOHV DUH DOORZHG WR GHIHFDWH GD\ WLPH

%HKDYLRUDO DQG (QYLURQPHQWDO)DFWRUV

0DMRULW\ RI KHDG RI KRXVHKROGV FODLPHG WR ZDVK WKHLU KDQGV EHIRUH HDWLQJ 2I WKHVH DQG ZDVKHG DVH FOHDQLQJ RI FKLOGUHQ DQG DW WKH IRXU FULWLFDO WLPHV UHVSHFWLYHO\ UHKXXQG\VHGRXVHKROGV OLYHG QHDU WR KHDOWK FHQWHU ZLWK D GLVWDQFH RI EHORZ NPV 6RPH RI WKH KRXVHKROGV KDG ZDWHU ZHOO 2I WKHVH ZHOOV ZHUH FRQVWUXFWHG DERYH P GLVWDQFH IURP ODWULQH IDFLOLW\ 7DEOH

(QYLURQPHQWDO IDFWRUV		1XPEHU	3HUFHQW
'LVWDQFH EHWZHHQ %HORZKHDOWK NP FHQWHU DQG YLOODJH	%HWZHHQ NP		
	$ERYH NP		
'LVWDQFH EHWZHHQ %HORZ NP KHDOWK SRVW DQG YLOODJH	%HWZHHQ NP		
	$ERYH NP		
+DYLQJ ZDWHU FRPSRXQG	ZHOO LQ		

7UDGLWLRQDO KDW

LVVWXG\ DOVR UHYHDOHG WKDW KRXVHKROGV ZLWK IDPLO\ PHPEHUV RI
DJH YHDQG DERYH \HDUV ZHUH   IROG KLJKHU WR XWLOL]H ODWULQH DV
FRPSDUHG WR IDPLO\ PHPEHUYYHDWLWK DJH RI WZR XS WR
FRXOG EH DWWULEXWHG WR OHDUQLQJ IURP H[SHULHQFH WDNLQJ WKH KLJKHU
UHVSRQVLELOLW\ RI LPSOHPHQWLQJ GXWLHV DQG UHVSRQVLELOLWLHV DQG PDWX
WR OHDUQ P0R